Monitoring Report

United Nations Framework Convention on Climate Change (UNFCCC)

Clean Development Mechanism (CDM)

Project Title:

18 MW Natural Gas based community power plant and 2 MW Waste Heat Recovery system

UNFCCC Ref. No.: **1912**
Monitoring period: 03/11/2008 – 21/11/2009
(inclusive of starting & ending days)
For initial & first periodic verification
Version: 01
Date: 12/May/2010

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1. Purpose of the report

This monitoring report has been prepared for the purpose of independent verification of the Green House Gas (GHG) emission reductions achieved by OPG Energy Pvt. Ltd.'s (referred to as OPG hereinafter) Clean Development Mechanism project titled "18 MW Natural Gas based community power plant and 2 MW Waste Heat Recovery system" during the period "03 November 2008 to 21 November 2009" (inclusive of starting and ending days). This monitoring report is for the initial and first periodic verification of the project.

2. General aspects of the project activity during this monitoring period

The project activity involves the usage of natural gas fuelled Internal Combustion (IC) engine technology against other emission intensive economical options available. The power project has been developed as a CDM project activity to improve its feasibility and assist OPG in its successful long term operation. The power plant includes three IC engines, each of 5.993 MW (total rated capacity 17.979 MW) integrated with a Waste Heat Recovery (WHR) system of 1.7 MW rated capacity. The total capacity of the natural gas based power plant is 20 MW (19.679 MW exactly).

The ownership of the project activity has remained the same since registration of the project activity. There has been no emergency incident occurred during the first monitoring period, hence there is no impact on the Certified Emission Reductions (CERs).

Crediting period

The project has been registered as a CDM project activity by the United Nations Framework Convention on Climate Change on 03, November, 2008 under the Reference No.: **1912**, thus commencing its crediting period. The project activity follows a fixed crediting period of 10 years starting from the date of registration: 03, November 2008 extending up to 02, November 2018. The first monitoring period has been taken for the period from 03, November 2008 to 21, November 2009. The reason why the project proponent has decided to extend the first monitoring period till 21, November 2009 is to match with the TNEB (part of the Southern Regional grid) monthly generation statement cycle.

Project location

The project activity is located at Maruthur Village, Mayiladuthurai Taluk - Nagapattinam District in the Indian state of TamilNadu. The site is located at Latitude 11º 01' 00'' North and Longitude 79º 35' 00'' East. The nearest major town is Mayiladuthurai about 12 Km from the site and the nearest railway station is Kuttalam (8 Km south). The nearest highway is Kumbakkonam – Mayavaram at a distance of about 4 km from the site.

Methodology applied:

The project activity employed the methodology AM0029 titled "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas", version 01.1, as indicated in the registered PDD available on the UNFCCC website (site: http://cdm.unfccc.int/Projects/DB/RWTUV1214906505.17/view). We have generated this monitoring report based on the monitoring plan outlined in registered PDD which would be in accordance with AM0029, version 01.1 methodology.

Technical details of the project activity:

Technology employed

The gas engine system is the major component of the project activity. The gas engine employed is a four stroke spark-ignited gas engine that works according to the Otto process and the lean-burn principle. The engine runs at 750 rpm and produces 5.993 MW in an 18-cylinder configuration. The engine gives a high thermal efficiency and is a reliable and low-pollution power source for small to medium sized power plants. The expected power generation at site conditions and available gas quality is 5.769 MW per engine (total 17.307 MW).

Present status of the project activity:

The project activity is currently employing three reciprocating internal combustion gas engines, each of capacity 5.993 MW resulting in a total installed capacity of 17.979 MW. The natural gas requirement for the project activity is sourced through Gas Authority of India Limited (GAIL) from the Kuttalam gas field located at a distance of 6 km from the project site and transported through pipelines. The power export to the TNEB grid is through the nearby substation located 12 kms from the project site after stepping it up to 110 kV. The waste heat recovery system in the steam turbine plant, due to a major breakdown of the steam turbine rotor and its casing, has not been operational and will not contribute to the total emission reductions for this monitoring period.

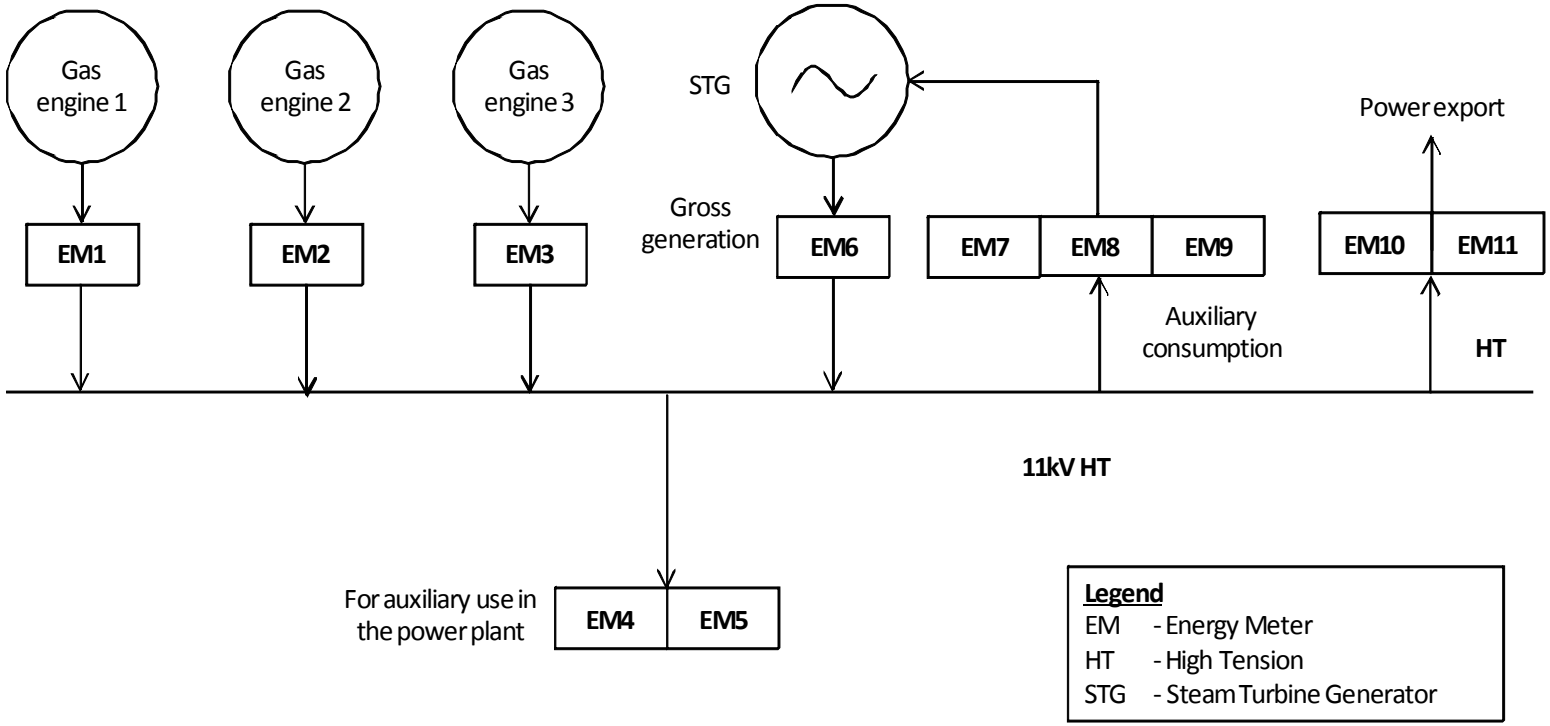
The downtime of the plant was 875.54 hours (or) 875 hours, 32 minutes and 24 seconds due to various forced, scheduled and deemed outages. The details of the same are provided in Annex 1.

3. Sustainable development aspects of the project activity

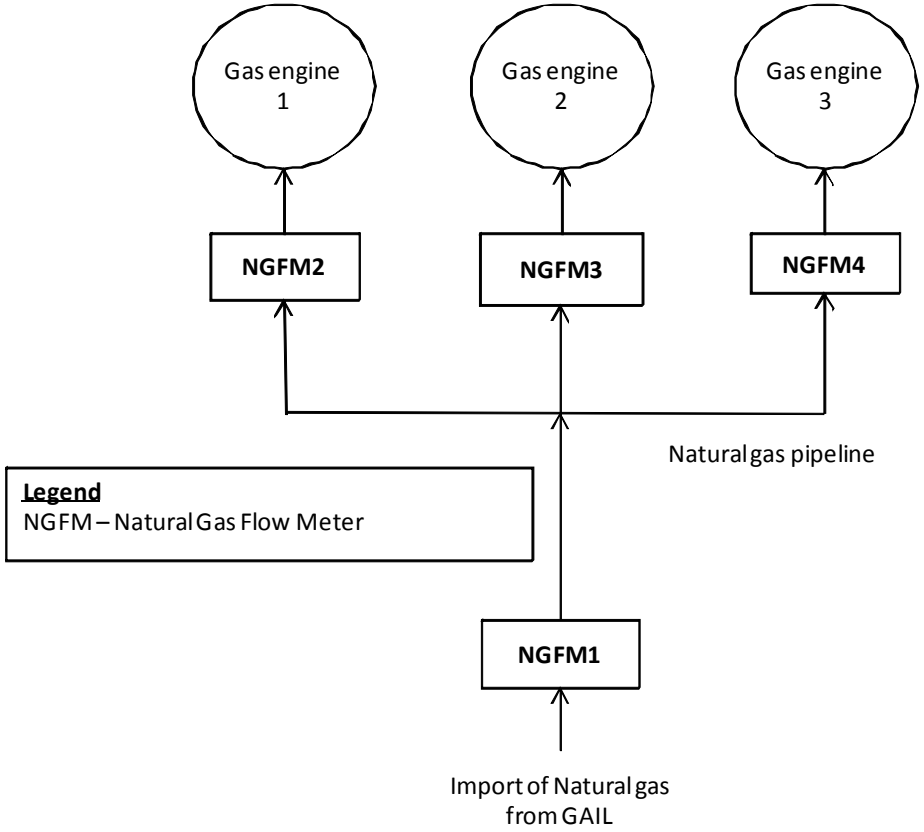
The project activity contributes to sustainable development in ways as described in the registered PDD. The project activity employs clean fuel for the generation of energy and promotes direct and indirect sources of employment.

4. Monitored parameters, calibration details and monitoring procedures

4.1. Electricity Monitoring Diagram:



4.2. Fuel (Natural Gas) Monitoring Diagram:



4.3. Details of Energy meters:

ID	Parameter	Equipment Name	Location	Serial No.	Make	Model No.	Accuracy class	CT / PT Range	Unit	Recording frequency
EM1	**Energy**	GE1[1] Energy Meter	Control room	12016	Vamp	Vamp	±0.5%	500/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM2	**Energy**	GE2 Energy Meter	Control room	12015	Vamp	Vamp 260	±0.5%	500/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM3	**Energy**	GE3 Energy Meter	Control room	011033	Vamp	Vamp 260	±0.5%	500/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM4	**Energy**	Aux PP [2] Energy Meter 1	Switch gear room	F30 / 765	ENERCON	DM5230	±0.5%	50/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM5	**Energy**	Aux PP Energy Meter 2	Switch gear room	F30 / 766	ENERCON	DM5230	±0.5%	50/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM6	**Energy**	STG [3] Energy Meter	STG control room	10985/845-3006	CONZERV	20301	± 1%	500/5A (CT) 11000/11V (PT)	Amps Volts	24 Hrs
EM7	**Energy**	STG Aux Energy meter 1	WHRB Panel Meter	100686/12739 -2906	CONZERV	20301	± 1%	100/5A (CT) 415V/415V (PT)	Amps Volts	24 Hrs
EM8	**Energy**	STG Aux Energy meter 2	ACC Panel Meter	95082/11428 -1806	CONZERV	20301	± 1%	250/5A (CT) 415V/415V (PT)	Amps Volts	24 Hrs
EM9	**Energy**	STG Aux Energy meter 3	LT Panel Meter	EEM0283P4126	PYOKDVS	PDM9023	± 1%	600/5A (CT) 415V/415V (PT)	Amps Volts	24 Hrs
EM10	**Energy**	Export meter 1	Switch gear room	F30 / 811	Conzerv	DM5230	±0.5%	500/5A (CT) 11000/110V (PT)	Amps Volts	24 Hrs
EM11	**Energy**	Export meter 2	EB yard	03177617	L & T	ER300P	±0.2%	150/1A (CT) 110KV/110V (PT)	Amps Volts	24 Hrs

The net electricity generated is monitored through three Gas Engine energy meters, 2 auxiliary energy meters, one STG energy meter and three STG auxiliary energy meters. Therefore,
Net Electricity Generation = Gross Electricity generation from power plant & STG – Auxiliary consumption at power plant & STG

Gross Electricity generation = Electricity generation recorded by Gas Engine 1 energy meter + Electricity generation recorded by Gas Engine 2 energy meter + Electricity generation recorded by Gas Engine 3 energy meter + Electricity generation recorded by STG energy meter

Auxiliary consumption at power plant = Auxiliary consumption recorded by two auxiliary energy meters at PP + Auxiliary consumption recorded by STG aux energy meter 1 (for boiler system) + Auxiliary consumption recorded by STG aux energy meter 2 (for Air Cooled Condenser fans) + Auxiliary consumption recorded by STG aux energy meter 3 (for lighting system/turbine pumps, etc.)

Emission reductions have been calculated based on the net electricity generated from the 18 MW natural gas based community power plant measured in OPG energy meters and recorded in the OPG monthly energy generation reports.

[1] The 18 MW Natural Gas based community power plant has three Gas Engines (GE) with individual energy meters (GE1, GE2 and GE3) to monitor the gross electricity generated.

[2] The power plant has two auxiliary power plant energy meters (Aux PP Energy Meter 1 and Aux PP Energy Meter 2) to monitor the auxiliary power consumption at the power plant.

[3] The Steam Turbine Generator (STG) of the 2 MW Waste Heat Recovery System has four energy meters, one STG energy meter that monitors the gross power generation from the STG and three STG energy meter that monitor the auxiliary power consumption of the STG.

ID	Equipment Name	Required Calibration frequency as per supplier	Calibration date	Previous calibration
EM1	GE1 Energy Meter	Annual	08.11.2008	08.11.2006
EM2	GE2 Energy Meter	Annual	08.11.2008	08.11.2006
EM3	GE3 Energy Meter	Annual	08.11.2008	08.11.2006
EM4	Aux PP Energy Meter 1	Annual	08.11.2008	08.11.2007
EM5	Aux PP Energy Meter 2	Annual	08.11.2008	08.11.2006
EM6	STG Energy Meter	Annual	08.11.2008	30.07.2006
EM7	STG Aux Energy meter 1	Annual	Plant not in operation	--
EM8	STG Aux Energy meter 2	Annual	Plant not in operation	--
EM9	STG Aux Energy meter 3	Annual	Plant not in operation	--
EM10	Export meter 1	Annual	08.11.2008	08.11.2006
EM11	Export meter 2	Annual	18.02.2009	27.02.2008

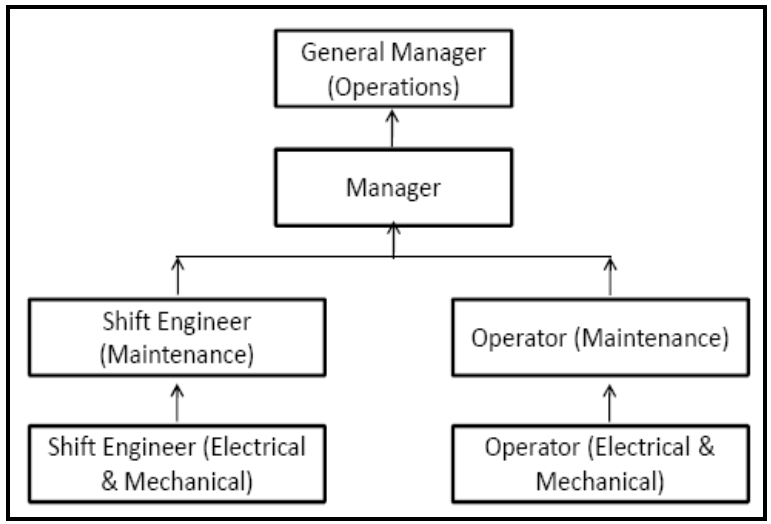
4.4. Details of fuel monitoring equipment:

ID	Parameter	Equipment Name	Location	Serial No.	Make	Model No.	Accuracy class	Range	Unit	Recording frequency
NGFM1	Fuel	GAIL Natural Gas flow meter	Gail yard	16329461	FISHER	FB 503	±0.075 %	0-800	KPA	24 Hrs
NGFM2	Fuel	Gas Engine 1 - OPG Natural Gas flow meter	Engine room	908128	RMG MESS TECHNIC	EC 694	±0.50 %	25-400	m^3/hr	24 Hrs
NGFM3	Fuel	Gas Engine 2 - OPG Natural Gas flow meter	Engine room	908127	RMG MESS TECHNIC	EC 694	±0.50 %	25-400	m^3/hr	24 Hrs
NGFM4	Fuel	Gas Engine 3 - OPG Natural Gas flow meter	Engine room	908126	RMG MESS TECHNIC	EC 694	±0.50 %	25-400	m^3/hr	24 Hrs
As per registered monitoring plan, natural gas consumption in the project activity is measured using online flow meters of gas suppliers (as recorded by the GAIL meters). In accordance to registered monitoring plan, the natural gas consumption is cross verified with the readings from the gas supply company invoices. As per methodology, the gas consumption data would also be cross verified from the readings of individual natural gas flow meters of three gas engines. Total Natural Gas consumption in the project activity = Natural gas consumed as recorded by GAIL natural gas flow meter										

ID	Equipment Name	Required Calibration frequency	Calibration date	Previous calibration
NGFM1	GAIL Natural Gas flow meter	Quarterly	04.11.2008, 07.02.2009, 28.04.2009, 16.07.2009, 16.10.2009	07.07.2008
NGFM2	Gas Engine 1 - OPG Natural Gas flow meter	Annual	07.02.2009	12.08.2006
NGFM3	Gas Engine 2 - OPG Natural Gas flow meter	Annual	07.02.2009	12.08.2006
NGFM4	Gas Engine 3 - OPG Natural Gas flow meter	Annual	07.02.2009	12.08.2006

4.5. Monitoring Procedures:

The "monitoring system and procedures" adopted is in compliance/accordance with the monitoring plan contained in registered PDD and monitoring methodology prescribed in AM0029 version 01.1. The monitoring procedures (including data reviewing, reporting, archiving & QA/QC procedure adopted) has been detailed for each monitoring parameter in section 5 (Data & parameters monitored). An overview of the organization team to manage the CDM project activity is illustrated below:



5. Legal Compliance

The project plant operated under a valid consent from the Tamil Nadu Pollution Control Board (TNPCB), details of which is presented as follows (Copies of this consent will be provided to the DOE).

S.No	Consent Details	Validity	Remarks	Document Ref.
1.	Consent to Operate under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981	Valid for the period from 01.04.2008-31.03.2009	Complied	Consent Order No.: 16696 Proceeding No.:T8/TNPCB/F-851/VNR/RL/A/2009 dated 04.02.2009
2.	Consent to Operate under Section 21 of the Air (Prevention and Control of Pollution) Act, 1981	Valid for the period 01.04.2009-31.03.2010	Complied	Consent Order No.: 16696 Proceeding No.:T8/TNPCB/F-851/NGP/URL/A/2009 dated 04.05.2009
3	Consent to Operate under Section 25 of the Water (Prevention and control of Pollution) Act, 1974	Valid for the period 01.04.2008-31.03.2009	Complied	Consent Order No.: 19941 Proceeding No.:T8/TNPCB/F-851/NGP/RL/W/2009 dated 04.02.2009
4	Consent to Operate under Section 25 of the Water (Prevention and control of Pollution) Act, 1974	Valid for the period 01.04.2009-31.03.2010	Complied	Consent Order No.: 19941 Proceeding No.:T8/TNPCB/F-851/VNR/RL/A/2009 dated 04.05.2009

This further demonstrates the legal compliance of the project during the first monitoring period under consideration.

6. Monitored parameters, calibration details and monitoring procedures

6.1 Annual quantity of natural gas consumed in the project activity ($FC_{NG,y}$)

Data / Parameter:	$FC_{NG,y}$
Data unit:	SCM (Standard[4] Cubic Metre)
Description:	Annual quantity of natural gas consumed in project activity
Source of data to be used:	Online Natural gas flow meter readings
Value of data:	26,703,847
Description of measurement methods and procedures to be applied:	***Monitoring Method:*** The data has been measured continuously in online flow meters of the gas supplier (GAIL) and recorded electronically on a daily basis. ***Review, Report and archive:*** GAIL gas flow meter: The Manager will review the fortnightly data submitted by gas supplier and record the data in computer. On a monthly basis, a compilation of the natural gas flow recorded by GAIL online flow meter would be prepared by the Manager and submitted to the GM (Operations) as monthly report. The Shift Engineer (SE) also records the natural gas consumption monitored by the GAIL online flow meter manually on a daily basis and record the data in computer in the form of Daily Report for the purpose of cross checking. OPG gas flow meter: The Shift Engineer will record the gas consumption monitored by OPG NG flow meter on a daily basis and log the data in computer in the form of Daily Report. The daily report would be reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations). The GM (Operations) would verify the daily and monthly natural gas consumption report and archive it.

[4] 1 bar pressure and 273 degree Kelvin

<table>
<tr><td></td><td>Monitoring frequency:
Measured continuously.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>QA/QC Procedure adopted
As per registered monitoring plan, the GAIL natural gas online flow meter is subjected calibrated once in three months. The readings are cross-verified with the gas supply company invoices and also with the readings from OPG natural gas flow meters installed at project end (Please refer to Annex 2 for the cross-verification of meter readings)

Calibration details
The GAIL gas flow meter has been calibrated on a quarterly basis. The details are as follows:
<table>
<tr><th>Equipment name</th><th>Serial No.</th><th>Accuracy class</th><th>Calibration date</th><th>Result</th></tr>
<tr><td>GAIL Natural Gas Flow meter</td><td>16329461</td><td>±0.075 %</td><td>04.11.2008
07.02.2009
28.04.2009
16.07.2009
16.10.2009</td><td>Error in % - Nil</td></tr>
</table>
</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

6.2 Net Calorific value of natural gas ($NCV_{NG,y}$)

Data / Parameter:	**$NCV_{NG,y}$**
Data unit:	GJ/m^3
Description:	Net calorific value of natural gas
Source of data to be used:	"Customer Fortnight Statement" provided by Fuel supplier (GAIL). The statement contains daily volume of fuel consumed; average NCV and fortnightly weighted average NCV. Fortnightly weighted average NCV values have been used for calculations. The NCV values in the statement are provided in $kcal/m^3$ which will be converted to GJ/m^3 for calculation purposes.
Value of data:	0.0394

Description of measurement methods and procedures to be applied:	***Monitoring Method.*** This data is monitored by GAIL using online gas flow meter and provided to OPG on a fortnightly basis. ***Review, Report and archive:*** The Manager will review the fortnightly data and record the data in computer. On a monthly basis, a compilation of the NCV would be prepared by the Manager and submitted to the GM (Operations) as monthly report. The GM (Operations) would verify the daily and monthly energy report and archive it. ***Monitoring frequency:*** 100% data is recorded. Measured continuously.
QA/QC procedures to be applied:	Since supplier-provided data is used, no additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

6.3 Oxidation factor of natural gas ($OXID_{NG}$)

Data / Parameter:	**$OXID_{NG}$**
Data unit:	-
Description:	Oxidation factor of natural gas
Source of data to be used:	IPCC current default value
Value of data:	1.0 (Default value as per IPCC 2006 guidelines)
Description of measurement methods and procedures to be applied:	Latest IPCC default value would be adopted. Since 2006 IPCC guidelines provide the most recent guidelines on emission factor, the same has been used for the monitoring period.
QA/QC procedures to be applied:	Since IPCC default value is used, no additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

6.4 Emission factor for natural gas ($EF_{CO2,NG,y}$)

Data / Parameter:	**$EF_{CO2,NG,y}$**
Data unit:	tCO_2/GJ
Description:	Emission factor for natural gas.
Source of data to be used:	IPCC default value is applied since national data is not available.
Value of data:	0.0561 (Default value as per IPCC 2006 guidelines)
Description of measurement methods and procedures to be applied:	Latest IPCC default value would be adopted. Since 2006 IPCC guidelines provide the most recent guidelines on emission factor, the same has been used for the monitoring period.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

6.5 CO_2 emissions coefficient of natural gas ($COEF_y$)

Data / Parameter:	**$COEF_y$**
Data unit:	tCO_2/m^3
Description:	CO_2 emissions coefficient of natural gas.
Source of data to be used:	Calculated under project activity.
Value of data:	0.002212
Description of measurement methods and procedures to be applied:	Data is calculated as per AM0029 formula and archived electronically.

QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

6.6 Project emission due to combustion of natural gas (PE_y)

Data / Parameter:	**PE_y**
Data unit:	tCO_2e
Description:	Project emission due to combustion of natural gas.
Source of data to be used:	Calculated under project activity.
Value of data:	59079.75
Description of measurement methods and procedures to be applied:	***Monitoring Method.*** The project emission data is calculated as per AM0029 and archived electronically.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	--

6.7 Baseline emission factor for the Southern Regional Grid of India ($EF_{BL,CO2,y}$)

Data / Parameter:	**$EF_{BL,CO2,y}$**
Data unit:	tCO_2/MWh
Description:	Baseline emission factor for the Southern Regional Grid of India
Source of data to be used:	CEA (Central Electricity Authority) CO2 Baseline Database for the Indian Power Sector
Value of data applied	0.8179 (Ex-post value, BM emission factor for the year 2008-09 as per the

for the purpose of calculating expected emission reductions in section B.5	CEA CO_2 Baseline Database, Version 05, which is calculated as per ACM0002 Version 10 and "Tool to calculate the emission factor for an electricity system, Version 1.1)
Description of measurement methods and procedures to be applied:	Calculated as the Build Margin (BM) emission factor for the Southern Regional Grid as per the CEA CO_2 Baseline Database for the Indian Power Sector. Formula and guidelines provided in the methodology ACM0002 has been used.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied.
Any comment:	This will be monitored ex-post as required by the methodology

6.8 Net electricity generated in the project activity ($EG_{PJ,y}$)

Data / Parameter:	**$EG_{PJ,y}$**
Data unit:	MWh
Description:	Net electricity generated in the project activity
Source of data to be used:	Energy meters of OPG
Value of data:	117290.223
Description of measurement methods and procedures to be applied:	***Monitoring Method.*** Energy meters measure the gross energy generated and auxiliary energy consumption on a continuous basis. Net electricity generation is calculated as follows: Gross electricity generation = Gas Engine 1 energy meter + Gas Engine 2 energy meter + Gas Engine 3 energy meter + STG energy meter Auxiliary consumption = Aux PP energy meter 1 + Aux PP energy meter 2 + STG Aux energy meter 1 + STG Aux energy meter 2 + STG Aux energy meter 3 Net electricity generation = Gross electricity generation – Auxiliary consumption

	Review, Report and archive: The Shift Engineer reviews and approves the log books (recorded by operators) on a daily basis and records the data in computer in the form of Daily Report. The daily report is then reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month is prepared by the Manager and submitted to the GM (Operations). The GM (Operations) verifies the daily and monthly energy report and archives it. ***Monitoring frequency:*** Measured continuously.
QA/QC procedures to be applied:	Net electricity generation is monitored based on the measured values of gross electricity generation and auxiliary consumption in the project activity using energy meters of OPG. Gross and Auxiliary Energy meters would be calibrated on an annual basis as per relevant standards. ***Cross checking procedure:*** Net electricity generation from the project activity is cross checked with energy sale records to consumers, TNEB records supported by annual energy balance ***Calibration details:*** Please refer to the monitoring procedures adopted for $EG_{gross,y}$ & $EG_{aux,y}$
Any comment:	-

6.9 Gross energy generation of the project plant ($EG_{gross,y}$)

Data / Parameter:	**$EG_{gross,y}$**
Data unit:	MWh
Description:	Gross energy generation of the project plant
Source of data to be used:	Energy meters of OPG

<table>
<tr><td>Value of data:</td><td>118273.093</td></tr>
<tr><td>Description of measurement methods and procedures to be applied:</td><td>Monitoring Method.
This data will be measured continuously in OPG gross energy meters. The Operators will record the generation data on a daily basis in log books. The gross electricity generation is the total of electricity generation from three gas engines and one STG.
Review, Report and archive:
The Shift Engineer (SE) reviews and approves the log books on a daily basis and records the data in computer in the form of Daily Report. The daily report is then reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations).
Data archiving The GM (Operations) would verify the daily and monthly energy report and archive it.
Monitoring frequency:
Measured continuously.</td></tr>
<tr><td>QA/QC procedures to be applied:</td><td>QA/QC Procedure adopted
A monthly energy balance (i.e. power balance) will be prepared to cross-check the recorded generation data with other parameters. Refer Annex 2 for "Power balance".
Calibration details
Gross energy meters have been calibrated on an annual basis, details of which is presented below:
<table>
<tr><th>Equipment name</th><th>Serial No.</th><th>Accuracy class</th><th>Calibration date</th><th>Result</th></tr>
<tr><td>GE1 Energy Meter</td><td>12016</td><td>±0.5%</td><td>8.11.2008</td><td>Error within limits</td></tr>
<tr><td>GE2 Energy Meter</td><td>12015</td><td>±0.5%</td><td>8.11.2008</td><td>Error within limits</td></tr>
<tr><td>GE3 Energy Meter</td><td>11033</td><td>±0.5%</td><td>8.11.2008</td><td>Error within limits</td></tr>
<tr><td>STG Energy Meter</td><td>10985/845-3006</td><td>±1.0%</td><td>8.11.2008</td><td>Error within limits</td></tr>
</table></td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

6.10 Auxiliary consumption of the project plant ($EG_{aux,y}$)

Data / Parameter:	**$EG_{aux,y}$**
Data unit:	MWh
Description:	Auxiliary consumption of the project plant
Source of data to be used:	Energy meters of OPG
Value of data:	982.870
Description of measurement methods and procedures to be applied:	***Monitoring Method.*** This data will be measured continuously in OPG auxiliary energy meters. The Operators will record the auxiliary consumption data on a daily basis in log books. The auxiliary consumption of the power plant is recorded in three energy meters i.e. two auxiliary PP energy meter and one STG auxiliary energy meter. The total of electricity consumed by the power plant for operating its auxiliary equipments equals auxiliary consumption of the project plant. ***Review, Report and archive:*** The daily report is reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month is prepared by the Manager and submitted to the GM (Operations). The GM (Operations) then verifies the daily and monthly energy report and archives it. ***Monitoring frequency:*** Measured continuously.
QA/QC procedures to be applied:	***Cross Checking Procedure adopted*** A monthly energy balance (i.e. power balance) will be prepared to cross-check the recorded consumption data with other parameters. Refer Annex 2 for "Power balance". Calibration ***Calibration details*** Auxiliary energy meters have been calibrated on an annual basis, details of which is presented below:

Equipment	**Serial No.**	**Accuracy**	**Calibration**	**Result**

	name		**class**	**date**	
	Aux PP Energy Meter 1	F30 / 765	±0.5%	8.11.2008	Error % within limits
	Aux PP Energy Meter 2	F30 / 766	±0.5%	8.11.2008	Error % within limits
	STG Aux Energy meter 1	100686/12739 - 2906	±1%	Plant not in operation	
	STG Aux Energy meter 2	95082/11428 - 1806	±1%	Plant not in operation	
	STG Aux Energy meter 3	EEM0283P4126	±1%	Plant not in operation	
Any comment:	-				

7. Measures to ensure data accuracy / uncertainty levels

Power & Fuel Balance:

The electricity parameters and fuel parameters monitored are cross-checked by doing an annual power balance and fuel balance respectively as elaborated in Annex 2.

Calibration:

All the energy meters and other monitoring equipments have been calibrated as per the required calibration frequency as indicated in sections 4.3 and 4.4 which will be in line with registered PDD to ensure that the accuracy levels are maintained within their specified levels. Copy of calibration reports are being submitted to the DOE.

CDM Team meeting:

A review meeting will be conducted based on the half yearly basis to assess the CDM performance of the project. Any particular concerns are discussed and appropriate action is taken.

Internal audit:

An internal audit of the project activity is done on a half yearly basis. The review (audit) team includes at least one technical person and an accounts person. Copy of internal audit reports are being submitted to the DOE.

Training:

The personnel involved in the data monitoring have been provided with periodic trainings. This helps to eliminate any manual recording or calculation errors. Proof of training provided is submitted to the DOE.

Data uncertainty:

The uncertainty of the monitored data depends on the following parameters:

- *Meter uncertainty*, which is equivalent to the accuracy level of the meter. All the meters have been calibrated at least annually which ensures that the uncertainty levels are within the accuracy level.
- *Operator uncertainty* – This is not applicable since none of the monitoring equipments need a manual operator.

Data apportioning:

The monitoring period covered in this monitoring report is from 3, November 2008 to 21, November 2009. The certified emission reductions calculated during this period is based on electricity and fuel data that is collected and monitored on a daily basis. The monitoring requirement of primary data used in arriving at the certified emission reductions and its relevance to apportioning is detailed in the table given below:

S.No	Primary parameter / Data used in arriving at CERs	Monitoring requirement as per registered PDD & AM0029 methodology	Procedure adopted in project plant	Remarks
1.	Annual quantity of natural gas consumed in the project activity ($FC_{NG,y}$) – Source: Online GAIL NG flow meter	Continuous recorded daily	Continuous recorded daily	Apportioning not required
2.	Gross energy generation of the project plant Source: Energy meters of OPG	Continuous (recorded daily)	Continuous (recorded daily)	Apportioning not required
3.	Auxiliary consumption of the project plant Source: Energy meters of OPG	Continuous (recorded daily)	Continuous (recorded daily)	Apportioning not required

From the above table, it can be noted that there is no apportioning required or done for the "electricity & fuel data" used to calculate certified emission reductions.

As has been said in the monitoring plan, a monthly power balance would be conducted as a cross-checking mechanism. As part of the power balance, the following two parameters are compared;

Parameter 1: Electricity export based on TNEB export meter as recorded by TNEB personnel on the 22nd of every month and available in TNEB's monthly generation statements

Parameter 2: Electricity export based on TNEB export meter as recorded by OPG personnel on a daily basis

When comparing net electricity export for the months from December 2008 to November 2009, the above two parameters can be directly compared. Comparison done for a sample month s provided below:

Month: November 2009

Parameter 1: TNEB electricity generation statement for November 2009 would cover electricity export from OPG for the period 21 October 2009 to 21 November 2009.

Parameter 2: Electricity export for November 2009 would be calculated as the total of electricity export for the days from 21 October 2009 to 21 November 2009.

For November 2008, the period covered in the TNEB statement is from 22 October 2008 to 21 November 2008. As our monitoring period starts from 3 November 2008, electricity export has been apportioned from 3 November 2008 to 21 November 2008 for parameter 1. The number of days: 19 out of a total 31 days in the month in the case of parameter 1 have been ensured to match the number of days considered in parameter 2. The details of this analysis are presented in Annex 2.

8. Formula applied

8. 1. Project Emissions

The CO_2 emissions from electricity generation (PE_y) are to be calculated applying the below equation as per AM0029:

$$PE_y = \sum_f FC_{f,y} * COEF_{f,y}$$

In this case, since natural gas is the only fuel used and start-up / auxiliary fuels are not required, the equation may be as follows:

$$PE_y = FC_{NG,y} * COEF_{NG,y}$$

Where:

$FC_{NG, y}$: is the total volume of natural gas combusted in the project plant (in standard m^3 - SCM) in year 'y'

$COEF_{NG, y}$: is the CO_2 emission coefficient (tCO_2/SCM) in year y for natural gas and is obtained as:

$$COEF_{NG,y} = \sum NCV_y * EF_{CO2NG,y} * OXID_{NG}$$

Where:

NCV_y : is the net calorific value per volume unit of natural gas in year 'y' (GJ/SCM) as determined from the fuel supplier.

$EF_{CO2,NG,y}$: is the CO_2 emission factor per unit of energy of natural gas in year 'y' (tCO_2/GJ) as determined from the fuel supplier, wherever possible, otherwise from local or national data. Since in this case local or national data is not available, IPCC default value would be applied.

$OXID_{NG}$: is the oxidation factor of natural gas

8.2. Baseline Emissions

Baseline emissions are calculated by multiplying the electricity generated in the project plant ($EG_{PJ,y}$) with a baseline CO_2 emissions factor ($EF_{BL,CO2,y}$), as follows:

$BE_y = EG_{PJ,y}$ **x** $EF_{BL,CO2,y}$

8.2.1 Baseline Emission Factor ($EF_{BL,CO2,y}$)

AM0029 prescribes that the lowest emission factor among the following three options should be used as the baseline emission factor for the project activity:

Option : The build margin, calculated according to ACM0002; and

Option 2 : The combined margin, calculated according to ACM0002, using a 50/50 OM/BM weight.

Option 3 : The emission factor of the technology (and fuel) identified as the most likely baseline scenario under "Identification of the baseline scenario" above.

Central Electricity Authority (CEA) of India has published a CO_2 baseline database for the regional grids of India. The database includes operating margin, build margin and combined margin emission factors for the regional grids calculated in accordance with the formula as prescribed by ACM0002. For this project activity, the emission factor values for the southern regional grid have been adopted from the CEA database Version 05 dated 01/11/2009. The emission factors as per CEA database is shown below:

$EF_{OM,y}$ = 0.9868 tCO_2/MWh

$EF_{BM,y}$ = 0.8179 tCO_2/MWh

$EF_{CM,y}$ = 0.8942 tCO_2/MWh

Option 1: Build Margin, calculated according to ACM0002

As described above, build margin calculated according to ACM0002 V7 is **0.8179 tCO_2/MWh.**

Option 2: Combined Margin, calculated according to ACM0002

As described above, combined margin calculated according to ACM0002 V7 is **0.9023 tCO_2/MWh.**

Option 3: Emission factor of technology identified as the most likely baseline scenario

In this case, the most likely baseline scenario identified is a coal based power plant, the emission factor of which is calculated using the below formula prescribed by AM0029:

$$EF_{BL,CO2} = \frac{COEF_{BL}}{\eta_{BL}} * 3.6$$

Where,

$COEF_{BL}$: the fuel emission coefficient (tCO_2/GJ), based on national average fuel data. In this case, the value is adopted from India's CEA CO2 database as 0.0958 tCO_2/GJ.

η_{BL} : the energy efficiency of the coal power plant. As per the heat rate indicated in section B.4 (2500 kCal/kWh), it is 34.4%. (Efficiency = output/input = 860[5] / 2500 = 0.344)

Applying values in the above formula:
Emission factor of coal power plant = (0.0958/0.344)*3.6 = **1.00 tCO_2/MWh**

The build margin emission factor is the lowest of the three options and therefore the same will be adopted as the baseline emission factor.

$EF_{BL,CO2,y}$ = 0.8179 tCO_2/MWh

As per AM0029, the ex-post build margin has been estimated and used in this monitoring report.

8.3. Leakage

The leakage emission sources considered are the fugitive CH4 emissions associated with fuel extraction, processing, liquefaction, transportation, regasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity. Since LNG is not used in the project activity, emissions associated with it need not be considered in the leakage calculations.

AM0029 prescribes the following formula:

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

Since LNG component is not applicable[6],

$LE_y = LE_{CH4,y}$

Where,

LE_y : Leakage emissions during the year y in tCO_2e

LE_{CH4} : Leakage emissions due to fugitive upstream CH_4 emissions in year y in tCO_2e, calculated using the below formula as prescribed by AM0029.

$$LE_{CH4} = [\, FC_y * NCV_y * EF_{NG,upstream,CH4} - EG_{PJ,y} * EF_{BL,upstream,CH4}] * GWP_{CH4}$$

[5] 1kWh = 860 kCal

[6] As per the natural gas allocation letter from the Ministry of Petroleum and Natural Gas, gas would be directly supplied from the Kuttalam gas field located at a distance of 6 kms from the project activity. No LNG component is involved.

Where,

FC_y : Quantity of natural gas combusted in the project plant during year y in SCM

NCV_y : Average net calorific value of natural gas combusted during year y in GJ/SCM

$EF_{NG,upstream,CH4}$: Emission factor for upstream fugitive methane emissions of natural gas from production, transportation and distribution in tCH_4/GJ

$EG_{PJ,y}$: Electricity generation in the project plant during year y in MWh

$EF_{BL,upstream,CH4}$: Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH_4/MWh

GWP_{CH4} : Global warming potential of methane valid for the relevant commitment period

As per AM0029, the emission factor for upstream fugitive CH_4 emissions are calculated consistent with the baseline emission factor (in this case Option 1: Build Margin) used as shown below:

$$EF_{BL,upstream,CH4} = \frac{\sum_j FF_{j,k}\, x\, EF_{k,upstream,CH4}}{\sum_j EG_j}$$

Where,

j : Plants included in the build margin

$FF_{j,k}$: Quantity of fuel type k (coal or oil type) combusted in power plant j included in the build margin

$EF_{k,upstream,CH4}$: Emission factor for upstream fugitive emissions from production of fuel type k in tCH_4 per MJ fuel produced

EG_j : Electricity generation in the plants j included in the build margin in MWh per year

For $EF_{NG,upstream,CH4}$,and $EF_{k,upstream,CH4}$, the IPCC default values as provided in Table 2 of AM0029 are used since reliable and accurate data on fugitive methane emissions associated with the production, transportation and distribution of fuels (natural gas, coal or gas) is not available.

9. Calculations and results

9.1. Project Emissions

Month	Total volume of NG combusted per year		Net Calorific Value of NG		CO_2 Emission factor of NG	Oxidation factor of NG	Total Project Emissions
	First Fortnight gas consumption	Second Fortnight gas consumption	First Fortnight weighted Average NCV	Second Fortnight weighted Average NCV			
	$FC_{NG,y}$		NCVy		$EF_{CO2,NG,y}$	$OXID_{NG}$	$PE_{NG,y}$
	m^3	m^3	GJ/m^3	GJ/m^3	tCO_2/GJ		tCO_2e
November-08	857234	1083792	0.0395	0.0394	0.0561	1	4297.41
December-08	1161129	1168234	0.0392	0.0392	0.0561	1	5124.20
January-09	1121566	1173750	0.0391	0.0393	0.0561	1	5045.01
February-09	1057838	916612	0.0393	0.0389	0.0561	1	4335.69
March-09	1078741	1153744	0.0392	0.0393	0.0561	1	4914.92
April-09	1042604	1003644	0.0395	0.0392	0.0561	1	4515.79
May-09	1118973	1045646	0.0393	0.0395	0.0561	1	4785.28
June-09	957314	994725	0.0395	0.0397	0.0561	1	4337.11
July-09	946814	1059252	0.0394	0.0399	0.0561	1	4462.20
August-09	1198433	1171185	0.0399	0.0397	0.0561	1	5288.30
September-09	1076450	988004	0.0397	0.0401	0.0561	1	4616.85
October-09	990237	1000417	0.0394	0.0396	0.0561	1	4411.24
November-09	959360	378149	0.0394	0.0389	0.0561	1	2945.75
Total	**13566693.00**	**13137154.00**	**Average NCV**	**0.0394**			**59079.75**

The total project emission from the combustion of natural gas in the project to generate electricity is **59079.75 tCO_2e.**

9.2. Baseline Emissions

The Net electricity generation is calculated based on the following formula:

Net Electricity generation = Gross Electricity generation from power plant & STG – Auxiliary consumption at power plant and STG

- There are 3 energy meters to measure gross electricity generation at power plant: GE1 EM, GE2 EM and GE3 EM
- There are 2 energy meters to measure auxiliary consumption at the power plant: Aux PP EM 1 and Aux PP EM 2
- There is 1 energy meter to measure gross electricity generation at STG[7] : STG EM
- There is 3 energy meter to measure auxiliary consumption at STG : STG aux EM 1, STG aux EM 2, STG aux EM 3

Month	Gross Electricity Generation ($EG_{gross,y}$)			GE Auxiliary consumption		Net Electricity Generation
	Gas Engine meter 1(GE1)	Gas Engine meter 2 (GE2)	Gas Engine meter 3 (GE3)	Aux PP meter 1	Aux PP meter 2	
	MWh	MWh	MWh	MWh	MWh	MWh
November-08	3411.405	1882.141	3434.646	65.9	0	8662.292
December-08	3529.143	3391.986	3533.566	61.98	10.53	10382.185
January-09	3492.893	3415.246	3409.117	17.21	53.48	10246.566
February-09	2818.158	2996.182	2972.925	68.14	0	8719.125
March-09	3185.620	3388.506	3356.041	79.46	0	9850.707
April-09	2818.311	3130.151	3135.382	64.35	15.22	9004.274
May-09	2927.461	3316.850	3340.232	0	85.97	9498.573
June-09	2703.492	2875.052	2884.594	0	80.45	8382.688
July-09	2815.830	2985.382	2937.588	0	83.32	8655.480
August-09	3190.523	3636.359	3822.563	0	87.31	10562.135
September-09	2894.899	3042.477	3140.233	0	85.04	8992.569
October-09	2740.923	2933.761	3007.616	17.81	60.56	8603.930
November-09	1859.557	2014.924	1901.358	46.14	0	5729.699
Total	**38388.215**	**39009.017**	**40875.861**	**420.99**	**561.88**	**117290.223**

The net electricity generation from the power plant for the first crediting / monitoring period 2008-2009, against which the emission reductions is calculated, is **117290.223 MWh.**

[7] STG is not in operation during the first crediting period, details on breakdown of STG are provided in Annex 3.

The net electricity generation presented above is for the first monitoring period i.e. 03 November 2008 till 21 November 2009. A comparison of the electricity generation from the project plant with estimated value considered in the registered PDD for a 1 year period (i.e. 03 November 2008 till 03 November 2009 is presented in the table given below.

Parameter	**Estimated value considered in the registered PDD for a 1 year period (MWh)**	**Actual value achieved in the project plant for a 1 year period (03 Nov 2008 – 03 Nov 2009) (MWh)**	**Difference (MWh)**
Gross electricity generation from gas engines	133174	113347.909	19826.91
Gross electricity generation from waste heat recovery system	10773	0	10773
Total gross electricity generation	143946	113347.909	30598.091

From the above table, it can be noted that there is a decrease in actual electricity generation as against the estimated value considered in the registered PDD for a period of 1 year. An analysis on number of days of operation, capacity utilization and plant load factor of the gas engines (the same has not been analyzed for WHR as this system was not in operation throughout the 1 year period) has been carried out to clearly describe the decreased electricity generation and it is presented in the table as follows.

Description (For the period 03 Nov 2008 – 03 Nov 2009)	**Units**	**Estimated value considered in the registered PDD**	**Actual value achieved in the project plant**
Number of days of operation in project plant in a year			
Total days of operation of the project plant in a year	Days	365	365
Number of hours of planned & unplanned outages	Hours	660	872.95
Number of hours of operation of the project plant	Hours	8100	7887.05
Number of days of operation of the project plant	Days	**337.5**	**328.63**
Number of days of planned & unplanned outages	Days	27.5	36.37

Description (For the period 03 Nov 2008 – 03 Nov 2009)	**Units**	**Estimated value considered in the registered PDD**	**Actual value achieved in the project plant**
Capacity Utilization Factor (CUF) of the project plant			
Gross energy generated in the project plant	MWh	133174	113347.91
Installed power capacity	MW	17.307	17.307
Actual number of operating hours	Hours	8100	7887.05
Maximum generation achievable with actual operating hours	MWh	140186.70	136501.17
Capacity Utilization of the project plant	%	**95.00%**	**83.0%**
Plant Load Factor (PLF) of the project plant			
Gross energy generated in the project plant	MWh	133174	113347.909
Installed power capacity	MW	17.307	17.307
Total operating hours in a year	Hours	8760	8760
Maximum generation achievable with total operating hours	MWh	151609.32	151609.32
Plant Load Factor of the project plant	%	**87.84%**	**74.76%**

From the above table, it can be noted that the decrease in electricity generation in the project plant has resulted on account of the followings:

- The number of days of operation of the gas engines has decreased from 337.5 to 328.63 days
- The CUF of gas engines has decreased from 95 % to 83 %
- The PLF of the gas engines has decreased from 87.84 % % to 74.76 %

Month	Net Electricity Generation	Baseline Emission Factor	Baseline Emissions
	MWh	$EF_{BL,CO2,y}$, tCO_2/MWh	tCO_2e
November-08	8662.292	0.8179	7085.09
December-08	10382.185	0.8179	8491.83
January-09	10246.566	0.8179	8380.90
February-09	8719.125	0.8179	7131.58
March-09	9850.707	0.8179	8057.12
April-09	9004.274	0.8179	7364.80
May-09	9498.573	0.8179	7769.10
June-09	8382.688	0.8179	6856.40
July-09	8655.480	0.8179	7079.52
August-09	10562.135	0.8179	8639.02
September-09	8992.569	0.8179	7355.23
October-09	8603.930	0.8179	7037.35
November-09	5729.699	0.8179	4686.45
Total	**117290.223**		**95934.40**

The Baseline emissions, calculated based on an emission factor of 0.8179 is **95934.40 tCO_2e.**

9.3. Leakage

Leakage in the project activity arises from fugitive methane emissions from natural gas. For the purpose of estimating fugitive CH_4 emissions, the quantity of natural gas consumed by the project in year y with an emission factor for fugitive CH_4 emissions from natural gas consumption is multiplied and subtracted from the emissions occurring from fossil fuels used in the absence of the project activity. Therefore,

Net Fugitive emissions increase due to project activity = Fugitive emissions in the project scenario – Fugitive emissions in the baseline scenario

Fugitive methane emissions in the project scenario

Month	Total volume of NG combusted per year		Net Calorific Value of NG		Emission factor for upstream fugitive emissions	Fugitive Emissions in the project scenario
	First Fortnight gas consumption	Second Fortnight gas consumption	First Fortnight weighted Average NCV	Second Fortnight weighted Average NCV		
	FCNG,y		NCVy		$EF_{NG,upstream,CH4}$	
	m^3	m^3	GJ/m^3	GJ/m^3	tCH_4/GJ	tCH_4
November-08	857234	1083792	0.0395	0.0394	0.00016	12.26
December-08	1161129	1168234	0.0392	0.0392	0.00016	14.61
January-09	1121566	1173750	0.0391	0.0393	0.00016	14.39
February-09	1057838	916612	0.0393	0.0389	0.00016	12.37
March-09	1078741	1153744	0.0392	0.0393	0.00016	14.02
April-09	1042604	1003644	0.0395	0.0392	0.00016	12.88
May-09	1118973	1045646	0.0393	0.0395	0.00016	13.65
June-09	957314	994725	0.0395	0.0397	0.00016	12.37
July-09	946814	1059252	0.0394	0.0399	0.00016	12.73
August-09	1198433	1171185	0.0399	0.0397	0.00016	15.08
September-09	1076450	988004	0.0397	0.0401	0.00016	13.17
October-09	990237	1000417	0.0394	0.0396	0.00016	12.58
November-09	959360	378149	0.0394	0.0389	0.00016	8.40
Total	**13566693**	**13137154**				**168.50**

The fugitive methane emission in the project scenario equals **168.50 tCH_4.**

Fugitive Methane Emissions in the baseline scenario

Month	Net Electricity Generation	Emission factor for upstream methane emissions in the baseline scenario	Fugitive Emissions in the Baseline Scenario
		$EF_{BL,upstream,CH4}$	
	MWh	tCH_4/MWh	tCH_4
November-08	8662.292	0.000583	5.0526
December-08	10382.185	0.000583	6.0558
January-09	10246.566	0.000583	5.9767
February-09	8719.125	0.000583	5.0858
March-09	9850.707	0.000583	5.7458
April-09	9004.274	0.000583	5.2521
May-09	9498.573	0.000583	5.5404
June-09	8382.688	0.000583	4.8895
July-09	8655.480	0.000583	5.0487
August-09	10562.135	0.000583	6.1608
September-09	8992.569	0.000583	5.2453
October-09	8603.930	0.000583	5.0186
November-09	5729.699	0.000583	3.3421
Total	**117290.223**		**68.41**

The fugitive methane emission in the baseline scenario equals **68.41 tCH_4.**

Net Fugitive emissions

Month	Global warming potential of Methane	Net Fugitive Emissions increase due to the project activity
	GWP_{CH4}	$LE_{CH4,y}$
		tCO_2e
November-08	21	151.28
December-08	21	179.73
January-09	21	176.65
February-09	21	152.88
March-09	21	173.71
April-09	21	160.17
May-09	21	170.26
June-09	21	157.08
July-09	21	161.23
August-09	21	187.36
September-09	21	166.37
October-09	21	158.81
November-09	21	106.25
Total		**2101.77**

Net Fugitive emissions increase due to the project activity, on applying a GWP of 21 for methane, is **2101.77 tCO_2e.**

9.4. Emission Reductions

To calculate the emission reductions, the following equation has been applied:
$ER_y = BE_y – PE_y – LE_y$

Month	Baseline Emissions	Project Emissions	Leakage	Emission Reductions
	tCO_2e	tCO_2e	tCO_2e	tCO_2e
November-08	7085.09	4297.41	151.28	2636.40
December-08	8491.83	5124.20	179.73	3187.90
January-09	8380.90	5045.01	176.65	3159.24
February-09	7131.58	4335.69	152.88	2643.01
March-09	8057.12	4914.92	173.71	2968.50
April-09	7364.80	4515.79	160.17	2688.85
May-09	7769.10	4785.28	170.26	2813.56
June-09	6856.40	4337.11	157.08	2362.20
July-09	7079.52	4462.20	161.23	2456.09
August-09	8639.02	5288.30	187.36	3163.36
September-09	7355.23	4616.85	166.37	2572.02
October-09	7037.35	4411.24	158.81	2467.30
November-09	4686.45	2945.75	106.25	1634.46
Total	**95934.40**	**59079.75**	**2101.77**	**34752.88**

Baseline emissions = 95934.40 tCO_2e
Project emissions = 59079.75 tCO_2e
Leakage = 2101.77 tCO_2e
Emission Reductions = 95934.40 – 59079.75 – 2101.77 = 34752.88 tCO_2e

The net emission reductions by the project activity during the monitoring period from 3 November 2008 to 21 November 2009 = **34752.88 tCO_2e, approximated to 34752 tCO_2e**

Annex 1: Forced outage and scheduled maintenance records during the monitoring period

Details on forced outage, scheduled maintenance and deemed hours for the three gas engines have been tabulated below. The gas engines are referenced by their Engine Serial Numbers (ESN) as fixed by the O&M contractor.

(1) Forced outages

Forced outage: The shutdown of a generating unit or other parts of the facility for emergency reasons or a condition in which the generating equipment is unavailable for load due to unanticipated breakdown.

Sl. No.	Date	Time		Duration[8]	Reason for failure
		From	To		
Gas Engine 2 (ESN 21594)					
1	1-Jan-09	14.40	17.00	2.6	Rotary Encoder Failure
Gas Engine 3 (ESN 21595)					
2	9-Apr-09	17.93	21.05	3.12	A7 cylinder exhaust temperature variation & WECS HW shut down
3	7-May-09	17.82	18.33	0.51	WECS HW Shutdown signal for PLC
4	16-May-09	19.58	20.33	0.75	WECS HW Shutdown signal for PLC
5	28-May-09	6.60	7.15	0.55	WECS Hard ware shutdown
6	25-Jun-09	10.98	11.45	0.47	B2 cylinder exhaust temperature variation
7	25-Jun-09	13.28	13.94	0.66	B2 cylinder exhaust temperature variation
8	26-Jul-09	14.93	19.20	4.27	WECS HW shutdown, inspection
9	2-Sep-09	12.02	12.70	0.68	WECS HW shutdown
Total				**13.61 hours (or) 13 hours, 36 minutes and 36 seconds**	Above said reasons

(2) Scheduled maintenance

Scheduled maintenance: Periodic prescribed inspection and/or servicing of equipment accomplished on a calendar, mileage, or hours of operation basis.

[8] If the duration is 13.61, it means 13 hours and 0.61 x 60 (1 hour has 60 minutes) = 37.8 (i.e.) 37 minutes and 48 seconds

Sl. No.	Date	Time		Duration	Reason for failure
		From	To		
Gas Engine 1 (ESN 21593)					
1	24-Dec-08	6.73	17.31	10.58	40k hours scheduled maintenance
2	14-Feb-09	6.72	19.10	12.38	41k hours scheduled maintenance
3	17-Apr-09	9.72	14.77	5.05	42k hours scheduled maintenance
4	16-Jul-09	6.70	16.25	9.55	44k & 45k hours scheduled maintenance
5	22-Aug-09	6.00	9.73	3.73	46k hours scheduled maintenance
6	22-Aug-09	14.08	19.49	5.41	46k hours scheduled maintenance
7	24-Oct-09	6.62	9.32	2.70	47k hours scheduled maintenance
8	24-Oct-09	19.93	2.23	6.30	47k hours scheduled maintenance
9	5-Nov-09	14.83	15.75	0.92	Stopped for waste gate problem
Sub-total for Gas Engine 1				**56.62 hours (or) 56 hours, 37 minutes and 12 seconds**	Above said reasons
Gas Engine 2 (ESN 21594)					
1	8-Nov-08	6.00	6.00	24.00	32k hours major overhaul
2	9-Nov-08	6.00	6.00	24.00	32k hours major overhaul
3	10-Nov-08	6.00	6.00	24.00	32k hours major overhaul
4	11-Nov-08	6.00	6.00	24.00	32k hours major overhaul
5	12-Nov-08	6.00	6.00	24.00	32k hours major overhaul
6	13-Nov-08	6.00	6.00	24.00	32k hours major overhaul
7	14-Nov-08	6.00	6.00	24.00	32k hours major overhaul
8	15-Nov-09	6.00	6.00	24.00	32k hours major overhaul
9	16-Nov-09	6.00	6.00	24.00	32k hours major overhaul
10	17-Nov-09	6.00	11.58	5.58	32k hours major overhaul
11	17-Nov-09	12.20	20.00	7.80	32k hours major overhaul
12	21-Nov-09	9.90	18.17	8.27	50 hours check after major overhaul
13	23-Nov-08	4.22	6.00	1.78	A8 cylinder prechamber change
14	24-Nov-08	6.00	7.00	1.00	A8 cylinder prechamber change
15	17-Dec-08	16.09	23.35	7.26	Waste gate work
16	11-Mar-09	6.70	12.01	5.31	41k hours scheduled maintenance
17	10-Apr-09	9.58	13.51	3.93	42k hours scheduled maintenance
18	26-May-09	7.07	9.25	2.18	43k hours scheduled maintenance
19	23-Jul-09	9.33	16.47	7.14	44k hours scheduled maintenance

20	29-Aug-09	6.00	11.99	5.99	45k hours scheduled maintenance
21	23-Sep-09	6.83	3.53	20.70	45 & 46k hours scheduled maintenance
22	24-Oct-09	21.06	1.91	4.85	B-bank T/C inspection
23	28-Oct-09	15.57	16.62	1.05	Hot web deflection measurement
Sub-total for Gas Engine 2				**298.84 hours (or) 298 hours, 50 minutes and 24 seconds**	Above said reasons
Gas Engine 3 (ESN 21595)					
1	5-Dec-08	9.32	21.01	11.69	40k hours scheduled maintenance
2	13-Jan-09	13.65	16.86	3.21	Valve heights & cylinder tightness check
3	24-Jan-09	8.32	12.00	3.68	40k hours scheduled maintenance
4	28-Mar-09	6.68	19.41	12.73	41k hours scheduled maintenance
5	25-Apr-09	6.97	9.50	2.53	Maintenance work
6	25-Apr-09	18.17	19.79	1.62	Maintenance work
7	25-Jul-09	17.15	23.46	6.31	44k hours scheduled maintenance
8	26-Sep-09	17.60	22.05	4.45	45 & 46k hours scheduled maintenance
Sub-total for Gas Engine 3				**46.22 hours (or) 46 hours, 13 minutes and 12 seconds**	Above said reasons
Total hours of scheduled maintenance for three gas engines				**56.62 + 298.84 + 46.22 = 401.68 hours (or) 401hours, 40 minutes and 48 seconds**	

(3) Deemed events

Deemed events: Unplanned stoppage of equipment due to external disturbances such as non-grid availability, input gas temperature fluctuations, etc. over which the O&M contractor has no control.

Sl. No.	Date	Time		Duration	Reason for failure
		From	To		
Gas Engine 1 (ESN 21593)					
1	3-Nov-08	6.40	7.66	1.26	110kV grid failure
2	8-Nov-08	18.15	18.67	0.52	A9 cylinder exhaust gas temperature low
3	8-Nov-08	20.88	21.34	0.46	B9 cylinder exhaust gas temperature low
4	17-Nov-08	11.58	12.20	0.62	110kV grid failure
5	19-Nov-08	11.10	12.20	1.10	110kV grid supply failure

6	23-Nov-08	2.52	2.92	0.40	A8 PCC cylinder valve change
7	24-Nov-08	11.50	11.88	0.38	A9 PCC cylinder valve change
8	24-Nov-08	15.22	16.00	0.78	100kV grid failure
9	25-Nov-08	1.40	2.20	0.80	EB grid failure
10	25-Nov-08	2.62	3.33	0.71	EB grid failure
11	26-Nov-08	9.02	9.60	0.58	100kV grid failure
12	26-Nov-08	13.13	13.43	0.30	Tripped due to low gas pressure
13	27-Nov-08	13.02	14.04	1.02	100kV grid failure
14	1-Dec-08	13.23	13.42	0.19	Tripped due to gas pressure fluctuation
15	10-Dec-08	20.93	21.80	0.87	A2 cylinder exhaust gas temperature variation
16	21-Dec-08	0.95	1.54	0.59	A2 & A8 cylinder exhaust temperature variation
17	24-Dec-08	0.20	0.68	0.48	B1 cylinder PCC valve failure
18	27-Dec-08	9.47	9.75	0.28	B9 cylinder PCC replaced
19	27-Dec-08	12.23	18.30	6.07	TNEB LC
20	28-Dec-08	20.02	20.51	0.49	A5 cylinder exhaust temperature variation
21	29-Dec-08	14.32	15.38	1.06	Grid power supply failure
22	30-Dec-08	6.33	6.55	0.22	B1 cylinder spark plug failure
23	31-Dec-08	9.27	9.60	0.33	A5 cylinder exhaust temperature variation
24	3-Jan-09	15.72	18.39	2.67	ABT meter fixing in TNEB yard
25	8-Jan-09	19.87	5.80	9.93	Stopped due to low gas pressure (GAIL)
26	13-Jan-09	12.05	12.57	0.52	Grid failure
27	15-Jan-09	7.57	8.55	0.98	100kV grid failure
28	17-Jan-09	11.38	13.02	1.64	A1 cylinder PCC replacement
29	24-Jan-09	12.00	16.46	4.46	TNEB PLC
30	27-Jan-09	20.39	20.60	0.21	A6 cylinder spark plug failure
31	12-Feb-09	23.80	0.56	0.76	A9 cylinder spark plug failure
32	13-Feb-09	10.52	10.72	0.20	A6 cylinder spark plug failure
33	13-Feb-09	18.20	18.54	0.34	A7 cylinder spark plug failure
34	22-Feb-09	19.62	19.90	0.28	B9 cylinder low exhaust gas temperature
35	22-Feb-09	1.28	2.02	0.74	B9 cylinder low exhaust gas temperature
36	26-Feb-09	23.58	0.84	1.26	Grid disturbance
37	31-Mar-09	17.90	18.10	0.20	Tripped on low gas feed pressure
38	21-Apr-09	18.43	18.60	0.17	A8 cylinder exhaust temperature variation
39	24-Apr-09	19.60	19.78	0.18	Low inlet gas pressure

40	25-Apr-09	9.48	18.07	8.59	TNEB LC
41	26-Apr-09	6.17	6.38	0.21	Low inlet gas pressure
42	26-Apr-09	6.72	8.08	1.36	EB grid failure
43	28-Apr-09	11.38	11.59	0.21	Low inlet gas pressure – sudden drop
44	6-May-09	22.90	23.78	0.88	B8 cylinder exhaust gas temperature variation
45	26-May-09	9.10	20.30	11.20	TNEB LC
46	6-Jun-09	12.40	15.25	2.85	B-bank T/C gasket renewal
47	10-Jun-09	7.90	9.47	1.57	Plant tripped due to grid under voltage
48	10-Jun-09	2.50	3.00	0.50	Tripped due to low gas inlet pressure
49	20-Jun-09	23.03	23.41	0.38	Plant tripped due to grid under voltage
50	2-Jul-09	19.67	19.84	0.17	Gas leak at A1 MCC coil
51	16-Jul-09	18.16	18.37	0.21	A6 unit sparkplug replacement
52	25-Jul-09	9.70	17.08	7.38	TNEB LC
53	27-Jul-09	11.08	11.49	0.41	B1 cylinder heavy knocking
54	31-Jul-09	21.12	21.30	0.18	A9 unit spark plug and NRV replacement
55	4-Aug-09	21.82	22.02	0.20	B9 cylinder exhaust gas temperature variation
56	14-Aug-09	5.50	5.72	0.22	B4 cylinder spark plug and NRV replacement
57	22-Aug-09	9.73	14.08	4.35	TNEB LC
58	25-Aug-09	18.75	19.00	0.25	A9 cylinder exhaust temperature variation
59	26-Aug-09	3.43	5.03	1.60	TNEB grid failure
60	30-Aug-09	17.02	17.24	0.22	B3 cylinder spark plug and NRV replacement
61	17-Sep-09	9.97	10.29	0.32	B4 cylinder exhaust gas temperature low
62	26-Sep-09	9.73	15.12	5.39	TNEB LC
63	26-Sep-09	17.18	17.60	0.42	Under Voltage trip due to grid voltage fluctuation
64	26-Sep-09	19.00	19.73	0.73	B6 exhaust temperature variation-PCC valve malfunction
65	3-Oct-09	14.97	15.86	0.89	A1 cylinder exhaust temperature variation
66	16-Oct-09	13.00	13.23	0.23	A1 cylinder exhaust temperature variation
67	21-Oct-09	22.65	5.02	6.37	Gas consumption restriction
68	24-Oct-09	9.32	19.93	10.61	TNEB LC
69	29-Oct-09	11.05	13.13	2.08	New Variable Frequency Drive installation
70	14-Nov-09	20.92	21.20	0.18	A1 cylinder exhaust gas temperature sudden drop
Sub-total for Gas Engine 1				**114.2 hours (or) 114 hours and 12 minutes**	Above said reasons

Gas Engine 2 (ESN 21594)					
1	3-Nov-08	6.40	7.31	0.91	110kV grid failure
2	4-Nov-08	22.43	22.68	0.25	B5 cylinder high exhaust gas temperature
3	6-Nov-08	10.40	10.63	0.23	B5 cylinder spark plug failure
4	7-Nov-08	2.33	2.53	0.20	A6 cylinder knocking
5	7-Nov-08	5.71	6.00	0.29	A2 cylinder exhaust gas temperature variation
6	17-Nov-08	11.58	12.20	0.62	110kV grid failure
7	17-Nov-08	20.00	6.00	10.00	Waste Heat Recovery Boiler top roof explosion
8	18-Nov-08	6.00	19.50	13.50	Waste Heat Recovery Boiler & DG inspection
9	18-Nov-08	19.62	20.20	0.58	A3 cylinder low exhaust gas temperature
10	18-Nov-08	20.52	4.43	7.91	Exhaust gas leak from A3
11	19-Nov-08	10.52	11.10	0.58	B2 cylinder exhaust gas temperature high
12	19-Nov-08	11.10	12.12	1.02	110kV grid supply failure
13	21-Nov-08	0.25	1.00	0.75	B2 cylinder exhaust temperature deviation
14	21-Nov-08	1.25	2.64	1.39	B2 cylinder exhaust temperature deviation
15	22-Nov-08	9.90	10.15	0.25	B2 cylinder PCC replacement
16	22-Nov-08	15.45	16.24	0.79	B4 cylinder PCC/spark plug replacement
17	22-Nov-08	19.75	19.94	0.19	B1 cylinder spark plug failure
18	24-Nov-08	8.72	9.72	1.00	B1 cylinder PCC valve change
19	24-Nov-08	11.00	12.08	1.08	B8 cylinder PCC valve change
20	24-Nov-08	15.22	16.08	0.86	100kV grid failure
21	24-Nov-08	19.17	19.55	0.38	B7 cylinder spark plug failure
22	25-Nov-08	11.33	11.78	0.45	B7 PCC valve failure
23	25-Nov-08	1.40	2.10	0.70	EB grid failure
24	25-Nov-08	2.62	3.24	0.62	EB grid failure
25	26-Nov-08	9.02	9.75	0.73	110kV grid failure
26	26-Nov-08	13.13	13.49	0.36	Tripped due to low gas pressure
27	27-Nov-08	13.02	14.08	1.06	110kV grid failure
28	27-Nov-08	17.92	18.24	0.32	A4 cylinder exhaust gas temperature variation
29	30-Nov-08	12.72	13.37	0.65	A9, B2 cylinders heavy knocking
30	4-Dec-08	12.12	18.22	6.10	Gas consumption restriction, T/C overhaul
31	5-Dec-08	14.72	14.92	0.20	Gas property changed
32	8-Dec-08	9.57	10.30	0.73	A4 cylinder spark plug & PCC valve change

33	10-Dec-08	22.53	23.78	1.25	A6 & B9 cylinder exhaust gas temperature variation
34	10-Dec-08	3.48	3.66	0.18	A6 cylinder spark plug failure
35	11-Dec-08	10.08	11.00	0.92	B9 cylinder exhaust temperature variation / PCC valve change
36	11-Dec-08	12.30	12.80	0.50	B1 cylinder exhaust temperature variation / PCC valve change
37	15-Dec-08	15.63	16.14	0.51	A4 & B9 cylinder exhaust temperature variation
38	17-Dec-08	11.68	13.88	2.20	B9 cylinder exhaust temperature variation
39	24-Dec-08	0.75	1.04	0.29	A4 PCC valve failure
40	25-Dec-08	11.80	12.11	0.31	B3 cylinder PCC valve failure
41	27-Dec-08	10.17	12.23	2.06	Rupture disc replacement
42	27-Dec-08	12.23	18.62	6.39	TNEB LC/40k hours scheduled maintenance
43	29-Dec-08	14.32	15.30	0.98	Grid power supply failure
44	1-Jan-09	12.00	12.42	0.42	B6 cylinder PCC replacement
45	1-Jan-09	13.70	14.32	0.62	A4 cylinder PCC replacement
46	3-Jan-09	15.17	20.26	5.09	ABT meter fixing in TNEB yard
47	5-Jan-09	12.82	13.13	0.31	A2 cylinder exhaust temperature low
48	5-Jan-09	13.33	13.63	0.30	A2 cylinder exhaust temperature low
49	5-Jan-09	13.85	14.37	0.52	A2 cylinder exhaust temperature low
50	8-Jan-09	18.77	6.00	11.23	Stopped due to low gas pressure (GAIL)
51	9-Jan-09	6.00	6.37	0.37	Stopped due to low gas pressure
52	11-Jan-09	15.20	15.90	0.70	A7&B8 cylinder exhaust temperature Variation
53	12-Jan-09	5.00	5.41	0.41	Cylinder exhaust gas temp Variation
54	13-Jan-09	12.05	13.26	1.21	Grid failure
55	13-Jan-09	16.75	17.02	0.27	A7 cylinder exhaust temp variation
56	15-Jan-09	7.57	8.70	1.13	110 kV grid failure
57	15-Jan-09	9.00	10.09	1.09	B7 cylinder exhaust temperature deviation
58	24-Jan-09	12.00	16.61	4.61	TNEB LC
59	30-Jan-09	15.97	16.24	0.27	B9 cylinder spark plug failure
60	5-Feb-09	9.90	10.18	0.28	A6 cylinder PCC valve replacement
61	5-Feb-09	11.68	12.87	1.19	B6 cylinder exhaust temperature deviation
62	6-Feb-09	16.95	17.86	0.91	A3 cylinder exhaust temperature deviation
63	12-Feb-09	15.55	15.85	0.30	B9 cylinder spark plug failure

64	26-Feb-09	23.58	0.89	1.31	Grid disturbance
65	28-Feb-09	0.88	2.09	1.21	A2 & B6 cylinder exhaust temp deviation
66	6-Mar-09	15.53	16.83	1.30	B3 & B5 cylinder exhaust temperature variation
67	6-Mar-09	21.30	21.57	0.27	A3 cylinder exhaust temperature variation
68	13-Mar-09	23.03	23.73	0.70	B4 & B5 cylinders exhaust temperature deviation
69	14-Mar-09	11.47	12.50	1.03	B3 & B4 cylinders exhaust temperature deviation
70	17-Mar-09	14.00	14.53	0.53	A3 cylinder exhaust temperature variation
71	13-Apr-09	12.48	13.42	0.94	B6 cylinder exhaust temperature variation
72	15-Apr-09	14.55	14.73	0.18	B5 cylinder exhaust temperature variation
73	17-Apr-09	11.55	11.67	0.12	B1 cylinder heavy knocking
74	25-Apr-09	9.50	18.14	8.64	TNEB LC
75	26-Apr-09	6.72	8.63	1.91	EB grid failure
76	27-Apr-09	17.38	17.56	0.18	B1 cylinder heavy knocking
77	28-Apr-09	11.38	11.62	0.24	Low inlet gas pressure-sudden drop
78	12-May-09	10.93	11.13	0.20	Low inlet gas pressure-sudden drop
79	14-May-09	10.27	10.77	0.50	A4 cylinder exhaust gas temperature variation
80	14-May-09	18.17	18.62	0.45	A4 cylinder MCC valve replacement
81	26-May-09	9.25	21.48	12.23	TNEB LC
82	28-May-09	8.85	9.25	0.40	Gas pressure low
83	30-May-09	16.45	16.85	0.40	B2 cylinder sparkplug and NRV replacement
84	1-Jun-09	16.88	17.34	0.46	B1 cylinder exhaust temperature variation
85	10-Jun-09	7.90	9.68	1.78	Plant tripped due to grid under voltage
86	10-Jun-09	19.53	19.80	0.27	Tripped due to low inlet gas pressure
87	10-Jun-09	2.50	2.80	0.30	Tripped due to low inlet gas pressure
88	20-Jun-09	23.03	23.87	0.84	Plant tripped due to grid under voltage
89	22-Jun-09	12.15	12.35	0.20	B1 heavy knocking
90	24-Jun-09	11.58	12.02	0.44	Tripped due to A5 cylinder exhaust gas
91	17-Jul-09	14.05	14.23	0.18	B9 cylinder sparkplug and NRV replacement
92	23-Jul-09	4.52	4.78	0.26	A2 cylinder sparkplug and NRV replacement
93	25-Jul-09	9.71	17.10	7.39	TNEB LC
94	26-Jul-09	21.77	22.23	0.46	High inlet gas pressure
95	2-Aug-09	16.75	17.06	0.31	B5 cylinder exhaust temperature variation
96	4-Aug-09	20.42	20.70	0.28	B6 cylinder heavy knocking

97	4-Aug-09	22.02	22.28	0.26	B2 cylinder exhaust gas temperature variation
98	4-Aug-09	3.42	3.75	0.33	B2 cylinder exhaust gas temperature variation-sudden drop
99	4-Aug-09	5.52	5.77	0.25	B5 cylinder exhaust gas temperature variation-sudden drop
100	5-Aug-09	18.93	19.88	0.95	B8 cylinder exhaust gas temperature variation
101	5-Aug-09	5.22	5.53	0.31	B3 cylinder exhaust gas temperature variation-sudden drop
102	7-Aug-09	13.72	14.12	0.40	B1 cylinder heavy knocking
103	7-Aug-09	17.32	17.83	0.51	A1 & B2 exhaust gas temperature variation
104	7-Aug-09	18.06	18.73	0.67	B2 cylinder exhaust gas temperature variation
105	11-Aug-09	15.87	16.22	0.35	B1 cylinder heavy knocking
106	12-Aug-09	9.28	9.62	0.34	B2 cylinder heavy knocking & A7 cylinder
107	12-Aug-09	2.85	3.13	0.28	B6 cylinder heavy knocking
108	13-Aug-09	12.13	13.35	1.22	B2 knocking & A7 exhaust temperature deviation
109	15-Aug-09	10.25	12.20	1.95	A7 cylinder sparkplug, NRV and
110	20-Aug-09	5.38	5.81	0.43	B1 cylinder sparkplug and NRV replacement
111	21-Aug-09	6.66	7.15	0.49	A2 cylinder sparkplug and NRV replacement
112	22-Aug-09	9.73	14.97	5.24	TNEB LC
113	22-Aug-09	15.28	15.44	0.16	High inlet gas pressure
114	24-Aug-09	14.52	15.14	0.62	B4, B6 cylinder sparkplug and NRV replacement
115	24-Aug-09	15.65	16.33	0.68	B4 & B6 cylinder MCC valve replacement
116	25-Aug-09	9.53	9.83	0.30	B6 cylinder exhaust temperature variation
117	25-Aug-09	20.23	21.20	0.97	Input convertor inspection
118	25-Aug-09	22.78	23.54	0.76	A8 cylinder exhaust temperature variation
119	26-Aug-09	20.30	22.00	1.70	Stopped for rupture disc replacement
120	26-Aug-09	3.43	5.10	1.67	TNEB grid failure
121	28-Aug-09	3.94	6.00	2.06	Stopped for rupture disc replacement
122	3-Sep-09	9.10	9.57	0.47	A5 & A6 low exhaust gas temperature
123	5-Sep-09	13.67	14.04	0.37	A4 cylinder exhaust temperature variation
124	11-Sep-09	6.53	7.35	0.82	A4 unit NRV replacement
125	11-Sep-09	7.55	8.12	0.57	A4 unit PCC swapped with A3 unit
126	11-Sep-09	9.18	10.60	1.42	A4 unit prechamber changed
127	14-Sep-09	17.85	18.27	0.42	B8 cylinder exhaust gas temperature low

128	14-Sep-09	18.72	19.19	0.47	B8 cylinder exhaust gas temperature low
129	26-Sep-09	9.77	15.25	5.48	TNEB LC
130	26-Sep-09	15.25	18.17	2.92	Exhaust gas temperature variations
131	26-Sep-09	19.67	20.09	0.42	A5 exhaust temperature drop
132	28-Sep-09	17.43	17.92	0.49	A9 cylinder exhaust temperature variation
133	3-Oct-09	6.62	6.90	0.28	A5 cylinder exhaust temperature variation
134	3-Oct-09	11.50	11.82	0.32	A5 cylinder exhaust temperature variation
135	20-Oct-09	23.40	4.20	4.80	Gas consumption restriction & TNEB export
136	24-Oct-09	9.32	20.39	11.07	TNEB LC
137	31-Oct-09	19.10	19.36	0.26	B2 cylinder exhaust temperature variation
138	3-Nov-09	0.28	1.33	1.05	B6 cylinder exhaust gas temperature variation
139	17-Nov-09	10.88	12.37	1.49	T/C speed sensor adjustment
Sub-total for Gas Engine 2				**203.45 hours (or) 203 hours and 27 minutes**	Above said reasons
Gas Engine 3 (ESN 21595)					
1	3-Nov-08	6.40	7.55	1.15	110kV grid failure
2	7-Nov-08	16.87	17.17	0.30	A8 cylinder exhaust gas temperature low
3	8-Nov-08	9.30	9.50	0.20	B1 cylinder spark plug failure
4	17-Nov-08	11.58	12.24	0.66	110kV grid failure
5	19-Nov-08	11.10	12.30	1.20	110kV grid supply failure
6	20-Nov-08	12.85	13.16	0.31	B3 cylinder exhaust gas temperature high
7	23-Nov-08	2.50	2.68	0.18	A9 cylinder spark plug failure
8	24-Nov-08	15.22	15.94	0.72	110kV grid failure
9	25-Nov-08	1.40	2.05	0.65	EB grid failure
10	25-Nov-08	2.62	3.17	0.55	EB grid failure
11	26-Nov-08	9.02	9.67	0.65	110kV grid failure
12	27-Nov-08	13.02	14.12	1.10	110kV grid failure
13	8-Dec-08	21.68	22.37	0.69	A4 & B5 cylinder exhaust temperature deviation
14	15-Dec-08	5.27	5.66	0.39	A8 low exhaust temperature/low gas feed
15	16-Dec-08	12.77	13.32	0.55	B4 cylinder PCC valve failure
16	16-Dec-08	13.92	14.93	1.01	A8 cylinder exhaust temperature variation
17	17-Dec-08	12.70	13.02	0.32	B2 & A5 cylinders spark plug failure
18	20-Dec-08	12.85	13.51	0.66	B6 &B9 PCC removed for analysis
19	27-Dec-08	12.23	18.33	6.10	TNEB LC

20	29-Dec-08	14.32	15.22	0.90	Grid power supply failure
21	30-Dec-08	21.55	21.98	0.43	A2 cylinder PCC valve failure
22	30-Dec-08	23.83	0.69	0.86	A2 cylinder PCC valve failure
23	1-Jan-09	13.83	14.05	0.22	B2 cylinder spark plug failure
24	1-Jan-09	15.65	16.20	0.55	B6 & B2 PCC replacement
25	3-Jan-09	15.22	18.36	3.14	ABT meter fixing in TNEB yard
26	8-Jan-09	21.05	5.83	8.78	Stopped due to low gas pressure (GAIL)
27	12-Jan-09	1.60	1.80	0.20	A1 cylinder exhaust temperature variation
28	12-Jan-09	2.78	4.00	1.22	B6 cylinder exhaust gas temperature low
29	12-Jan-09	4.27	6.00	1.73	B6 cylinder exhaust gas temperature low
30	13-Jan-09	6.00	6.25	0.25	B6 cylinder exhaust gas temperature low
31	13-Jan-09	11.35	12.05	0.70	B1 & B3 cylinder exhaust temperature variation
32	13-Jan-09	12.05	13.28	1.23	Grid failure
33	14-Jan-09	13.88	14.16	0.28	B9 cylinder exhaust temperature variation
34	15-Jan-09	7.57	8.58	1.01	110kV grid failure
35	19-Jan-09	12.55	13.62	1.07	B8 cylinder PCC valve failure
36	20-Jan-09	6.75	8.52	1.77	A4 cylinder exhaust temperature variation
37	24-Jan-09	12.00	16.52	4.52	TNEB LC
38	4-Feb-09	5.69	6.00	0.31	B7 cylinder exhaust temperature variation
39	5-Feb-09	6.00	7.81	1.81	B7 cylinder exhaust temperature deviation
40	11-Feb-09	4.82	6.00	1.18	A4 & A5 cylinders low exhaust temperature
41	12-Feb-09	6.00	7.32	1.32	A4 cylinder PCC valve replacement
42	13-Feb-09	6.33	6.90	0.57	B7 cylinder PCC valve replacement
43	13-Feb-09	13.62	13.81	0.19	B8 cylinder PCC valve cleaning
44	16-Feb-09	8.66	8.84	0.18	B7 cylinder low exhaust temperature
45	20-Feb-09	19.35	19.54	0.19	B5 cylinder spark plug failure
46	26-Feb-09	23.58	0.81	1.23	Grid disturbance
47	10-Mar-09	11.92	12.32	0.40	B3 cylinder exhaust temperature deviation
48	14-Mar-09	18.08	18.36	0.28	B7 cylinder exhaust temperature deviation
49	21-Mar-09	10.92	11.68	0.76	T/C, A bank speed sensor renewal
50	30-Mar-09	16.73	16.95	0.22	B2 cylinder exhaust temperature sudden drop
51	31-Mar-09	12.40	12.78	0.38	Tripped on A1 knocking – low gas pressure
52	31-Mar-09	17.90	18.17	0.27	Tripped on low gas feed pressure
53	7-Apr-09	17.61	17.81	0.20	A6 cylinder exhaust temperature variation

54	10-Apr-09	11.87	12.07	0.20	Tripped due to A8 cylinder heavy knocking
55	13-Apr-09	6.28	6.47	0.19	B1 cylinder heavy knocking
56	17-Apr-09	11.58	11.90	0.32	A3 cylinder exhaust temperature deviation
57	25-Apr-09	9.50	18.17	8.67	TNEB LC
58	26-Apr-09	6.72	7.91	1.19	EB grid failure
59	28-Apr-09	11.38	12.14	0.76	Low inlet gas pressure-sudden drop
60	5-May-09	12.90	14.73	1.83	B6 cylinder exhaust temperature variation
61	7-May-09	14.53	15.91	1.38	A3 cylinder exhaust temperature variation
62	7-May-09	20.63	20.95	0.32	B1 cylinder heavy knocking
63	7-May-09	21.73	22.40	0.67	A6 & B4 cylinder exhaust temperature variation
64	7-May-09	3.26	3.53	0.27	B3 cylinder exhaust temperature variation
65	8-May-09	10.42	10.62	0.20	B9 cylinder exhaust temperature variation
66	9-May-09	10.92	11.13	0.21	B9 cylinder exhaust temperature variation
67	11-May-09	15.82	16.02	0.20	B7 spark plug failure
68	15-May-09	20.32	20.53	0.21	B2 unit spark plug and NRV replacement
69	15-May-09	21.02	21.65	0.63	B2 unit MCC valve replacement
70	15-May-09	22.40	22.60	0.20	B7 unit spark plug and NVRV replacement
71	16-May-09	12.03	12.50	0.47	A6 & B8 cylinder exhaust temperature variation
72	16-May-09	17.60	18.62	1.02	A4, A7 & B5 cylinder exhaust temperature variation
73	21-May-09	21.00	21.37	0.37	B2 cylinder exhaust temperature variation
74	21-May-09	22.12	22.54	0.42	A3 cylinder exhaust temperature variation
75	21-May-09	1.00	1.52	0.52	A8 cylinder exhaust temperature variation
76	21-May-09	3.90	5.83	1.93	Waste Gate positioned problem
77	22-May-09	6.00	7.29	1.29	WECS HW connection checking
78	23-May-09	11.87	12.13	0.26	A1 unit sparkplug replacement
79	24-May-09	10.65	10.87	0.22	A3 cylinder exhaust temperature variation
80	26-May-09	9.10	20.01	10.91	TNEB LC
81	27-May-09	14.85	15.08	0.23	A3 cylinder spark plug and NRV replacement
82	27-May-09	15.45	15.90	0.45	A3 cylinder spark plug and NRV replacement
83	27-May-09	5.95	6.00	0.05	B7 cylinder spark plug and NRV replacement
84	28-May-09	6.00	6.25	0.25	B7 cylinder exhaust temperature variation
85	30-May-09	15.48	15.68	0.20	A7 unit spark plug replacement
86	1-Jun-09	11.72	11.93	0.21	B2 cylinder exhaust temperature variation

87	1-Jun-09	3.10	3.30	0.20	B8 cylinder exhaust temperature variation
88	4-Jun-09	7.97	8.22	0.25	B2 exhaust temperature sudden drop
89	4-Jun-09	8.50	8.87	0.37	A3 cylinder exhaust temperature variation
90	9-Jun-09	1.60	1.82	0.22	B2 cylinder exhaust gas temperature variation
91	10-Jun-09	7.90	9.50	1.60	Plant tripped due to grid under voltage
92	10-Jun-09	2.50	2.83	0.33	Tripped due to low gas inlet pressure
93	12-Jun-09	17.13	17.92	0.79	A3 cylinder, MCC valve replacement
94	12-Jun-09	19.98	20.38	0.40	A3 cylinder spark plug and NRV replacement
95	12-Jun-09	20.85	21.06	0.21	A3 cylinder ignition coil and extension
96	13-Jun-09	10.57	10.98	0.41	Tripped due to A4 cylinder exhaust gas
97	13-Jun-09	11.63	12.15	0.52	Tripped due to A4 cylinder exhaust gas
98	20-Jun-09	23.03	23.38	0.35	Plant tripped due to grid under voltage
99	20-Jun-09	0.38	0.52	0.14	B2 cylinder spark replacement
100	3-Jul-09	16.73	16.95	0.22	B5 cylinder spark plug and NRV replacement
101	25-Jul-09	6.82	17.15	10.33	TNEB LC
102	26-Jul-09	13.40	14.57	1.17	A6 cylinder spark plug and NRV replacement
103	30-Jul-09	15.35	15.53	0.18	B1 cylinder exhaust temperature variation
104	3-Aug-09	20.12	20.32	0.20	A1 cylinder heavy knocking
105	16-Aug-09	8.20	8.70	0.50	A2 cylinder sparkplug and NRV replacement
106	19-Aug-09	11.48	11.70	0.22	A2 cylinder sparkplug and NRV replacement
107	20-Aug-09	12.05	12.44	0.39	B1 cylinder sparkplug and NRV replacement
108	21-Aug-09	8.90	9.08	0.18	A2 cylinder sparkplug and NRV replacement
109	21-Aug-09	9.90	10.66	0.76	B7 cylinder sparkplug and NRV replacement
110	22-Aug-09	9.75	14.08	4.33	TNEB LC
111	22-Aug-09	15.28	15.91	0.63	High inlet gas pressure
112	24-Aug-09	2.15	2.42	0.27	B7 cylinder sparkplug and NRV replacement
113	25-Aug-09	22.45	23.23	0.78	B3 cylinder exhaust temperature variation
114	26-Aug-09	3.43	4.92	1.49	TNEB grid failure
115	2-Sep-09	23.60	0.42	0.82	B4 cylinder sparkplug and NRV replacement
116	23-Sep-09	6.22	6.42	0.20	A5 cylinder exhaust gas temperature sudden drop
117	23-Sep-09	1.83	2.03	0.20	B9 cylinder exhaust gas temperature variation
118	26-Sep-09	7.02	17.60	10.58	TNEB LC

119	27-Sep-09	12.15	12.49	0.34	A1 cylinder exhaust temperature variation
120	15-Oct-09	11.33	11.46	0.13	B3 cylinder low deviation in exhaust temperature
121	24-Oct-09	9.32	20.22	10.90	TNEB LC
Sub-total for Gas Engine 3				**142.6 hours (or) 142 hours and 36 minutes**	Above said reasons
Total hours of deemed generation for three gas engines				**114.2 + 203.45 + 142.6 = 460.25 hours (or) 460 hours and 15 minutes**	

(1) Total hours of forced outage **= 13.61 hours**

(2) Total hours of scheduled maintenance **= 401.68 hours**

(3) Total hours of deemed generation **= 460.25 hours**

Total of (1), (2) and (3) **= 875.54 hours**

(or) 875 hours, 32 minutes & 24 seconds

Annex 2: Power and Fuel balance

Power Balance:

The power balance is done as follows:

(Gas Engine meter 1 gross generation + Gas Engine meter 2 gross generation + Gas Engine meter 3 gross generation) – (Auxiliary power plant consumption 1 + Auxiliary power plant consumption 2) – Electricity export to consumer – Electricity export to TNEB grid = Difference

Month	Net Electricity Generation	Total energy export (Energy export to consumer + TNEB grid)	% Difference
	MWh	MWh	%
November-08	8662	8667	-0.06%
December-08	10382	10387	-0.05%
January-09	10247	10252	-0.05%
February-09	8719	8664	0.63%
March-09	9851	9837	0.14%
April-09	9004	8986	0.20%
May-09	9499	9486	0.13%
June-09	8383	8366	0.20%
July-09	8655	8649	0.08%
August-09	10562	10553	0.09%
September-09	8993	8985	0.09%
October-09	8604	8589	0.17%
November-09	5730	5720	0.17%
Total	**117290.223**	**117141.400**	**0.13%**

The % difference between the net electricity generation and total energy export to the consumer and the TNEB grid (as per readings recorded by OPG personnel) comes out to **0.13%.**

The electricity export to TNEB grid as per TNEB statement and as recorded by OPG personnel have been compared and tabulated below.

Month	Electricity export to grid based on TNEB meter reading - recorded by TNEB personnel	Electricity export to grid based on TNEB meter reading - recorded by OPG personnel	Difference	
	MWh	MWh	MWh	%
November-08	1690[9]	1694	-4	-0.25%
December-08	3321	3300	21	0.63%
January-09	5521	5539	-18	-0.33%
February-09	6400	6356	44	0.69%
March-09	7339	7339	0	0.00%
April-09	7995	7985	10	0.13%
May-09	7789	7782	7	0.09%
June-09	7675	7656	19	0.25%
July-09	6881	6927	-46	-0.67%
August-09	7361	7408	-47	-0.64%
September-09	6102	6071	31	0.51%
October-09	5852	5807	45	0.77%
November-09	6999	7007	-8	-0.11%
Total	**80924.774**	**80573.000**	**351.774**	**0.07%**

The average % difference between the two readings comes out to **0.07%.**

[9] TNEB statements provide electricity export readings from the 22nd to the 21st of every month. Hence, the TNEB statement for the month of November 2008 provides the electricity export from OPG for the period 22 October, 2008 to 21 November, 2008. Since the monitoring period starts from 3 November, 2008, the electricity export has been apportioned for 19 days (3 November to 21 November). Thus,
(Electricity export to grid from 3 Nov to 21 Nov, 2008) = (19/31) x (Electricity exported to grid from 22 Oct, 2008 to 21 Nov, 2008)
The same principle has been applied for electricity export to grid based on TNEB energy meter reading as recorded by OPG personnel.

Fuel Balance:

The fuel balance is done as follows:

GAIL Natural Gas flow meter – (Gas Engine 1 flow meter + Gas Engine 2 flow meter + Gas Engine 3 flow meter) = Difference

Month	GAIL Natural Gas Flow Meter			Gas Engine 1	Gas Engine 2	Gas Engine 3	Difference
	First Fortnight	Second Fortnight	Total Natural Gas consumption	Total Natural Gas consumption	Total Natural Gas consumption	Total Natural Gas consumption	
	m^3	m^3	m^3	m^3	m^3	m^3	%
November-08	857234	1083792	1941026	757777	416735	762953	0.18%
December-08	1161129	1168234	2329363	785125	751473	785117	0.33%
January-09	1121566	1173750	2295316	778324	758519	759723	0.05%
February-09	1057838	916612	1974450	633374	674503	667887	0.07%
March-09	1078741	1153744	2232485	709408	761445	763236	0.07%
April-09	1042604	1003644	2046248	636619	706049	707890	0.21%
May-09	1118973	1045646	2164619	663072	752670	768667	0.91%
June-09	957314	994725	1952039	622999	660694	659195	0.47%
July-09	946814	1059252	2006066	642884	679548	670682	0.65%
August-09	1198433	1171185	2369618	728430	796224	872731	1.17%
September-09	1076450	988004	2064454	667932	685889	708856	0.09%
October-09	990237	1000417	1990654	634345	671332	685223	0.01%
November-09	959360	378149	1337509	459868	463096	436070	1.61%
Total	**13566693**	**13137154**	**26703847**	**8720157**	**8778177**	**9248230**	**0.16%**

The % difference between the two readings comes out to **0.16%.**

Annex 3: Details on breakdown of Steam Turbine Generator

OPG experienced a major breakdown of the steam turbine rotor and its casing in the Steam Turbine Generator (STG) plant (which is connected to the Waste Heat Recovery boiler system that is connected to the three gas engines). The incident occurred soon after the maintenance was carried out on the throttle valve and the governor on the 13th and 14th of October, 2008. The equipment has not been operational throughout the first monitoring period from 3rd November 2008 to 21st November 2009 and hence no emission reductions have been generated from the STG.

Immediately after the STG was started and synchronized, load hunting was observed. This further caused tripping of the TG breaker. The boiler steam pressure was brought down to 0 bar and on stoppage of the turbine, the following damages were observed:

- Turbine blades uprooted and pierced the turbine casing broken at 3-4 places in the bottom side.
- Exhaust bellow punctured at 2-3 places.
- Governor base bolts uprooted from place and governor displaced from position
- Throttle valve lever got bent
- Turbine blade pieces and Turbine casing bottom pieces found scattered underneath the turbine casing
- Some of the Turbine blade pieces have travelled inside the exhaust duct.
- Bearings/carbon seals have failed and badly damaged
- Rotor blades have been badly damaged and discs seating area also damaged

Annex 4: Abbreviations

ABT	Availability Based Tariff
Aux	Auxiliary
BM	Build Margin
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CER	Certified Emission Reductions
CH_4	Methane
CM	Combined Margin
CO_2	Carbon dioxide
DOE	Designated Operational Entity
ESN	Engine Serial Number
GAIL	Gas Authority of India Limited
GE	Gas Engine
GHG	Greenhouse Gas
GJ	Giga Joule
GM	General Manager
GWP	Global Warming Potential
HW	Hardware
IC	Internal Combustion
IPCC	Inter-governmental Panel on Climate Change
kCal	Kilo calories
kW	Kilo Watt
kWh	Kilo Watt hour
LC	Line Clearance
MCC	Main Chamber Control
MW	Mega Watt
MWh	Mega Watt hour
NCV	Net Calorific Value
NG	Natural Gas

NRV	Non Return Valve
OM	Operating Margin
OPG MPL	OPG Metals Private Limited
PCC	Prechamber Control
PDD	Project Design Document
PLC	Programmable Logic Controller
PP	Project Plant
QA/QC	Quality Assurance/Quality Control
rpm	Revolutions per minute
SCM	Standard Cubic Meter
SO_2	Sulphur dioxide
STG	Steam Turbine Generator
T/C	Turbo charger
tCH_4	Tonnes of methane
tCO_2e	Tonnes of carbon dioxide equivalent
TNEB	Tamil Nadu Electricity Board
UNFCCC	United Nations Framework Convention on Climate Change
WECS	Wartsila Engine Control System
WHR	Waste Heat Recovery