119.8 MW NATURAL GAS BASED COMBINED CYCLE POWER PLANT, AT TANJAVUR, TAMILNADU BY M/S ABAN POWER COMPANY LIMITED

Document Prepared by EKI Energy Services Limited

Project Title	119.8 MW Natural Gas Based Combined Cycle Power Plant, at Tanjavur, Tamilnadu by M/s Aban Power Company Limited
Version	02
Report ID	-
Date of Issue	20-Sept-2021
Project ID	68[1]
Monitoring Period	16-December-2010 to 10-August-2015 (first and last date included)
Prepared By	Anant Ladukar Senior Manager - Operations EKI Energy Services Limited
Contact	EnKing Embassy, Office No. 201, Plot 48, Scheme 78, Part 2 Vijay Nagar, Near brilliant Convention Centre, Indore- 452010 Madhya Pradesh, India Website: www.enkingint.org Email ID: anant@enkingint.org; registry@enkingint.org M: +91 9770900205

[1] https://registry.verra.org/app/projectDetail/VCS/68

CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Project activity, Lanco Tanjore Power Company Limited[2] formerly Aban Power Company Limited (APCL) 119.8 MW Natural Gas based Power Combined Cycle Power Plant, has been setup at Karuppur Village, Thiruvidaimarudur Taluk, Tanjavur Dist, Tamilnadu, India. APCL is an ISO 14001 and ISO 18001 certified Company. The project is situated around 260 kilo meters from Chennai (capital of Tamilnadu state). This power plant operating on cleaner fuel like Natural Gas will lead to lower Carbon Dioxide (GHG) emissions for producing equivalent amount of power as compared to the other power plants in the region operating on other fuels like coal/ lignite/oil/ naphtha.

Brief description of the installed technology and equipment:

The Natural gas based Combined Cycle Power Project (CCPP), with installed capacity of 119.8 MW, has one (1) Gas Turbine Generating (GTG) Unit of 68.6 MW rated capacity, one (1) Heat Recovery Steam Generator (HRSG) and one (1) Steam Turbine Generating (STG) Unit of 51.2 MW rated capacity, along with all electrical systems, controls and Instrumentation, Civil, Structural and Architectural works.

The 'Can' type combustor is fired with Natural gas and produces hot, high pressure, low NOx containing flue gases, which is expanded in the Gas Turbine. The Gas turbine would drive on one end an AC generator and on other end an axial compressor, which supplies the compressed ambient air to the combustor. The heat of high temperature exit gases of turbine is recovered in HRSG, designed to maximize the heat recovery of gases and allows the outlet of gases at minimum stack temperature (105- 110ºC). The steam turbine of single cylinder, no reheat, condensing type is designed to operate with steam at 105 bar, 538ºC / 6.9 bar, 257ºC. The designed speed of turbine is 5810 rpm and is suitable for continuous operation at Maximum Continuous Rating (MCR) output in the frequency band of +5% to –3% of 50 Hz without any limitation. The steam turbine has control system of electro hydraulic type. The turbine is designed for sliding pressure mode of operation for high efficiency at part load.

The cycle efficiency of natural gas based combined cycle power plant is in the range of 50-55% as compared to average cycle efficiency of 36-42% of coal fired Rankine cycle based thermal power plants[3]. The project, to be operated by independent power producer, is one of the rare CCPP projects in India, which will work at such high cycle efficiency.

The relevant implementation dates
After obtaining all necessary statutory approvals, the Plant has commenced its commercial operations since 11-August-2005 and started exporting clean power to grid. However, the

[2] The name of Aban Power Company Limited has changed to Lanco Tanjore Power Company Limited on dated 18/04/2011.Incorporation certificate is attached for verification.

[3] Infraline report on " Natural gas in Power Sector: Issues and Challenges" – Page No. 2 (http://www.infraline.com/ong/naturalgas/enduse/InfralinePaperNatGasPowSec.pdf). This page can be viewed with paid subscription.

credit period of the Project Activity started from January 2006 as per the Registered Project Design Document (PDD) considering the four months of stabilization period.

The total GHG emission reductions or removals generated in this monitoring period.

The total emission reductions achieved in this monitoring period i.e. from 16-December-2010 to 10-August-2015 (first and last date included) is 13,54,428 tCO_2 e.

1.2 Sectoral Scope and Project Type

Project Title: Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas
Sectoral Scope: 1 Energy industries (renewable - / non-renewable sources)

Project is not grouped project activity as per VCS guidelines.

1.3 Project Proponent

Organization name	Lanco Tanjore Power Company Limited (formerly Aban Power Company Limited)
Contact person	Mr. S. Kathir Kamanathan
Title	Chief Financial Officer
Address	No. 25, G N Chetty Road, T Nagar, Chennai – 600 017
Telephone	NA
Email	NA

1.4 Other Entities Involved in the Project

Organization name	EKI Energy Services Limited
Role in the Project	Project Consultant
Contact person	Anant Ladukar
Title	Senior Manager
Address	Office No 201, Plot No 48, Scheme 78, Vijay Nagar Part- II, Indore 452010, India
Telephone	9770900205
Email	anant@enkingint.org / registry@enkingint.org

1.5 Project Start Date

Project Start date: 11-August-2005
This date is considered due to the fact that the project activity began reducing GHG emissions from this date as it is the commercial operation date.

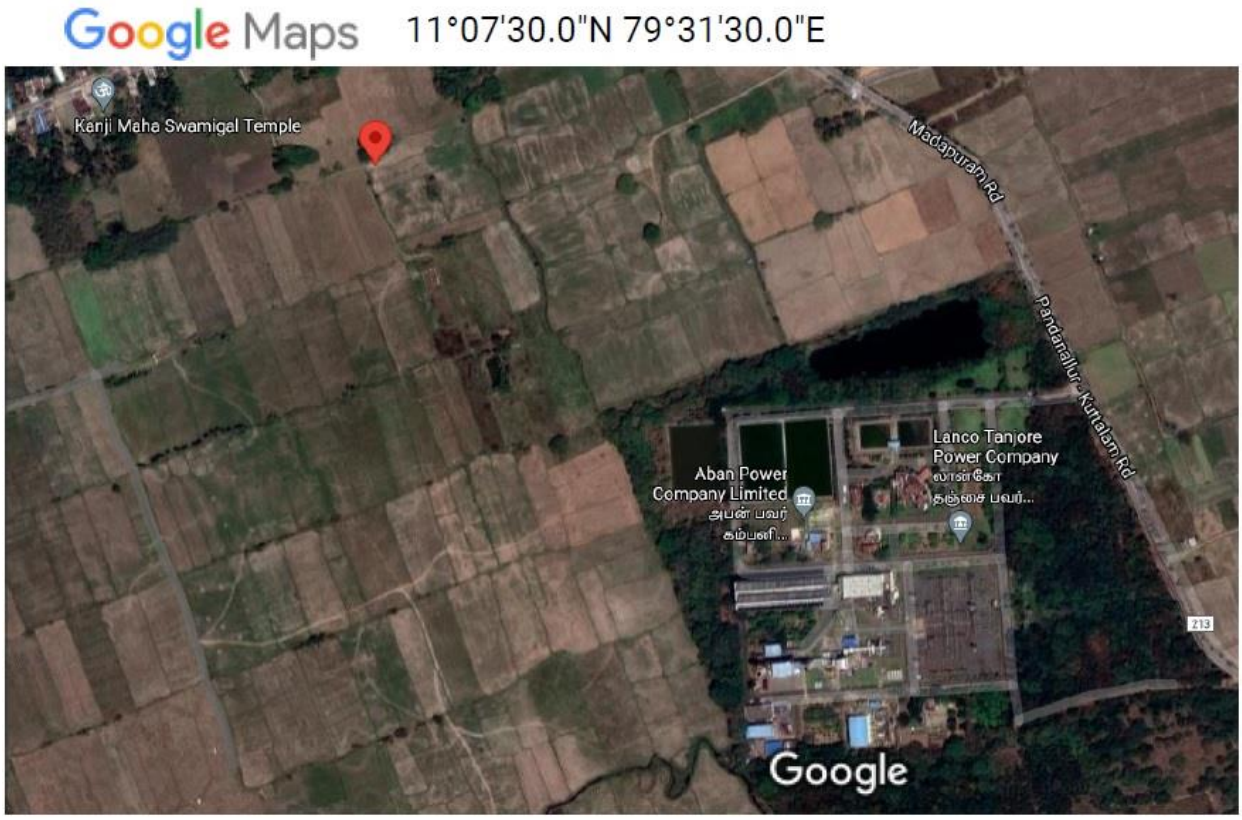
1.6 Project Crediting Period

Project Crediting Period Start date: 11-August-2005
Project Crediting Period End date: 10-August-2015
Total Crediting Period: 10 Years (Fixed)

1.7 Project Location

The power plant has been set up in Karuppur Village, Taluk Thiruvidaimarudur of Thanjavur District in the state of Tamilnadu, India. The site is at 11º7'30"N latitude and 79º31'30"E longitude. The site elevation is 10.5 m above the mean sea level.

The nearest Railway station is at Kuttalam, which is about 8 kms from the site towards south. The power plant site including infra-structural facilities, green belt, open space etc. encompasses a total area of 51 acres. The ambient temperature varies between 20ºC to 35ºC and the annual average rainfall is about 1300 mm.



1.8 Title and Reference of Methodology

Title: "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas". Version 01.1[4]

Reference: Approved baseline methodology AM0029

Methodology refers to the tool for calculating baseline CO_2 emission factor.

[4] https://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_AM_KTKZTS1HEG4JBIETV74WMLZY10061X

Title: "Tool to calculate emission factor for an electricity system" Version 03.0, EB 70 Annex 22[5]

1.9 Participation under other GHG Programs

The project is registered in CDM with UNFCCC reference 0999[6].

For CDM Project 0999 CERs issued from 01-January-2006 to 15-December-2010 and in VCS current monitoring period is considered from 16-December-2010 to 10-August-2015.

PP has provided undertaking that in current monitoring period, it would not claim GHG emission reduction credits in any GHG program other than that in VERRA. There would be no double counting of GHG emission reductions.

1.10 Other Forms of Credit

Emission Trading Programs and Other Binding Limits: The project proponent is not participating in any other emission trading program and other binding limits.
The project activity is not availing any REC benefits and the same can be confirmed from publicly available link of REC generators.
https://www.recregistryindia.nic.in/index.php/publics/registered_regens

Other Forms of Environmental Credit: The project activity neither has nor intends to generate any other form of GHG related environmental credit for GHG emission reductions or removals claimed under the VCS Program.

1.11 Sustainable Development

A brief description of the contribution of the project activity towards 'Sustainable Development of India' is discussed hereunder.

1. **Environment Wellbeing**

The project activity is a clean fuel power project, which uses Natural Gas as a fuel for power generation and export the clean power to TNEB grid. This power generation substitutes the power generation by TNEB which is predominantly operated with coal as fuel. Since the Carbon Dioxide (CO_2) emission due to combustion of Natural Gas is substantially less as compared to combustion of coal, lignite or Naptha, the project helps in reducing GHG emission.

Indian economy is highly dependent on "Coal" as fuel to generate energy and for production processes. Thermal Power Plants are the major consumers of Coal in India, and yet the basic power needs of a large section of society are not being met. This results in excessive demands for electricity and places immense stress on the environment. Changing coal consumption patterns will require a multi-pronged strategy focusing on demand, reducing wastage of energy and the optimum use of Clean Energy Sources like Natural Gas.

Since this project activity is based on natural gas, it will positively contribute towards the reduction in (demand) use of coal and increasing its availability to other places where natural gas is not available.

[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v3.0.0.pdf
[6] https://cdm.unfccc.int/Projects/DB/RWTUV1173779090.0/view

The project activity, by feeding clean power to grid will reduce CO_2 emissions, which would have been otherwise generated by coal dominated power plants. This project activity therefore has excellent environmental benefits in terms of reduction in carbon emissions and coal resource conservation. Also, gas based power plants would not lead to production of huge quantities of solid waste (like ash in thermal power plants) and hence reduces the burden of solid waste disposal.

2. Technical wellbeing

The project activity also consumes comparatively lesser quantity of water than coal based power plants and hence conserves scarce resource and also due to the installation of air cooled condensers in place of water cooled condensers. The project also uses the latest available technology for gas based power generation using FA[7] type of gas turbines.

3. Social wellbeing

Project activity is providing direct employment to about 60 persons and indirectly creating business opportunity for stakeholders like bankers, consultants, suppliers, manufacturers, contractors, traders, caterers etc. Also, plant management is involved in several social activities like conducting health camps, setting up of artificial limb centre etc.

4. Economic Wellbeing

Implementation of project activity would encourage the economic development in the region and also improves the economic wellbeing of neighbouring villages by providing direct and indirect employment opportunities in the region. The project implementation also improves the power supply situation in the state which in turn help industry to improve their productivity due to reduction of power cuts.

Overall, this project activity will contribute to the Environmental & Social issues locally and globally by:

- Exporting 113.2 MW to TNEB and thereby eliminating the generation of same quantity of power by a fossil fuel based power plants, which would have been installed to meet the increasing electricity supply and demand gap in the state;
- Conserving Coal, a fuel used by masses in India for daily living need
- Making coal available for other important applications;
- Reducing GHG (Carbon Dioxide) emissions; and
- Providing direct employment to about 60 person and indirectly creating business opportunity for stakeholders like bankers, consultants, suppliers, manufacturers, contractors, traders, caterers etc.
- Space requirements per MW for a gas based stations are less than coal based stations.

2 SAFEGUARDS

[7] "F" is main series and "A" is sub series

2.1 No Net Harm

Host party regulations requires Aban Power Company Limited (APCL) to obtain environmental clearance in the form of "No objection Certificate" from Tamil Nadu Pollution Control Board. The other condition is that the site of the project is to be approved from the environmental angle and that the Environmental Management Plans are to be prepared and submitted to the pollution control board. Environmental Impact Assessment has been conducted for the project activity and the study indicates that the impacts of the project are not significant. The assessment of environmental impact due to the project activity has been carried out to understand if there are any significant environmental impacts and a management plan has been prepared to minimise adverse environmental impact.

The findings of the EIA are summarised below.

Sr. No.	Component of environment	Possible Impact (Phase wise)		Measures taken by APCL
		Construction Phase	Operational Phase	
1	Soil	• Soil erosion • Decreased permeability	• Soil contamination from sludge discharge • Change in pH level of soil due to deposition of air pollutants	• The impacts during construction stages were localised in nature and not posed any significant long term threat over a period of time. • The discharged sludge is not expected to contain any obnoxious substance to contaminate the soil. The NOx level was well within the permissible levels and did not have any adverse effect on soil. • As a precautionary measure, however, soil samples will be periodically collected from close to the maximum deposition areas of air pollutants and analysed for relevant parameters during the post operational monitoring
2	Hydrology	• No significant impact on surface hydrological conditions • The possibility of slight depletion of ground water table as water for construction will be drawn from ground water source	• impact on the surface hydrological conditions for the withdrawal of water for running the plant • No impact on groundwater conditions during operational phase	• The slight depletion of ground water table during construction phase is only temporary, and is negligible in the long run • The impact on the surface hydrological conditions would be felt marginally during operational phase.
3	Water	• Discharge of untreated sewage would result in fecal	• The possible contamination of water due to effluent discharge	• In order that no adverse environmental impacts are created due to setting up of this plant through improper sanitation, drainage etc, the

Sr. No.	Component of environment	Possible Impact (Phase wise)		Measures taken by APCL
		Construction Phase	Operational Phase	
		contamination that could lead to development of waterborne diseases as cholera, typhoid etc	in the river. • The possible groundwater contamination for improper disposal of sludge.	settlements are provided with suitable provision of essential basic amenities as water supply, sewerage and drainage system and solid waste disposal arrangements • The different plant effluents are subjected to various forms of treatment and would be monitored to conform to more than the applicable discharge standards as per EPA, 1986. • The impact from water is due to plant waste water like service water and sanitary effluent totaling up to 168 m^3/day. Sanitary waste water will be let into a septic tank and the overflow into the STP. Service waste water also will flow into the ETP system. Total quantity of service water and sanitary waste water is about 7 m^3/hr. About 6.5-m^3/hr water will be taken to RO (Reverse Osmosis) Plant and out of this 5 m^3/hr water will be recycled to Demineralisation (DM) plant. The ETP system consists of guard pond, aerator tank with a surface aerator, RO plant and solar evaporation pond. In the aeration tank, due to aerobic degradation of organic matter, BOD and COD levels will come down and after settling of suspended solids in the settling tank, the supernatant water from this tank will be let out for gardening and green belt development within the plant premises as the quality of water will conform to the permissible limits as per Indian Standard IS- 2490.
5	Air	• Suspended particulate matter generation because of various construction activities. • Air pollution because of exhaust from vehicular	• Air pollution from combustion of natural gas.	• During construction suitable dust suppression system through atomized sprinklers was installed at the major dust generation points. The plant area was watered from trucks through water sprays. • The pollution due to vehicular exhausts and other related activities during construction phase was negligible, when compared to dust. • Tall stack of 38 metres height for wider dispersal of pollutants, resulting

Sr. No.	Component of environment	Possible Impact (Phase wise)		Measures taken by APCL
		Construction Phase	Operational Phase	
		movements during the construction activities		in lower ground level concentrations. • Low NOx burners would be used to limit NOx emissions to only 50 ppm
8	Demography and socio economics	• Demographic changes due to sudden influx of population • Effect of necessary resettlement	• The demographic impact on the plant site and in the nearest cities for the plant.	• The demographic impact on the area during construction phase will be marginal. • The demographic impact on the existing community and its surrounds are unlikely to feel any significant impacts during the operational phase of the project activity.
9	Noise	• Noise pollution from heavy earth moving and construction machineries. • Noise pollution from blasting operation	• High noise generation from turbine generator and cooling tower	• Careful scheduling of the operation of the high noise machines was done during this period, particularly during night time, so that minimum disturbances are caused. To reduce noise pollution from blasting, noise absorbers were used between the foundation and the earth/soil. This would appease impacts due to noise and vibrations on the nearby villages. • Impacts on persons working very close to the sources are likely. Therefore, the latter would be provided with adequate protection against noise in the form of ear plugs, helmets etc.

2.2 Local Stakeholder Consultation

During this monitoring period, Aban Power Company Limited maintained a formal grievance and redress procedure for local communities and other stakeholders. All reported cases were assessed and resolution was done based on the feedback from the stakeholders.

The issues raised by the stakeholders and the resolution done by project promoters are as follows.

Date	Name of Stakeholder	Comments by Stakeholder	Feedback by Abhan Power Limited
27-May-2010	S. Ramdas President, Alangudi Panchayat	Provide of medical camp facility in our village	Medical camp was conducted by qualified doctor, nurse, Admin Asst. with mob. health van driver on every Saturday
10-Jan-2011	Mrs. G. Thanghwan, President, Karppur Panchayat	Provide Scholarship for poor village students for their academic studies	For every eligible students

Date	Name of Stakeholder	Comments by Stakeholder	Feedback by Abhan Power Limited
08-March-2011	Mrs. G. Thanghwan, President, Karppur Panchayat	Employment opportunity for village person	We have recruited 10 nos. of person from the nearby villages for landscaping and house keeping
19-August-2011	A. Jagannathan, B.A	Provide of saplings to 5 villages	Provided 2000 nos. of saplings to each villages for 5 villages
19-August-2011	K. Kanagaraj, Head Master	Broken study bench chair to be repaired	The broken furniture has repaired and put back in to use
06-March-2012	Mrs. B. Kalaisdevi, Head Mistress	Improving of toilets Lavatory facilities for girls students	Carried out the civil and plumbing works as required by them
06-August-2012	M. Vaithyanathan, Head Master, Govt High School, Thiruvamabnallur	Request of providing 2 no. of computer system, CPU with 1 no. printer for school office and teaching purpose	Arranged and handover 2 systems with 1 printer to the school
23-April-2013	Mrs. Anusiya, President, Karppur Panchayat	Request for providing 4 no. of drinking water hand pumps	4 no. of hand pumps were installed in the required location
06-Jan-2014	The Secretary Pandanallur welfare association	Supply of mat, pillow and blankets to old aged people	250 nos. of mat, pillow and blankets were issued
16-April-2014	K. Rajesh, President	For village temple annual festival, request to arrange medical camp with doctor, first aid, medicines, ambulance.	Based on their request we have decided to provide this facility every year regularly
22-Oct-2015	Mrs. B. Shamum1uuga,	Providing Sanitary napkin incinerator for hygiene disposal	Installed 2 no. of incinerator as required by them

2.3 AFOLU-Specific Safeguards

Not applicable as this is not an AFOLU project activity.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

After obtaining all necessary statutory approvals, the Plant has commenced its commercial operations since 11-August-2005 and started exporting clean power to grid. During the monitoring period the project activity was operated and monitored in accordance with the applicable baseline and monitoring methodology AM0029 (Version 1.1).

The Natural gas based Combined Cycle Power Project (CCPP), with installed capacity of 119.8 MW, has one (1) Gas Turbine Generating (GTG) Unit of 68.6 MW rated capacity, one (1) Heat Recovery Steam Generator (HRSG) and one (1) Steam Turbine Generating (STG) Unit of 51.2 MW rated capacity, along with all electrical systems, controls and Instrumentation, Civil, Structural and Architectural works.

Technical Details are as follows

Gas Turbine	
Make	General Electric Europe
Model	PG-6101-FA
Rating	70,100 KW (ISO condition)
Control system	Mark V speedtronic
Heat Rate	10,300 kJ/kWh
Pressure Ratio	14.9 : 1
RPM	5231
Fuel	Natural Gas
Gas consumption	19250 sm3/hr
Generator	
Apparent Power	93882 KVA
Voltage	11500 V + 10 %
Current	4713 A
Cos ø	0.85
Frequency	50Hz
Speed	3000RPM

HRSG	
Manufacturer	Thermax Babcock & Wilcox Ltd
Maximum continuous rating (MCR)	168 TPH
HP steam pressure at Main steam stop valve	110 bar (a)
Design pressure	130 Kg/cm^2
Steam temp at HRSG outlet	542 ± 5° C
Design pressure LP	6.0 Kg/cm2
Feed water temp at Eco inlet	105 °C

Steam Turbine	
Type	ST4/C240S
Make	DeMag DeLaval Industrial Turbine license from Siemens
MCR output at Generator terminal	55 MW
Turbine rated speed	5810 rpm
Type	Multistage, Condensing, Radial Exhaust
Inlet pressure	101 bar at 540 deg C
Steam Flow (MCR)	177.3 TPH
Heat rate	884.27Kcal/kw hr
Turbine Exhaust pressure	0.152 kg/cm2 (A) [vacuum -.85 kg/cm^2]

The project has been under operation since commissioning, without any major breakdowns.

The breakdown details are as follows

Month	From		To		Outage hrs		Remarks
	Date	Time	Date	Time			
Jan-11	15.01.2011	18:19	15.01.2011	23:03	4.73	4.73	Grid disturbance- Gas Turbine tripped on over frequency
Mar-11	11.03.2011	23:19	12.03.2011	2:59	3.66	249.69	Gas turbine defective air filter replacement
	21.03.2011	17:58	31.03.2011	24:00:00	246.03		Gas turbine Annual Maintenance - Major Inspection
Apr-11	01.04.2011	0:00	14.04.2011	18:56	330.93	334.13	Gas turbine Annual Maintenance - Major Inspection
	14.04.2011	19:33	14.04.2011	21:27	1.9		Gas turbine tripped while checking dynamics
	16.04.2011	16:39	16.04.2011	17:57	1.3		GBC tripped and Gas Turbine got tripped
Jun-11	09.06.2011	12:30	09.06.2011	14:23	1.88	3.66	Gas turbine lube oil system trouble
	17.06.2011	17:13	17.06.2011	19:00	1.78		Grid disturbance(Blackout) - Gas turbine tripped
Oct-11	07.10.2011	22:56	09.10.2011	6:00	31.07	31.07	Gas turbine water wash shutdown
Feb-12	18.02.2012	22:21	20.02.2012	18:45	44.4	44.4	Gas turbine water wash shutdown
Jun-12	13.06.2012	17:20	15.06.2012	18:25	49.09	49.09	Gas turbine tripped due to Standby Earth fault and GT water wash
Jul-12	20.07.2012	21:10	29.07.2012	16:25	211.25	212.65	Gas turbine Annual Maintenance - Combustion inspection
	29.07.2012	17:28	29.07.2012	18:52	1.4		Gas turbine tripped due to gas leak
Oct-12	03.10.2012	21:06	05.10.2012	1:55	28.82	28.82	Gas turbine water wash shutdown
Dec-12	11.12.2012	17:20	12.12.2012	18:04	24.74	24.74	Gas turbine water wash shutdown
Apr-13	05.04.2013	22:10	06.04.2013	21:54	23.73	23.73	Gas turbine water wash shutdown
Jul-13	02.07.2013	1:38	02.07.2013	5:24	3.77	159.34	Gas turbine tripped due to low purge air pressure
	13.07.2013	21:38	20.07.2013	9:12	155.57		Gas turbine Annual Maintenance - Combustion inspection
Oct-13	23.10.2013	21:43	25.10.2013	14:41	40.96	40.96	Gas turbine water wash shutdown
Nov-13	12.11.2013	2:20	12.11.2013	8:04	5.73	7.03	Gas turbine tripped due to Purge air compressor trouble
	16.11.2013	16:15	16.11.2013	17:33	1.3		Gas turbine tripped on Generator RTD fault spurious
Feb-14	15.02.2014	22:30	17.02.2014	13:43	39.22	41.07	GTG Transformer oil leak
	17.02.2014	15:40	17.02.2014	17:31	1.85		Gas turbine tripped on DLN Trouble
Jun-14	21.06.2014	1:05	30.06.2014	24:00:00	238.92	238.92	Gas turbine Annual Maintenance
Jul-14	01.07.2014	0:00	07.07.2014	12:53	156.88	165.86	Gas turbine Annual Maintenance
	07.07.2014	15:27	07.07.2014	20:54	5.45		Gas turbine Trip
	29.07.2014	7:58	29.07.2014	11:30	3.53		Disc Flash over in Switch yard
Aug-14	25.08.2014	18:22	25.08.2014	19:48	1.43	1.43	GT tripped due to gas pressure low
Dec-14	08.12.2014	8:56	12.12.2014	7:20	94.39	94.39	Gail pipe line work
Feb-15	23.02.2015	17:18	25.02.2015	5:26	36.13	36.13	Gas turbine water wash shutdown
May-15	24.05.2015	20:49	25.05.2015	0:30	3.68	6.13	Gas turbine tripped-DLN combustion trouble

Month	From		To		Outage hrs		Remarks
	Date	Time	Date	Time			
	27.05.2015	18:51	27.05.2015	21:18	2.45		Gas turbine tripped-Exhaust gas temp high

The plant is running smoothly since commissioning with scheduled maintenance. No events or situations happened expect the normal breakdowns for the reported monitoring period that can alter the applicability of the applied methodology.

3.2 Deviations

2.3.1 Methodology Deviations

There is no request for methodology deviation applied during current monitoring period.

2.3.2 Project Description Deviations

There is no Project description deviations applied during current monitoring period.

3.3 Grouped Projects

This project activity is not a grouped project activity. Hence not applicable.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	**$EF_{NG,Upstream,CH4}$**
Data unit	tCH_4/PJ
Description	Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution ($EF_{NG,Upstream,CH4}$)
Source of data	Default values provided in the methodology
Value applied	160 tCH_4/PJ
Justification of choice of data or description of measurement methods and procedures applied	GAIL is maintaining all its processing plants and gas transmission lines matching the international standards. GAIL also formulating guidelines for the pipelines along with the BIS for development of uniform standards for high-pressure oil and gas transmission pipeline systems. Also GAIL conducts the regular safety audits to maintain the international safety standards with some reputed international firms.
Purpose of Data	Leakage emissions calculation
Comments	The value is fixed for the entire crediting period.

4.2 Data and Parameters Monitored

Data / Parameter	$FC_{f,y}$
Data unit	m^3
Description	Annual quantity of fuel "f" consumed in project activity
Source of data	Fuel flow meter reading at project boundary
Description of measurement methods and procedures to be applied	The total fuel consumption has been monitored both at supplier and project end for cross verification and measured in standard cubic meters
Frequency of monitoring/recording	Monitored daily and aggregated monthly
Value monitored	702,162,594.62
Monitoring equipment	Flow Meter (please refer appendix 1 for more details)
QA/QC procedures to be applied	Natural gas supply metering to the project has subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings has been double checked by the gas company.
Purpose of the data	Project emission and leakage emission calculation
Calculation method	Not Applicable
Comments	-

Data / Parameter	$NCV_{f,y}$
Data unit	GJ/m^3 or kcal/scm
Description	Net Calorific Value of fuel f
Source of data	Fuel supplier
Description of measurement methods and procedures to be applied	The calorific value of the gas has been provided by the supplier and recorded and verified by the project participant
Frequency of monitoring/recording	Recording Frequency: Fortnightly
Value monitored	9,380.66
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	The calorific value of the gas has been provided by the supplier (GAIL) and recorded and verified by the project participant. No additional QA/QC procedures may need to be planned
Purpose of the data	Project and Leakage emissions calculation
Calculation method	Not Applicable
Comments	-

Data / Parameter	$OXID_f$
Data unit	-

Description	Oxidation factor
Source of data	IPCC (Default Value)
Description of measurement methods and procedures to be applied	IPCC default value of the current year is considered. The same was suggested in the GHG inventory information report submitted by India's Initial National Communication (Chapter 2) where in it is mentioned that in the case of petroleum products and natural gas, the use of default emissions would be fairly accurate due to relatively low variation in quality of these fuels across the globe, as compared to coal.
Frequency of monitoring/recording	Annually
Value monitored	1.0
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	As per IPCC guidelines
Purpose of the data	Project emission calculation
Calculation method	Not Applicable
Comments	Oxidation factor of the gas has been updated as per the latest guidelines available from IPCC on national greenhouse gas inventory on year to year basis.

Data / Parameter	$EF_{CO2,f,y}$
Data unit	tCO_2/GJ
Description	Emission factor for fuel 'f'
Source of data	Local/ Regional/ Global (IPCC default value).
Description of measurement methods and procedures to be applied	PP will be using the local/Regional/Global (IPCC) source in the same order of preference to arrive at the emission factor of fuel. Since there is no local/national data available at present for the emission factor of the fuel used, the IPCC default value of 0.0561 tCO_2/GJ has been considered for the same.
Frequency of monitoring/recording	Annually
Value monitored	0.0561
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of the data	Project emission calculation
Calculation method	Not Applicable
Comments	-

Data / Parameter	$COEF_y$
Data unit	tCO_2/m^3
Description	CO_2 emission coefficient
Source of data	Calculated under project activity

Description of measurement methods and procedures to be applied	Has been calculated based on the standard procedures available
Frequency of monitoring/recording	Annually
Value monitored	2010: 0.00217 2011: 0.00220 2012: 0.00220 2013: 0.00221 2014: 0.00221 2015: 0.00223
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	No additional QA/QC procedures may need to be planned
Purpose of the data	Project emission calculation
Calculation method	Calculated based on equation 2a in the methodology. (The emission coefficient is calculated as an average value of total monitoring period).
Comments	-

Data / Parameter	PE_y
Data unit	tCO_2
Description	Project Emissions due to combustion of fuel
Source of data	Calculated under project activity
Description of measurement methods and procedures to be applied	Calculated based on equation (2) of the approved methodology
Frequency of monitoring/recording	Annually
Value monitored	1,548,406.00
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of the data	Project emission calculation
Calculation method	Calculated based on equation (2) of the approved methodology
Comments	-

Data / Parameter	$EG_{PJ,y}$
Data unit	MWh
Description	Electricity exported to grid by the project activity
Source of data	Data measured and recorded from Energy meters installed in the plant and in substation
Description of measurement methods	Electricity supplied by the project activity to the grid. Double check by receipt of sales

and procedures to be applied	
Frequency of monitoring/recording	Measured Daily and aggregated monthly
Value monitored	3,368,443.52
Monitoring equipment	Energy Meter (please refer appendix 1 for more details)
QA/QC procedures to be applied	Meters are calibrated as per the standard procedures and documents for the same are maintained throughout.
Purpose of the data	Baseline and leakage emissions calculation
Calculation method	Calculated based on equation (2) of the approved methodology
Comments	-

Data / Parameter	$EF_{BM,y}$
Data unit	tCO_2/MWh
Description	CO_2 Build Margin emission factor of the grid
Source of data	CEA Database Version 15 dated Dec 2019
Description of measurement methods and procedures to be applied	Calculated as per ACM0002 “Consolidated methodology for grid-connected electricity generation from renewable sources” and in line with latest version of “Tool to calculate emission factor for an electricity system” as per ACM 0002.
Frequency of monitoring/recording	Annually
Value monitored	2010:0.9284 2011:0.9083 2012:0.8723 2013:0.8643 2014:0.8810 2015:0.8682
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of the data	Baseline emissions calculation
Calculation method	As per methodology ACM0002 and "Tool to Calculate the Emission Factor for an Electricity System", Version 3.0.0
Comments	The Build emission factor has been concluded as baseline emission factor for the project activity base on lowest emission factor among following options “Option1: The build margin, Option 2: The combined margin and Option 3: The emission factor of the technology (and fuel) identified as the most likely baseline scenario under “Identification of the baseline scenario". Hence the build margin ($EF_{BM,y}$) represents baseline emission factor ($EF_{BL,CO2}$) for the project activity.

Data / Parameter	$EF_{BL,upstream\ CH4}$
Data unit	tCO_2/MWh
Description	Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity

Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculated consistently with the Build margin emission factor which is the baseline emission factor for the project activity. Hence the equation used to calculate $EF_{BL,upstream\ CH4}$ is as follow $EF_{BL,upstream,CH4} = \frac{\sum_j FF_{j,k} \cdot EF_{k,upstream,CH4}}{\sum_j EG_j}$
Frequency of monitoring/recording	Annually
Value monitored	2010: 0.013287 2011: 0.013854 2012: 0.013853 2013: 0.013030 2014: 0.013260 2015: 0.013326
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of the data	Baseline emissions calculation
Calculation method	As per methodology ACM0002 and "Tool to Calculate the Emission Factor for an Electricity System", Version 3.0.0
Comments	$EF_{BL,upstreamCH4}$ has been calculated based on IPCC's default emission factors for fugitive CH_4 upstream emissions furnished in the methodology and the latest version of CEA's CO_2 Baseline Database for the Indian Power Sector.

4.3 Monitoring Plan

The project employs state of art monitoring and control equipment that measure, record, report, monitor and control various key parameters. Parameters monitored are quantity and quality of fuel used, total power generated, power exported to the grid from the project, etc. These monitoring and controls are part of the Distributed Control System (DCS) of the entire plant. All monitoring and control functions are done as per the internally accepted standards and norms. The instrumentation and control system available comprises of microprocessor-based instruments of reputed make with desired level of accuracy. All instruments will be calibrated and marked at regular intervals so that the accuracy of measurement can be ensured all the time.

The instrumentation and control system available comprises of microprocessor-based instruments of reputed make with desired level of accuracy. All instruments will be calibrated and marked at regular intervals so that the accuracy of measurement can be ensured all the time.

Fuel Used

The major fuel to be used by the plant is Natural Gas. The Natural Gas (about 5,00,000 Sm^3 per day) for the power generation is supplied at the plant boundary, through a dedicated

pipeline, by GAIL (India) Limited, from a gas station of Oil and Natural Gas Commission (ONGC) located at Kuttalam, which is about 8 kms from the plant site.

The following parameters has been monitored at the gas receiving station.

- Calorific value of NG
- Flow of natural gas to APCL

Southern region having a ample reserve of natural gas to sustain the successful running of the plant.

Quantity of the fuel used in the Gas Turbine

Based on natural gas analysis and the configuration considered in Detailed Project Report (DPR), the requirement of gas fuel for 119.8 MW Capacity (Nominal Gross Site Rating) is estimated to be 500000 Sm^3 per day.

Natural gas is supplied by ONGC through its pipeline from gas wells up to the power plant boundary. Fuel gas supplier have the necessary pressure regulation, conditioning and tariff gas metering station at their gas supply terminal near power plant to ensure proper monitoring and quantification of gas intake in the power plant.

The Proprietary control system for gas turbine includes electronics required for data acquisition, processing and control, sequence starting of the equipment and comprehensive alarm indication. It would be possible to execute performance-monitoring functions in control system. Start-up, shutdown and normal operation would be possible from the GTG (Gas Turbine Generator) control system and would be monitored from the DCS. The system is capable of measuring accurate gas fuel flow. The data is recorded for further verification.

NG used in the gas Turbine

The main type of fuel used for the power generation is only NG. The properties of NG like chemical composition, calorific value etc. varies from well to well. The performance of GTG will also depend on the properties of the NG used as fuel.

Total power generated

The total power generated by the power project is measured in the plant premises to the best accuracy and will be recorded, monitored on a continuous basis through DCS. All measurement devices area microprocessor based with best accuracy. All instruments re calibrated at regular intervals. The parameter is substantiate the smooth operations of the project. During verification, the total power generated is verified as compared to the power exported to the grid.

Power consumed by the plant auxiliaries:
The power consumed by plant auxiliaries is recorded in the plant premises to the best accuracy. This is recorded and monitored on a continuous basis through DCS. All measurement devices are microprocessor based with best accuracy. All the instruments are calibrated at regular intervals. The total quantum of power consumed by the auxiliaries would affect the total power exported to the grid and in turn the amount of GHG reductions. Therefore any increase in the consumption pattern of the auxiliary system would be attended to.

Power exported to the grid:

The project revenue is depend on net units exported to power off taker. All metering and check metering facilities are installed within the plant premises as well in the TNEB grid substation through which power is evacuated to southern grid. The measurement are recorded and monitored on a continuous basis through DCS. The actual net quantity of power exported is arrived at after joint verification of data by both APCL and TNEB.

Efficiency and Heat rate of the project activity:

Based on the measured input and output parameters, plant system efficiency and Heat rate is calculated and monitored by DCS. In case of any irregularity, the root cause of the deviations would be identified and the necessary corrective actions are taken.
All the above parameters / factors demonstrates the performance of the project at any point of time.

Verification:

The performance of the NG based combined cycle power project leads to CO_2 emission reductions. In other words, if the power plant operates at high PLF and high efficiency and exports power to the grid, more emission reductions would be possible. The project control system is comprise of a sophisticated control and monitoring system like Distributed Control System (DCS) which measures, collects the information about various process parameters, records, monitors and controls on a continuous basis.

The major activities and parameter that are to be verified are listed below:

Activities

- Verification of various measurement and monitoring methods
- Verification of instrument calibration methods
- Verification of data generated by DCS
- Verification of measurement accuracy

Parameters:

- Quantity of the NG used
- Efficiency and heat rate of the power plant
- Total power generation and captive power requirements.
- Power exported to the grid

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

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

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

As per the methodology the Baseline emission factor is chosen as the minimum of the following three

Option 1. 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, and calculated as follows

$$EF_{BL,CO2}\,(tCO_2 / MWh) = \frac{COEF_{BL}}{\eta_{BL}} * 3.6\,GJ / MWh$$

Where:

$COEF_{BL}$ = The fuel efficiency coefficient /tCO_2e/GJ), based on national average fuel data, if available, otherwise IPCC defaults can be used.
η_{BL} = The energy efficiency of the technology, as estimated in the baseline scenario analysis above.

Further, the methodology states that this determination are made once at the validation stage based on an ex ante assessment and if either option 1 (BM) or option 2 (CM) are selected, they are estimated ex post, as described in ACM0002.

The determination of the build margin, the combined margin and the emission factor of the technology was made at the time of validation. The build margin had worked out as the lowest of the three options and had been used for the ex-ante calculation of the baseline emissions. As required by the methodology, for the calculation of the baseline emissions during the monitoring period, the build margin has been determined ex post as described in the latest version of the methodology ACM0002.

As per the registered PDD, "the lower value of BM, CM, $EF_{BL,CO2,y}$ (tCO_2/MWh) has to be chosen as the baseline emission factor" and hence the project proponent has considered Build margin as the baseline emission factor. The value of the build margin, taken from CEA database is as follows:

	CEA Version	CEA Version 11	CEA Version 12	CEA Version 13	CEA Version 14	CEA Version 15	CEA Version 16		
	Applied on Year	2010	2011	2012	2013	2014	2015	Unit	Remark
Option 1	The Build Margin	0.9284	0.9083	0.8723	0.8643	0.8810	0.8682	tCO_2/MWh	Determined Ex-post
Option 2	Combined Margin	0.9613	0.9468	0.9227	0.9127	0.9216	0.9124	tCO_2/MWh	Determined Ex-post
Option 3	Baseline Emission Factor of the Technology Identified	1.048	1.048	1.048	1.048	1.048	1.048	tCO_2/MWh	Determine at the time of registration

	CEA Version	CEA Version 11	CEA Version 12	CEA Version 13	CEA Version 14	CEA Version 15	CEA Version 16		
	Estimation of Baseline Emission Factor on conservative basis	0.9284	0.9083	0.8723	0.8643	0.8810	0.8682	tCO_2/ MWh	Min of (BM, CM, EF_{BLCO2y})

Estimation of Baseline Emission Factor:

So as to have conservative emissions, lower value of BM, CM and the value as per equation above has to be chosen as baseline emission factor

$$\text{BEF} = \text{lowest of (BM, CM, } EF_{BL,CO2}\ (tCO_2 / MWh)\text{)}$$

BEF	CEA Version 11	CEA Version 12	CEA Version 13	CEA Version 14	CEA Version 15	CEA Version 16
	tCO_2/MWh	tCO_2/MWh	tCO_2/MWh	tCO_2/MWh	tCO_2/MWh	tCO_2/MWh
Estimation of Baseline Emission Factor on conservative basis	0.9284	0.9083	0.8723	0.8643	0.8810	0.8682

Baseline Emission are calculated as follows

Year	Net Export to grid (Export to Grid - Import from Grid)	Emission Factor of Grid	Baseline Emissions
	MWh	tCO_2/MWh	tCO_2
2010	78,360	0.9284	72,749
2011	755,616	0.9083	686,325
2012	866,005	0.8723	755,415
2013	702,301	0.8643	606,998
2014	580,692	0.8810	511,589
2015	385,471	0.8682	334,665
Total	**3,368,443.52**		**2,967,741.00**

5.2 Project Emissions

The project activity is on-site combustion of natural gas to generate electricity. The CO_2 emissions from electricity generation (PEy) are calculated as follows:

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

Where:

$FC_{f,y}$ = is the total volume of natural gas or other fuel 'f' combusted in the project plant or other start-up fuel (m^3 or similar) in year(s) 'y'

$COEF_{f,y}$ = is the CO_2 emission coefficient (tCO_2/m^3 or similar) in year(s) for each fuel and is obtained

Also $COEF_{f,y}$ is calculated using the below formula

$$COEF_{f,y} = \sum NCV_y * EF_{CO2,f,y} * OXID_f$$

Where:

NCV_y : is the net calorific value (energy content) per volume unit of natural gas in year 'y' (GJ/m^3) as determined from the fuel supplier, wherever possible, otherwise from local or national data

$EF_{CO2,f,y}$: is the CO_2 emission factor per unit of energy of natural gas in year 'y' (tCO2/GJ) as determined from the fuel supplier, wherever possible, otherwise from local or national data

$OXID_f$: is the oxidation factor of natural gas (as per latest IPCC guidelines)

For startup fuels, IPCC default calorific values and CO_2 emission factors are acceptable, if local or national estimates are unavailable

Project Emission are calculated as follows

Year	Gas Consumption	Avg. Net Calorific value of gas	Emission factor of Gas (IPCC)	Oxidation Factor of Gas	COEF of Gas	Project Emissions
	SCM	kcal/SCM	tCO_2/GJ		tCO_2/m^3	tCO_2
2010	16,430,416.84	9258.97	0.0561	1	0.00217	35,726.00
2011	156,487,263.08	9353.46	0.0561	1	0.00220	343,715.00
2012	179,572,906.65	9381.17	0.0561	1	0.00220	395,554.00
2013	144,106,649.27	9396.60	0.0561	1	0.00221	317,952.00
2014	125,104,010.41	9408.52	0.0561	1	0.00221	276,419.00
2015	80,461,348.38	9485.26	0.0561	1	0.00223	179,040.00
Total	**702,162,594.62**	**9380.66**			**0.00220**	**1,548,406.00**

5.3 Leakage

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered.

Fugitive CH_4 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.

In the case LNG is used in the project plant: CO_2 emissions from fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system

Thus, leakage emissions are calculated as follows:

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

Where

LE_y : Leakage emissions during the year y in tCO_2e
$LE_{CH4,y}$: Leakage emissions due to fugitive upstream CH_4 emissions in the year y in tCO_2e
$LE_{LNG,CO2,y}$: Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in tCO_2e

There is no LNG consumption in the project activity, so $LE_{LNG,CO2,y}$ is zero.

Fugitive methane emissions

For the purpose of estimating fugitive CH_4 emissions, project participants should multiply the quantity of natural gas consumed by the project in year y with an emission factor for fugitive CH4 emissions ($EF_{NG,upstream,CH4}$) from natural gas consumption and subtract the emissions occurring from fossil fuels used in the absence of the project activity, as follows

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

Where

$LE_{CH4,y}$: Leakage emissions due to fugitive upstream CH_4 emissions in the year y in tCO_2e
FC_y : Quantity of natural gas combusted in the project plant during the year y in m^3
$NCV_{NG,y}$: Average net calorific value of the natural gas combusted during the year y in GJ/m^3
$EF_{NG,upstream,CH4}$: Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution and in the case of LNG, liquefaction, transportation, regasification and compression in to a transmission or distribution system, in tCH_4 per GJ fuel supplied to final consumers
$EG_{pJ,y}$: Electricity generation in the project plant during the year in MWh
$EF_{BL,upstream,CH4}$: Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH_4 per MWh electricity generation in the project plant, as defined below
GWP_{CH4} : Global warming potential of methane valid for the relevant commitment period

The emission factor for upstream fugitive CH_4 emissions occurring in the absence of the project activity ($EF_{BL,upstream,CH4}$) has been calculated consistently with the baseline emission factor ($EF_{BL,CO2}$) using the equation specified in above. The lowest baseline emission factor has been found to be the one calculated as per build margin method, so the same calculation procedure has been adopted to calculate $EF_{BL,upstream,CH4}$. The same has been described below.

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

Where

$EF_{BL,upstream,CH4}$: Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in t CH_4 per MWh electricity generation in the project plant
J : Plants included in the build margin
$FF_{j,k}$: Quantity of fuel type k (a coal or oil type) combusted in power plant j included in the build margin
$EF_{k,upstream,CH4}$: Emission factor for upstream fugitive methane emissions from production of the fuel type l (coal or oil type) in tCH_4 per PJ fuel produced
EG_j : Electricity generation in the plant j included in the build margin in MWh/a plant included in the operating margin

The value has been calculated using the latest version of the CO_2 Baseline Database for the Indian Power Sector, made available by the Central Electricity Authority, Ministry of Power, Govt. of India.

Year	$EF_{BL,upstream,CH4}$ Fugitive Emission Factor in Baseline (tCO_2/MWh)	Reference
2010	0.013287	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, Version 11, April 2016
2011	0.013854	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, version 12, May 2017
2012	0.013853	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, version 13, June 2018
2013	0.013030	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, version 14, Dec 2018
2014	0.013260	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, version 15, Dec 2019
2015	0.013326	CO_2 Baseline Database for Indian Power Sector, published by Central Electricity Authority, Ministry of Power, Government of India, version 15, Dec 2019

The default values used in the project activity, which are fixed for throughout crediting period are as follows

S. No.	Parameter	Default Value	Remarks
1	Emission factor for fugitive CH_4 Upstream emissions for Coal	0.8 tCH4 /kt coal	Most of the coal production in India comes from open pit mines contributing over 81% of the total production. A number of large open pit mines of over 10 million tonnes per annum capacity are in operation. Underground mining currently accounts for around 19% of national output. (As per the registered PDD) Hence 0.8t/ CH_4 /kt coal value is used for surface mining.

S. No.	Parameter	Default Value	Remarks
2	Emission factor for fugitive CH_4 upstream emissions for Oil	4.1 tCH_4 /PJ	As per the Table 2 of the methodology. This value includes for oil production, transport, refining and storage.
3	Emission factor for fugitive CH_4 upstream emissions for Natural Gas	160 tCH_4/PJ Or 0.00016 tCH4/GJ	As per the Table 2 of the methodology, 296 tCH_4 /PJ is applicable for rest of the world and 160 tCH_4 /PJ is for USA and Canada. However, the US/Canada value is used as the system element (gas production and / or processing/transmission / distribution) is predominantly of recent vintage and built and operated to international standards. GAIL is maintaining all its processing plants and gas transmission lines matching the international standards and are of recent vintage. GAIL also formulating a guidelines for the pipelines along with the BIS for development of uniform standards for high-pressure oil and gas transmission pipeline systems. Also GAIL conducts the regular safety audits to maintain the International safety standards with some reputed international firms.
4	Oxidation factor of natural gas	1	IPCC value as per 2006 IPCC guidelines for National Green House Gas inventories

Leakage Emission are calculated as follows

Year	Gas Consumption	Avg. Net Calorific value of gas	Total Energy Content of Gas Consumed	Fugitive Emission Factor for NG	Global warming potential of methane	Fugitive Emissions for NG
	SCM	kcal/SCM	GJ	tCH_4/GJ		tCO_2
2010	16,430,416.84	9,258.97	636,810.62	0.00016	25	2,547.24
2011	156,487,263.08	9,353.46	6,126,818.94	0.00016	25	24,507.28
2012	179,572,906.65	9,381.17	7,050,865.89	0.00016	25	28,203.46
2013	144,106,649.27	9,396.60	5,667,582.63	0.00016	25	22,670.33
2014	125,104,010.41	9,408.52	4,927,240.65	0.00016	25	19,708.96
2015	80,461,348.38	9,485.26	398,930.17	0.00016	25	12,765.77

Year	Net Export to grid	Fugitive Emission Factor in Baseline	Fugitive Emission in Baseline	Net Leakage Attributable to the project activity
				Fugitive Emissions for NG - Fugitive Emission in Baseline
	MWh	tCO_2/MWh	tCO_2	tCO_2
2010	78,360	0.013287	1,041.16	1,507.00
2011	755,616	0.013854	10,468.02	14,040.00
2012	866,005	0.013853	11,996.97	16,207.00

Year	Net Export to grid	Fugitive Emission Factor in Baseline	Fugitive Emission in Baseline	Net Leakage Attributable to the project activity
				Fugitive Emissions for NG - Fugitive Emission in Baseline
	MWh	tCO_2/MWh	tCO_2	tCO_2
2013	702,301	0.013030	9,151.15	13,520.00
2014	580,692	0.013260	7,699.80	12,010.00
2015	385,471	0.013326	5,136.96	7,629.00
			Total	**64,913.00**

5.4 Net GHG Emission Reductions and Removals

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
2010	72,749	35,726	1,507	35,516
2011	686,325	343,715	14,040	328,572
2012	755,415	395,554	16,207	343,655
2013	606,998	317,952	13,520	275,527
2014	511,589	276,419	12,010	223,162
2015	334,665	179,040	7,629	147,996
Total	**2,967,741**	**1,548,406**	**64,913**	**1,354,428**

During the current monitoring period, the project achieved net emission reductions of **1,354,428** tCO_2 compared to the estimated emission reduction of **843,230** tCO_2 which is **60.62 %** higher as compared to estimated. A detailed explanation for the same is given below.

The value of net electricity exported by the project plant to the southern grid was assumed at **874** Million kWh for **365** days as per registered PDD and for the current monitoring period of **1699** days, the value stands at **4068.29** Million kWh.

Parameter	Net Export to grid		Gas Consumption	
Description	For Monitoring Period	As Per registered PDD	For Monitoring Period	As Per registered PDD
Year	Million kWh	Million kWh	Million SCM	Million SCM
2010-11	244.49	**289.74**	51.54	**60.12**
2011-12	795.06	**874.00**	163.91	**181.350**
2012-13	834.78	**874.00**	173.62	**181.350**
2013-14	705.20	**874.00**	143.41	**181.350**
2014-15	565.91	**874.00**	123.80	**181.350**
2015-16	223.00	**282.55**	45.89	**58.63**
Total	**3368.44**	**4068.29**	702.16	**844.15**

Form above table it has been observed that there has no increase in Net Export to grid and Gas Consumption during the current monitoring period as compared to the estimated in registered PDD. Hence there has no impact on the additionality.

However, there is an increase in the actual emission reduction achieved during the current monitoring period as compared to registered CDM PDD due to the increase in the Build Margin emission factor for current monitoring period (Please refer table below) against **0.6733** tCO_2/MWh (registered CDM PDD) which is ex-post and PP don't have control over it.

PP has used conservative emission factor from respective CEA database to calculate the emission reduction of respective year.

	CEA Version	CEA Version 11	CEA Version 12	CEA Version 13	CEA Version 14	CEA Version 15	CEA Version 16		
	Applied on Year	2010	2011	2012	2013	2014	2015	Unit	Remark
Option 1	The Build Margin	0.9284	0.9083	0.8723	0.8643	0.8810	0.8682	tCO_2/MWh	Determined Ex-post
Option 2	Combined Margin	0.9613	0.9468	0.9227	0.9127	0.9216	0.9124	tCO_2/MWh	Determined Ex-post
Option 3	Baseline Emission Factor of the Technology Identified	1.048	1.048	1.048	1.048	1.048	1.048	tCO_2/MWh	Determine at the time of registration
	Estimation of Baseline Emission Factor on conservative basis	0.9284	0.9083	0.8723	0.8643	0.8810	0.8682	tCO_2/MWh	Min of (BM, CM, EF_{BLCO2y})

Comparison of Emission reduction for earlier and current monitoring period are as follows.

Monitoring Period	Baseline Emission	Project Emission	Leakage Emission	Emission Reduction	Estimated as per Registered PDD	Variation in the emission reduction
16-May-2007 to 15-June-2008	630,226	407,445	7,263	215,518	204,480	5.40%
16-June-2008 to 15-Jan-2009	357,237	225,708	7,144	124,385	106,707	16.57%
16-Jan-2009 to 15-Feb-2010	636,043	350,710	14,389	270,944	196,539	37.86%
16-Feb-2010 to 15-Dec-2010	466,977	289,666	8,346	168,965	150,382	12.36%
16-Dec-2010 to 10-August-2015	2,932,167	1,548,437	64,941	1,318,789	843,230	56.40%

APPENDIX I: CALIBRATION DETAILS

Feeder	**GTG**	**STG**	**Manalmedu Feeder**	**Kattumannarkoil Feeder**	**Cuddalore Feeder**	**Kadalangudi Feeder**	
Meter Details	**Main meter**	**Main meter**	**Main meter**	**Main meter**	**Main meter**	**Main meter**	
Serial Number	**04248996**	**04248994**	**04249077**	**04249074**	**04187300**	**04187302**	**Validity of Calibration**
Date of Calibration	06-Jan-2010						05-July-2010
	07-July-2010						06-Jan-2011
	04-Jan-2011						03-July-2011
	05-July-2011						04-Jan-2012
	04-Jan-2012						03-July-2012
	04-July-2012						03-Jan-2013
	08-Jan-2013						07-July-2013
	24-July-2013						23-Jan-2014
	07-Jan-2014						06-July-2014
	09-July-2014						08-Jan-2015
	21-Jan-2015						20-July-2015
	07-July-2015						06-Jan-2016
Meter Details	**Check meter**	**Check meter**	**Check meter**	**Check meter**	**Check meter**	**Check meter**	
Serial Number	**04248997**	**04248995**	**04249078**	**04249081**	**04187301**	**04187303**	**Validity of Calibration**
Date of Calibration	28-Jan-2010						05-July-2010
	21-July-2010						06-Jan-2011
	19-Jan-2011						03-July-2011
	20-July-2011						04-Jan-2012
	24-Jan-2012						03-July-2012
	18-July-2012						03-Jan-2013
	22-Jan-2013						07-July-2013
	21-August-2013						23-Jan-2014
	22-Jan-2014						06-July-2014
	23-July-2014						08-Jan-2015
	18-Feb-2015						20-July-2015
	22-July-2015						06-Jan-2016

Fuel Flow Meter	**DP Transmitter**	**Pressure Transmitter**	**Temperature Transmitter**	
Meter Serial No.	**51309424**	**51309423**	**DGR-1215**	**Validity of Calibration**
Date of Calibration	16-Jan-2010			15-April-2010
	15-March-2010			14-July-2010
	19-July-2010			18-Oct-2010
	13-Oct-2010			12-Jan-2011
	13-Jan-2011			12-April-2011
	04-March-2011			03-June-2011
	26-April-2011			25-July-2011
	25-July-2011			24-Oct-2011

Fuel Flow Meter	DP Transmitter	Pressure Transmitter	Temperature Transmitter	
Meter Serial No.	**51309424**	**51309423**	**DGR-1215**	**Validity of Calibration**
	13-Oct-2011			12-Jan-2012
	18-Jan-2012			17-April-2012
	21-May-2012			20-August-2012
	27-July-2012			26-Oct-2012
	17-Oct-2012			16-Jan-2013
	10-Jan-2013			09-April-2013
	26-April-2013			25-July-2013
	18-July-2013			17-Oct-2013
	18-Oct-2013			17-Jan-2014
	28-Jan-2014			27-April-2014
	17-April-2014			16-July-2014
	26-June-2014			25-Sept-2014
	22-Sept-2014			21-Dec-2014
	22-Dec-2014			21-March-2015
	19-March-2015			18-June-2015
	19-June-2015			19-Sept-2015
	30-Oct-2015			29-Jan-2016
	23-Dec-2015			22-March-2016

Note: Considering the monitoring period as 16-Dec-2010 to 10-Aug-2015, there has been delay in calibration of meters – hence conservative error factor 0.2% has been applied to the values of both electricity export and electricity import on respective months.

Also there has delay in calibration of gas flow meter hence application of error factor 0.075% on gas consumption has been applied on the respective months (Please refer Gas consumption sheet for more details of ER sheet).