



Voluntary Carbon Standard Project Description Template

18 November 2008

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[Table of Contents]

S.NO	CONTENTS
1	<u>Description of project</u>
2	<u>VCS Methodology</u>
3	<u>Monitoring</u>
4	<u>GHG Emission Reductions</u>
5	<u>Environmental Impact</u>
6	<u>Stakeholders comments</u>
7	<u>Schedule</u>
8	<u>Ownership</u>

List of Annexures:

Annex-1 : BASE LINE INFORMATION

Annex-2 : Abstract sheet for levelised cost for the project activity and other alternate plausible scenarios.

1 Description of Project:

1.1 Project title

Natural Gas based Combined Cycle Power Project at Valatharavai Village, Ramanathapuram District, Tamil Nadu by Penna Electricity Limited [Formerly Arkay Energy Limited]

1.2 Type/Category of the project

- Project category which is part of a GHG program that has been approved by the VCS Board.

As per Voluntary Carbon Standard (VCS 2007.1) the Project falls under Industrial energy.

According to the approved methodologies¹ for CDM project activities, the proposed project activity falls under the following type / category.

Type: Energy Industries (Renewable & Non-Renewable Sources) Sectoral scope number 1 – Grid connected electricity generation plants using Natural Gas.

- Specify here if the project is a Grouped project

The project is not a Grouped Project.

1.3 Estimated amount of emission reductions over the crediting Period including project size:

- Micro project: Less than 5,000 tonnes CO₂ equivalent emissions reductions per year.
- Mega Project: More than 1,000,000 tonnes CO₂ equivalent emissions reductions per year

The emission reductions from Natural Gas based Combined Cycle Power Project for a grid system by Penna Electricity Limited (PEL), in the state of Tamil Nadu, India. The total emission reductions over the crediting period from the plant are estimated to be 903390 tCO_{2e}.

Year wise generation of emission reduction during the crediting period is shown below:

Years	Estimation of annual emission reductions in tonnes of CO _{2e}
1 st July 2006-30 th June 2007	90339
1 st July 2007-30 th June 2008	90339

¹

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

1 st July 2008-30 th June 2009	90339
1 st July 2009-30 th June 2010	90339
1 st July 2010-30 th June 2011	90339
1 st July 2011-30 th June 2012	90339
1 st July 2012-30 th June 2013	90339
1 st July 2013-30 th June 2014	90339
1 st July 2014-30 th June 2015	90339
1 st July 2015-30 th June 2016	90339
Total estimated reductions (tCO₂e)	903390
Total number of crediting years (in 1st crediting period)	10
Annual average estimated reductions over the crediting period of (tCO₂e)	90339

As the annual emission reductions are in the range of 5,000-1,000,000 tCO₂e, the activity falls under projects² as per VCS 2007.1

1.4 A brief description of the project:

The purpose of the project activity is to set up a Natural Gas based Combined cycle power plant with a total installed capacity of 58.15 MW to meet the contract capacity i.e. net electricity generation of 52.8 MW. The plant consists of one gas turbine of 38.15 MW and steam turbine of 20 MW. Electricity will be sold to the State utility company i.e. Tamil Nadu State Electricity Board (TNEB). This Power plant will operate on the cleaner fuel like Natural gas will lead lower the 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.

The project increased the installed electricity generating capacity of Tamil Nadu State Electricity Board (TNEB), thereby helping in bridging the gap between demand and supply of electrical energy in the state. The project will also enhance the economic growth and development of the area.

At the optimum year, the project would consume around 243042 SCMD of Natural Gas from the Cauvery Asset, Ramanathapuram Zone of Oil and Natural Gas Corporation (ONGC). The Natural Gas will be piped by GAIL from the Gas Collecting Station of ONGC, which is located at about 500 meters away from the plant site.

Reduction of greenhouse gas emissions:

² As per 5.1 of Voluntary Carbon Standard Program Guidelines(18 November 2008) vide http://www.v-c-s.org/docs/Voluntary%20Carbon%20Standard%20Program%20Guidelines%202007_1.pdf

First, the project activity is an alternative to a previous planned Diesel generator which if installed would have led to higher GHG emissions as compared with the project activity that uses natural gas.

Use of Natural Gas would result in lower Carbon Dioxide emission as compared to emissions by power plants generating energy through other fuels such as coal, lignite and oil. Southern grid, where the plant is located, is dominated by coal/lignite based power generation, which are highly carbon intensive, responsible for higher emission of greenhouse gases. The project activity is using natural gas, whose emissions is less compared to coal/lignite, would result in reducing the carbon intensity of the grid. Emission factor for coal is 95.8 CO₂/TJ, lignite is 106.2 CO₂/TJ (Source: India's Initial National Communication), diesel is 74.1 t CO₂/TJ (Source: IPCC 2006) and natural gas is 54.3 tCO₂/TJ (Source: Appendix B – Assumptions for CO₂ Emission Calculations http://www.cea.nic.in/planning/c%20and%20e/user_guide_ver4.pdf) The computation reveals that the project would reduce Carbon dioxide emissions to the extent of 86935 tonnes per annum in the optimum year.

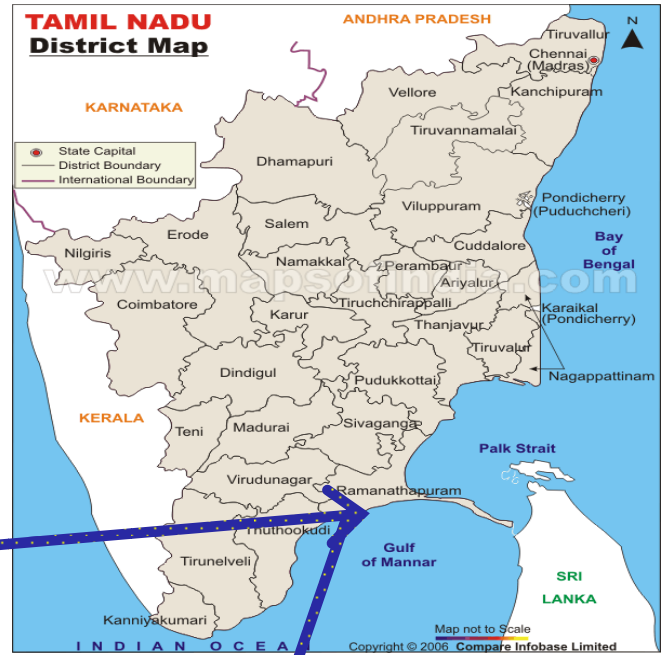
1.5 Project location including geographic and physical information allowing the unique identification and delineation of the specific extent of the project:

Include GPS project boundaries.

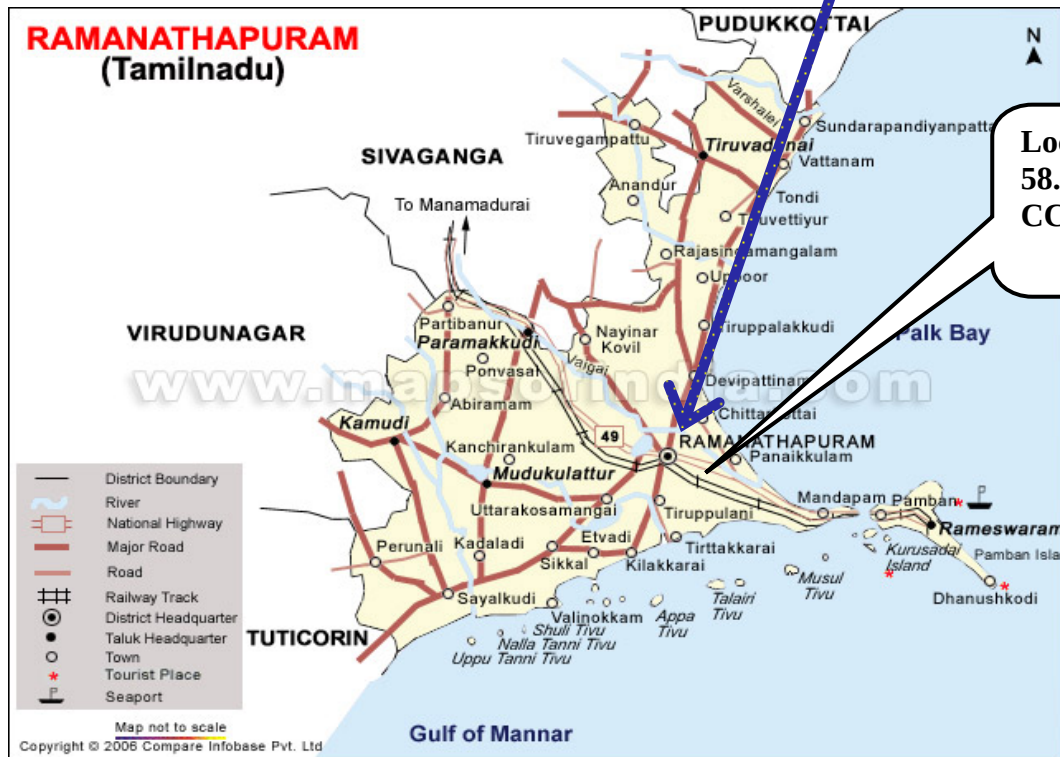
The power plant will be located at Survey Nos. 203 & 204 of Valantharavai Village, Ramanathapuram District, Tamil Nadu State. The site is approximately 12 km from Ramanathapuram Town and 40 km from Rameswaram. The site is easily approachable by National Highway No. 49. The nearest airport is Madurai, which is at a distance of 150 km from the site. The nearest Railway Station is Ramanathapuram, which is at a distance of 12 Kms. from the site. The latitude and longitude of the site are 09°19'24" N and 78°54'42" E. The power plant site including infra-structural facilities, green belt, open space etc. encompasses a total area of 18.89 acres. The location is indicated in the maps below.



Map 1: Location of Tamil Nadu in India



Map 2: Location of Ramanathapuram District in the Tamil Nadu



Map:3 Location of Natural Gas Turbine Based CCGP in Ramanathapuram District

1.6 Duration of the project activity/crediting period:

Project Start date: 01 July 2006

(Commencement of Commercial operation i.e. the day project activity started reducing GHG emissions)

- *Crediting period start date: the date the first monitoring period commenced*

Crediting period start date: 01 July 2006

- o *VCS project crediting period: A maximum of ten years which may be renewed at most two times*

VCS project crediting period: 10 years (i.e. from 01 July 2006 to 30 June 2016). As the life time of the Project is 15 years, the crediting period has been fixed for 10 years.

1.7 Conditions prior to project initiation:

Tamil Nadu state is one of the preferred destinations for new industries. The industrial growth has led to growing demand for energy. As a result, the state has been facing deficit in energy availability as well as peak load. The gap between availability and supply as well as peak load demand and supply is expected to widen in the years to come as shown in the following table:

Year	Availability (MUs)			Peak Load (MWs)		
	Demand	Supply	Deficit	Demand	Supply	Deficit
2005-06	52105	42213	9893	8401	6300	2102
2006-07	54872	43473	11399	8847	6466	2381
2007-08	57737	44778	12959	9309	6618	2491

(Source:

<http://www.infraline.com/power/default.asp?URL1=power/demand/RepPerCapitalDemSuppPow.asp#2>)

As shown in the table given above, the deficit in availability and peak load is projected to touch 19% and 25% respectively in 2005-06 and 20.8% and 26.9% respectively in 2006-07. This gap in demand and supply is likely to increase in the future. The project's objective is to help bridge the deficit to some extent.

Initially, project proponents planned to install a diesel generator based power plant of 52.8 MW capacity and clearances were obtained from the regulatory authorities for installation of power project in Dharmapuri District of Tamil Nadu State. However, based on environmental considerations and availability of natural gas in Tamil Nadu, the plan was changed in favour of setting up of a Natural Gas based Combined Cycle Power Plant (CCPP) with a total installed capacity of 58.15 MW.

Use of Natural Gas would result in lower Carbon Dioxide emission as compared to emissions by power plants generating energy through other fuels such as coal, lignite and oil. Southern grid, where the plant is located, is dominated by coal/lignite based power generation, which are highly carbon intensive, responsible for higher emission of greenhouse gases.

1.8 A description of how the project will achieve GHG emission reductions and/or removal enhancements:

Emission reductions due to the project activity depend on the energy fed to the regional grid and the content of fossil fuel based generation in the grid system. Hence, power fed to the regional grid and the generation mix in the baseline becomes the basis for estimating emissions reductions. The Contracted capacity (net electricity generated) of the Project activity is 52.8 MW, which includes the Gas Turbine & Heat recovery steam turbine.

In the absence of the project activity the power would be generated from the new installation of the other renewable /non- renewable sources, or continue to import from the grid already overwhelmed by fossil fuel generation. The emission reductions from the project are projected using the latest baseline emission factor for the Southern Region of 713.3 tCO₂/GWh. The baseline for the project activity is calculated according to AM0029 Ver.3 i.e. Option-1 Build Margin and it will be estimated ex post during crediting period, as described in "Tool to calculate emission factor for an electricity system".

1.9 Project technologies, products, services and the expected level of activity:

The project envisages setting up a combined cycle (gas and steam cycles) power plant with an installed capacity of 58.15 MW consisting of one Gas Turbine Generating Unit of 38.15 MW rated capacity, one Heat Recovery Steam Generator Unit of 67 TPH rated capacity coupled to a Steam Turbine Generating Unit of 20 MW rated capacity along with all electrical systems, controls and Instrumentation, Civil, Structural and Architectural works. The rating of the power plant is 38.15 MW at PF: 0.8 in Open Cycle and about 58.15 MW at PF: 0.8 in Combined Cycle.

The steam turbine generator would be of the condensing non-reheat type, designed to operate with steam at 65 kg/sq.m @ 500°C.

The exhaust system consists of exhaust ducting from the turbine/engine connected to the chimney through, gas silencer and an exhaust gas duct. The system is designed suitably to limit the back pressure. The silencer is installed in the exhaust gas ducting for reducing the noise level. The DM water for the Plant is been sourced from a Water Desalination plant being installed close to the site.

The generators are of the air cooled type. The excitation system for the generators would be brushless or static type. It is envisaged to step up the power to 110 kV and evacuate the power through the Tamil Nadu Power grid through at 110 kV line to various consumers. The switchyard is outdoor air insulated type and has a nominal voltage of 110 kV.

As the plant would be using clean fuel in the form of natural gas, it would not discharge any effluents, solid, liquid or gaseous; the technology is environmentally safe and sound as it would operate well within the prescribed environmental norms.

There is no technology transfer in the project activity.

The Technical details of the project as follows:

Contract Capacity (MW)	52.8
Aux. consumption	4%
Gross electricity generation	55.0
Plant Load Factor (%)	85
Gross energy generation (GWh)	409.53
Auxiliary Consumption(GWh)	16.38
Net electricity generated(GWh)	393.15
Heat rate (kcal/kWh)	1980
Calorific value of fuel (kcal/scm)	8775
Fuel requirement, (scm)	92406769
(SCMD)	253169

1.10 Compliance with relevant local laws and regulations related to the project:

The VCS PD shall include identification of relevant local laws and regulations related to the project and demonstration of compliance with them.

The project activity involving setting up of a combined cycle Gas turbine based power plant would emit very small quantity of CO₂ as compared to other fossil fuel based power plants. The suspended particulate matters in the stack gas are almost nil. The project, in other words, is an eco-friendly project. However, as required by the regulations, a public hearing was convened by the project proponent on 13th July 2002 at District Collector's office, Ramanathapuram.

The suggestions made by the stakeholders and the compliance thereof are given in the following table:

Suggestions	Compliance
Provide continuous ambient air quality	Project has provided for the same and

VCS Project Description

monitoring and stack air quality monitoring	the Ambient Air Quality and Stack Air Quality would be continuously monitored by the project
To provide requisite acoustic measures to contain the Noise Pollution within the limits prescribed by the Board. The noise pollution control measures may be as below: • Double wall systems in machineries room • Noise absorbent medium on the surface of the walls and roofs in machineries room • Suitable foundation to mitigate the noise pollution in the machineries room	• The machinery room is a double walled hollow bricks construction, which prevents noise pollution • Noise absorbent medium has been used in the surface of the walls and in roof • Appropriate care has been taken in making the foundation for gas engine room to mitigate the noise
To prepare onsite and off site emergency preparedness plans	The project proponent has prepared an onsite and off site emergency preparedness
To plant adequate trees	An area of about 5 acres has been earmarked for planting trees and tree planting has already commenced
Details of monitoring systems to be adopted by the GAIL shall be obtained and furnished to the TNPCB	Already collected and handed over
To educate the nearby villages regarding the project so as to avoid unnecessary complaints	The project proponent has already informed the nearby village panchayats about the project and its activity.

The project proponent has approached and obtained all the necessary clearances/approvals that are necessary for setting up power project in the state of Tamil Nadu. The details are furnished below:

Name of the Stakeholder	Description	Responsibility
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VCS Project Description

Tamil Nadu Energy Development Agency. (TEDA) www.tn.gov.in/department/energy.htm	Tamil Nadu Energy Development Agency (TEDA) is an organization devoted entirely to the promotion of non-conventional energy sources in Tamil Nadu.	Issues clearance for setting up the project in the state of Tamil Nadu.
Tamil Nadu State Electricity board www.tneb.in	Tamil Nadu power Transmission Corporation Limited is mainly vested with the function of transmission and Distribution of Power in the state of Tamil Nadu any Electricity generation project proposed in Tamil Nadu shall approach TNEB for power evacuation arrangements. Both TNEB and the project Proponent shall sign a Power purchase Agreement, Before implementing the project	Both TNEB and the project proponent shall sign a Power Purchase Agreement, before implementing the project Power Purchase Agreement to determine the tariff and other terms.
Tamil Nadu State Pollution Control Board(TNPCB) www.tnpcb.gov.in	A statutory local body that oversees the pollution control aspects in the state. Any project activity shall obtain clearance from the TNPCB before implementation.	Issues consent for establishment and consent for operation of the project.
Local Village Panchyat	Project proponents approach Elected administrative of the village Panchayat where the project is being implemented to obtain clearance.	Accords permission for setting up of the project under the jurisdiction of the village.
Chief Inspector of Factories	Is part of Govt. of Tamil Nadu looks after all industrial activities through out the state of Tamil Nadu.	Accords approval for establishing the power plant.

Hence the project activity is in compliance with relevant local laws and regulations related to the project. Copies of consents/approvals are provided to the DOE for validation/Verification.

1.11 Identification of risks that may substantially affect the project's GHG emission reductions or removal enhancements:

The prices of petroleum products including Natural Gas have been controlled by the Government of India (GoI) under the Administered Pricing Mechanism (APM). However, in April 2002 the GoI dismantled the APM after which there has been an increase in their prices³. Natural gas prices were revised in

³ Since dismantling of APM, the Petrol/Gasoline price has gone up by 35% and diesel prices by 58% till 26/06/2005 (IOC Website)

September 1997 linking them to the prices of international fuel oils (FO) with the linkage progressively increasing to 55%, 65% and 75% during the years 1997-98, 1998-99 and 1999-2000 respectively for general consumers. On May 27, 2005, Government hiked the price of natural gas supplied to Power and Fertilizer sectors to Rs.3200 from Rs.2850 per thousand standard cubic meters. At present, the gas for domestic use, Fertilizer and Power sectors are still under APM. Once the APM is dismantled, which is likely to happen any time, the price would go up⁴. In the above background, it is evident that the cost of power generation is likely to go up. This is one of the key risk factor affecting the project GHG emission reductions.

1.12 Demonstration to confirm that the project was not implemented to create GHG emissions primarily for the purpose of its subsequent removal or destruction.

The main purpose of the project activity is to generate electricity by utilising the available gas in the Ramanathapuram ONGC zone. This leads to reduction GHG emissions in the whole power generation process of the project activity. Hence it is demonstrated that the project is not implemented to create GHG emissions primarily for the purpose of its subsequent removal or destruction.

1.13 Demonstration that the project has not created another form of environmental credit (for example renewable energy certificates).

If the project has created another form of environmental credit, the proponent must provide a letter from the program operator that the credit has not been used and has been cancelled from the relevant program.

The project activity does not call for another environmental credit or not taken under any other renewable energy certification. Hence the project activity has not created another form of environmental credit.

1.14 Project rejected under other GHG programs (if applicable):

Projects rejected by other GHG programs, due to procedural or eligibility requirements where the GHG program applied have been approved by the VCS Board; can be considered for VCU but project proponents for such a project shall:

- *clearly state in its VCS PD all GHG programs for which the project has applied for credits and why the project was rejected, such information shall not be deemed commercially sensitive information; and*
- *provide the VCS verifier and Registry with the actual rejection document(s) including explanation; and*
- *have the project validated against VCS program requirements.*

The project activity is not applied for any other form of credits. Hence, the rejection by other GHG programs is not applicable.

1.15 Project proponents roles and responsibilities, including contact information of the project proponent, other project participants:

Project proponent: Penna Electricity Limited.

⁴ Presently, ONGC charges Rs.6740 for thousand standard cubic meters of gas supplied to sectors other than power and fertilizers (Financial Express May 28, 2005). This is the price, which ONGC is likely to charge, once the APM is dismantled.

The management structure proposed for monitoring of emission reductions due to the project activity mainly comprises a GHG audit team / committee and authorized to perform various functions such as measuring, recording, storage of measured data and reporting to the project proponent. The outcomes of the committee, in the form of GHG audit reports, are being monitored periodically. The committee comprised representatives of the project participant and other experts as decided from time to time. It was proposed that whenever required an external independent GHG auditor would be deputed for the monitoring activities.

Organization:	Penna Electricity Limited
Street/P.O.Box:	Sriniketan Colony, Road No.3, Banjara Hills
Building:	Plot No. 703
City:	Hyderabad
State/Region:	Andhra Pradesh
Postcode/ZIP:	500 034
Country:	India
Telephone:	+91-040-2335395,23353952
Fax:	+91-040-23355941,23353951
E-Mail:	projets@pennacements.com
Title:	Managing Director
Salutation:	Mr.
Last Name:	Reddy
Middle Name:	Pratap
First Name:	P.
Mobile:	
Direct FAX:	
Direct tel:	+91-040-2335395

1.16 Any information relevant for the eligibility of the project and quantification of emission reductions or removal enhancements, including legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and temporal information.):

Legislative

The project participant obtained all statutory clearances from stakeholders hence no legal risks are anticipated.

Sustainable development

The expected contribution from the project to sustainable development can be studied under four broad heads, viz.,

- Environment Wellbeing
- Technical Wellbeing
- Social Wellbeing, and

- Economic Wellbeing

Environment Wellbeing:

A substantial portion of energy generated in India is through coal and lignite. Power plants based on coal and lignite account for more than half of the installed capacity. Lignite, being mined in the State of Tamil Nadu, is used as one of the major fuels for power generation in the State. Therefore, increase in demand for energy places stress on the environment. The stress can be relieved only through reduction of wastages and optimum use of Clean Energy sources, like Natural Gas, Water and Wind.

The project envisages using Natural Gas, a cleaner fuel as compared to fossil fuels like lignite (brown coal) and sub-bituminous coal. The proposed plant will help replace this fuel, which is environmentally less clean. As the emission due to combustion of Natural Gas is substantially less as compared to combustion of coal or lignite, the project would reduce SO_x, NO_x as well as GHG emissions. Further, since Natural Gas power projects do not lead to production of huge quantities of solid waste like ash in thermal power plants, the project would also reduce the burden on the environment. Finally, generation of power through Natural Gas by this plant would also go to reduce the demand for coal and lignite, which could be used by other industries / sectors.

Technical Wellbeing

The proposed project would be employing the latest combined cycle technology. The technology envisages

- recovering flue gases through Heat Recovery Steam Generation (HRSG) and using the same for generation of energy;
- providing turbines with electro hydraulic governing system to regulate turbine speed during normal on-load operation and during turbine run-up control;
- use of forced draft air-cooled condenser with a frame structure supporting fin tube heat exchanger bundles;
- use of brushless or static type of excitation system for generators;
- use of DM water desalination plant instead of water from the river; and
- Reducing the water requirement to the bare minimum by recirculation of water.
- The project activity is least water intensive. In the first place it does not use water for cooling. Instead, it uses Air-cooled condenser, which cost as much as 4 times more than the Water-cooled condenser. Water Cooled Condenser requires additional water as much as 2050 cu.m per day. Secondly, the water

used for (waste heat recovery) boiler is recycled and additional water requirement is only to take care of evaporation losses.

- Finally, the project activity is a zero discharge effluent plant. It does not discharge any effluent – gas, or solid or liquid and thus does not cause any harm to the environment.
- These kinds of facilities exist in very few gas based power plants in the country. Thus, this type of projects are not common in India and more particularly, Southern region.

The project could also offer possibility of collaboration with the local engineering and technical schools, which would be mutually beneficial.

Social Well being

The project would confer benefits on the society as a whole and the nearby areas in particular, both directly and indirectly. The project would provide employment to about 70 persons directly. The employed would represent an amalgam of both skilled and unskilled workers and engineering graduates. Direct employment apart, the project would give rise to ancillary economic activity in the vicinity of the project site as well as in the proximity. The direct employment provided by the project apart, the industrial units using the energy generated by the project would provide employment to thousands of skilled and unskilled workforce. The spread and demonstration effect the project would confer on the country in general and the State in particular and the contribution it would make to the hinterland development would be substantial.

Economic well being

The project is essentially an infrastructure projects. As such, its contribution is not restricted to only direct contribution, but also extends to contribution derived indirectly from the economic activity arising out of this project. Setting up of this project in Valuthur Village in Ramanathapuram District would give rise to development of social and physical infrastructure in and around the area. Besides, being an infrastructure project, the resultant industrialization (consequent upon this project) would also contribute to the development of physical, social and institutional infrastructure in the State as a whole. The successful operation of this project would lead to the setting up of socially desirable projects like schools, colleges, technical institutes, hospitals, clinics etc. among others by the project proponents. The project proponent has already taken up a project to construct a community hall in the village and the Panchayat building to start with.

In sum, the project activity would contribute to the environment, social and economic issues both locally and globally by

- Net generating power 52.8 MW through relatively clean fuel and augment the power supply in the country;

- reducing GHG emissions;
- conserving lignite/coal for other sectors, which cannot use natural gas;
- providing employment both directly as well as indirectly;
- contributing to the overall development of the area near by and the State as a whole; and
- space requirements per MW for a gas based stations are less than coal based stations

Hence the project is not likely to have any significant adverse negative environmental effects during execution/after commissioning /during the operational lifetime of the project.

Further the project would support to establish, promote the development, manage and safeguard the rational and sustainable exploitation and utilization of renewable energy resources for social and economic development, and can play a critical role in improving the overall energy scenario of the country, particularly of the remote and inaccessible areas. There by support the global climate change programme by cleaner energy.

1.17 List of commercially sensitive information (if applicable):

Any commercially sensitive information that has been excluded from the public version of the VCS PD that will be displayed on the VCS Project Database shall be listed by the project proponent.

It doesn't apply to the project activity as there was no commercially sensitive information that has been excluded from the VCS PD.

2 VCS Methodology:

2.1 Title and reference of the VCS methodology applied to the project activity and explanation of methodology choices:

Projects shall use one of the VCS program approved project methodologies and provide information relevant to methodology deviations or methodology revisions.

As per Voluntary Carbon Standard (VCS– 2007.1) the Project falls under Industrial energy.

The project participant proposes to use the following approved methodologies for CDM Project activities from UNFCCC CDM⁵.

⁵ <http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

Approved baseline methodology AM0029 Ver.03, “**Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas**” in combination with approved Monitoring Methodology AM0029 Ver.03, “**Grid Connected Electricity Generation Plants using Non-Renewable and Less GHG Intensive Fuel**”.

Latest version i.e. Ver. 01.1, 30 May 2008 of “**Tool to calculate the emission factor for an electricity system**”.

2.2 Justification of the choice of the methodology and why it is applicable to the project activity:

The project meets the applicability conditions stipulated in the approved baseline methodology AM0029, “**Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas**” as shown below:

As described in the above sections, the project activity is construction and operation of a Natural Gas fired Grid-Connected Electricity Generation Plant. The power generated by the plant would be evacuated through the power grid of Tamil Nadu State Electricity Board (TNEB), which is a part of the Southern Indian grid.

The proposed project would be using only Natural Gas and use of other fuel is not at all envisaged in the project design.

The geographical and physical boundaries of both the TNEB as well as the Southern Regional Load Dispatch Centre are clearly identified and managed by independent entities, viz., TNEB and the Southern Regional Electricity Board (SREB). The information pertaining to the grid required for estimation of baseline emissions is made available publicly by the Central Electricity Authority (CEA) of Ministry of Power, Govt. of India as well as SREB. This is done through hard publications as well as the respective websites (<http://cea.nic.in> and www.srldc.org). The Central Electricity Authority of India, which is a statutory technical authority under the Ministry of Power, Government of India, has published the Operating Margin and Build Margin data of all regional power grids, which are available on its website <http://cea.nic.in>. Thus, information pertaining to the grid and baseline emissions is available publicly. The Southern grid and the Tamil Nadu power map are given in the enclosed Charts. The location of the project could be seen marked in the Tamil Nadu Power map.

Since the discovery of Natural Gas in India in mid 70s on-shore and off-shore, there has been a steady improvement in its availability. Based on efforts of Oil and Natural Gas Corporation (ONGC), which has pioneered gas exploration, Govt. of India (GOI) opened several blocks, both on-shore as well as off-shore, for exploration of Natural Gas by private sector. During these as well as continued explorations by ONGC, more gas fields have been discovered. Two of these fields, viz., Krishna-Godavari (KG) basin and Cauvery basin (which

include Cauvery Asset in Ramanathapuram Zone) are located in Southern India.

Cauvery Asset Gas wells from where GAIL will source the gas from ONGC are located 4 Km from the site, while the Gas Gathering Station of ONGC is 500 meters from the site. Natural Gas production from Cauvery basin (including Cauvery Asset) has witnessed a steady growth over the years as shown in the following table:

PRODUCTION OF NATURAL GAS IN TAMIL NADU

(in mm. cubic meters)

Year	Production	Flared	Net Production
1990-91	64	55	9
2000-01	200	74	126
2001-02	349	98	251
2002-03	466	88	378
2003-04	605	68	537
2004-05	678	50	628

(Source: www.petroleum.nic.in/petstat.pdf)

The gas availability for the proposed project is unlikely to be a problem for the following reasons

- Out of the total estimated gas reserves of 985 bcm in India, Cauvery basin (including Cauvery Asset) accounts for 14 bcm. and KG basin is about 380 bcm⁶. Cauvery basin (including Cauvery Asset) occupies most of the coastal plains of Tamil Nadu and Pondicherry and extends offshore into the Bay of Bengal. The southern portion extends across Palk Strait and Gulf of Mannar into the western coastal area of Sri Lanka.
- It is gathered that so far, ONGC has drilled 50 wells in Ramanathapuram zone. As of now, it is operating only 10 wells, which is meeting the entire demand of power plants located in this region. Other wells would be operationalized as and when the demand picks up.
- Moreover, similar projects using Natural Gas as feed stock have been already been implemented and more projects are likely to be implemented in future. A list of power projects already in Commission given below⁷.

LIST OF GAS BASED POWER PLANTS IN TAMIL NADU

S.NO	Name of the Station	Capacity (MW)	Year of Commission

⁶ www.bg-india.com/presentations/20feb_06/Fourth Asia Gas Partnership Summit.pdf

⁷ Page no:15 of :Statistics at a Glance 2006-07 published by TNEB and provided a scanned copy to DOE for verification.

1	Narmmanam	10	1992
2	Basin Bridge	120	1996
3	Kovilkalappal	107.88	2001
4	Valthur	95	2003
5	Kuttalam	101	2004
6	Pillaiperumal Nallur	330.5	2001
7	Aban Power co.Ltd	113.2	2005
8	Penna Electricity [Formerly Arkay Energy Limited]	52.8 ^{\$}	2006
	Total	930.88	

^{\$} Contract capacity i.e. net electricity generation

- As could be seen from the above, out of 8 Natural Gas based power plants, 2 (S.Nos. 4&8) are located in Ramanathapuram, where the gas wells of ONGC are located. These power plants ^{\$}for a total installed capacity of about 147.80 MW (Including this Project activity). It is also understood that Tamil Nadu Electricity Board is setting up another natural gas based power project in Valuthur with an installed capacity of 75 MW for which GAIL has agreed to supply required natural gas.
- Project Proponent (PP) has made agreement with GAIL for supply of gas to an extent of 298,000 SCMD. The diameter of pipe connection given to the company is 8", which can supply 398,000 SCMD of gas per day, which is indicative of the GAIL's willingness to supply additional gas to the company and hence the availability of gas in surplus quantities.
- Over and above these reserves, the ONGC has found more potential zones of natural gas reserves in Ramanathapuram district and in a survey conducted recently by its geophysics division in a 50 km radius of Ramanathapuram, ONGC has announced that though the exploration survey was still in the initial stage and the exact quantity of gas reserves would be known only after the completion of survey, the results have been encouraging signifying the availability of adequate reserves⁸;
- Reliance Industries Limited has found significant quantities of gas in the KG-D6 block an offshore, deepwater location near Kakinada, Andhra Pradesh leading to doubling the gas production from KG-D6 block to 80 million standard cubic meters of gas a day. It has announced its plan to lay a pipeline to bring the gas to Tamil Nadu from KG basin and the supply should start sometime around 2008⁹.

⁸ www.hindu.com/2006/09/05/stories/2006090507230500.htm

⁹ www.thehindubusinessline.com/2006/12/04/stories/2006120403200300.htm

- GAIL is laying a national grid connecting Chennai and Madurai. From Madurai, Ramanathapuram, which is about 90 Kms. away from Madurai, would be connected, thus ensuring supply of natural gas to the project not only from Cauvery Asset, but also from other parts of the country.

From the foregoing, it is evident that Natural Gas is available in sufficient quantities in Tamil Nadu for setting up more projects of comparable size. In addition to the above, Liquefied Natural Gas (LNG) can also be imported through the ports of Chennai, Tuticorin etc. Therefore, this project activity will not deprive any other economic activity of the supply of Natural Gas.

2.3 Identifying GHG sources, sinks and reservoirs for the baseline scenario and for the project:

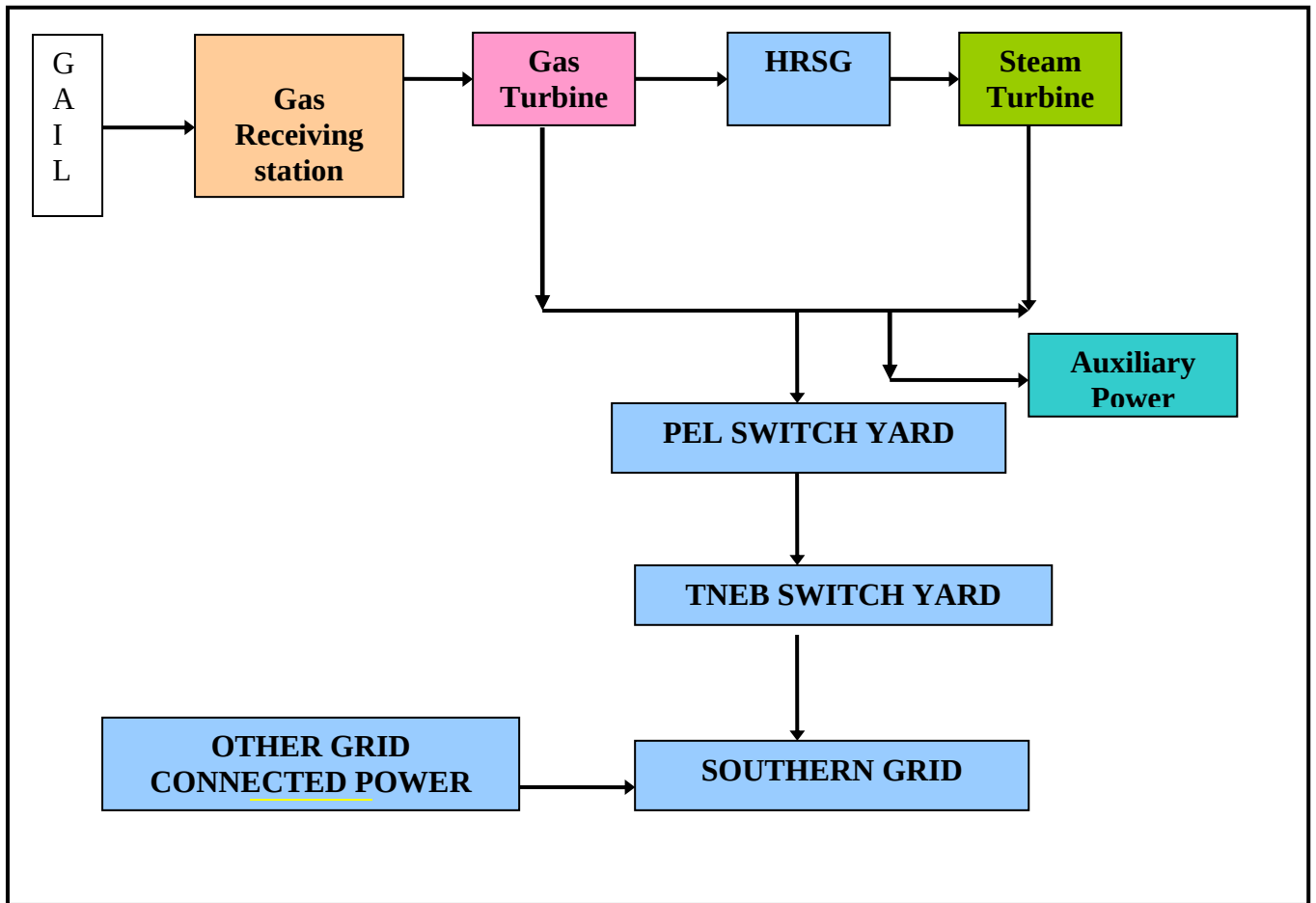
GHG Sources:

The major anthropogenic (man-made) sources of GHGs -: CO₂ by burning of fossil fuels like coal, petroleum, natural gas for industrial, commercial, transportation, residential and other uses. Small amounts of methane (CH₄) are emitted during coal mining, flaring and the venting of natural gas.

The production and use of CFCs and other halocarbons during industrial processes also emits GHGs. The Montreal Protocol concerns issues related to these substances. Changes in land use patterns Deforestation, biomass burning (including fuel wood) and other changes in land-use practice release carbon dioxide, methane and nitrous oxide into the atmosphere.

The spatial extent of the project boundary includes the project site and all power plants connected physically to the baseline grid as defined in “Tool to calculate emission factor for an electricity system”. The boundary starting point is the Gas Receiving Station, where the fuel is received from GAIL and ends at PEL Switch Yard, where it would be exporting power to the grid. The project boundary would include Gas Turbine, HRSG, Steam Turbine, energy consuming auxiliary equipments, PEL Switch Yard, etc. A flow chart indicating the project boundary is given below:

PROJECT BOUNDARY



The GHG emission sources applicable to this project activity that are within the project boundary are mentioned below

	Source	Gas	Included	Justification & Explanation
Base line	Power Generation in base line	CO ₂	yes	Main Emission Source
		CH ₄	No	Excluded for simplification. This is conservative
		N ₂ O	No	Excluded for simplification. This is conservative
Project Activity	On-site fuel combustion due to the project activity	CO ₂	yes	Main Emission Source.
		CH ₄	No	Excluded for simplification. This is conservative.
		N ₂ O	No	Excluded for simplification.

				This is conservative.
--	--	--	--	-----------------------

2.4 Description of how the baseline scenario is identified and description of the identified baseline scenario:

The project proponent shall select the most reasonable baseline scenario for the project. This shall reflect what most likely would have occurred in the absence of the project.

The baseline scenario is evaluated in accordance with AM0029 of approved GHG Program as described below.

Step1: Identification of alternatives to the project activity consistent with current laws and regulations:

Sub-step 1a: Define alternatives to the project activity

It is required to identify realistic and credible alternative(s) that were available and provide output or services comparable with the project activity. These alternatives are required to be in compliance with all applicable legal and regulatory requirements:

Step 1a. Identification of plausible baseline scenario

Potential Baseline Scenario	Does it deliver outputs and services comparable to Project activity?	Is it permitted by applicable Regulations?	Is the alternative 'Realistic and Credible'?	Conclusion
A) Project activity not taken up as CDM project i.e. Gas based CCPP with 43.4% efficiency at 85% PLF (Source: specifications furnished by the equipment supplier & PPA of this project activity) Lifetime: 15 years ¹⁰	Yes	Yes	Yes	Plausible baseline scenario
B) Power generation using natural gas, but with different technology i.e. Natural gas power generation using Internal Combustion (IC) engine technology Efficiency: 43.3% at 80% PLF (Source: Wartsila make Gas engine specifications) Technical lifetime: 15 years	Yes	Yes	Yes	Plausible baseline scenario
C) Power generation using energy sources other than Natural Gas	No 1) Wind plants cannot deliver expected PLF on a continuous	Yes	No 1) Wind flow not available throughout the year.	Not a plausible baseline scenario

¹⁰ Look at GTW handbook and Appendix-II CERC guidelines for tariff calculations-
www.cercind.org.

(1) Wind power PLF: 25 to 30% ¹¹ Lifetime of 15-20 years	basis. 2) Capacity factor is very low: Wind power delivers only 17% capacity factor on average.		2) Wind based generation is possible only in a few places with wind potential. 3) Due to low and unpredictable capacity factor, wind based power is not a realistic and credible baseline scenario	
C) Power generation technologies using energy sources other than Natural Gas (2) Solar Power solar thermal parabolic trough power plant	No 1) Cannot provide base load power throughout the year on continuous basis, unless expensive molten salt storage is used.	Yes	No 1) Solar thermal plant construction in Rajasthan has been discussed for over 20 years without any outcome despite availability of concessional funds (infraline.com)	Not a plausible baseline scenario
C) Power generation Technologies using energy sources other than Natural Gas (3) Hydro power Technical lifetime: 50- 100 years	Yes	Yes	Yes	Plausible baseline scenario
C) Power generation Technologies				

¹¹ Under Table for Economics of Wind Power (Tentative) of web link <http://www.teda.gov.in/page/Wind.htm>

¹² <http://www.iea.org/textbase/work/2004/zets/apec/presentations/sharma.pdf>

using energy sources other than Natural Gas (4) Power generation using Coal (conventional) Efficiency: 34–36% ¹² , PLF 80%. Technical Life time: 20-30 years	Yes	Yes	Yes	Plausible baseline scenario
C) Power generation Technologies using energy sources other than Natural Gas (5) Power generation using Lignite (conventional) Efficiency: 31 – 34% ¹³ ; PLF 80% Technical Life time: 20-30 years	Yes	Yes	Yes	Plausible baseline scenario
C) Power generation Technologies using energy sources other than Natural Gas (6) Coal based power plant with super critical boiler Efficiency: >40% ¹⁴ Technical Life time: 20-30 Years	Yes Capacity would be much larger than the proposed project	Yes	No Currently not applicable to low capacities, but due to technological changes could become a plausible baseline scenario	Not a plausible baseline scenario
C) Power				

¹³ Appendix B of vide web link [CEA database Version 04 . Sep 2008](#)

¹⁴ Report of the committee to recommend next higher size of coal fired thermal power plant- issued by CEA, Ministry of Power, Government of India- www.cea.nic.in & appendix II to CERC guidelines – www.cercind.org.

¹⁵ Report of the expert committee on fuels for power generation (Chapter 3)

generation Technologies using energy sources other than Natural Gas (7) Nuclear power Technical Life time: 30 years ¹⁵	Yes	No National policy does not allow private sector power generation in nuclear power ¹⁶ . For all Stakeholders including the Project Activity except for Nuclear Power Corporation of India, a 100% Government owned company	No	Not a plausible baseline scenario
C) Power generation Technologies using energy sources other than Natural Gas (8) Biomass power, using agricultural residues Efficiency: 23.24% ¹⁷ ; PLF 80% (source: Same web link as provided above). Technical Life time: 20 to 25 years	Yes	Yes	Yes	Not Plausible baseline Scenario.
C) Power generation Technologies using energy sources other than Natural Gas (9) DG set based power plant Efficiency: 35-40%	yes	yes	No This is not a realistic and credible Alternative for	Not Plausible baseline Scenario.

¹⁶ <http://www.thehindu.com/2008/02/12/stories/2008021255351000.htm>

¹⁷ http://www.ercap.org/OtherOrders/Order_RP_84_2003.doc

¹⁸ Report of the Expert Committee on Fuels for Power Generation (February, 2004) – Chapter 1, pp6

Life Time: 20 to 30 years			grid supply. Moreover, the cost of generation of power using Diesel is almost 5 times higher than that of thermal Power ¹⁸ .	
D) Power imports from connected grids (9) Imports from the Western, Eastern, Northern or Sri Lankan grid	Yes	Yes	No The connected grids do not have sufficient surplus for long-term power export	Not a plausible baseline scenario

As the project activity is envisaged to meet the base load power demand, certain alternatives are not possible in the project region and the reasons are explained below:

Hydro power generation: In the State of Tamil Nadu in last 5 years there was only 150 MW capacity additions in the run-of-river based hydro power generation. From this data it is clear that in the state of Tamil Nadu there is no untapped potential for development of hydroelectric power.

Power generation using lignite: Out of the total lignite reserves of 30,300 million tones available in the country, a little more than 85% is available in Tamil Nadu. However, as mentioned above, this alternative is neither possible nor advisable, as lignite is prone to catch fire if transported over long distance. Hence, lignite based power plants are invariably established on the pit heads only. Moreover, lignite based power plants, like coal based power plants would add to carbon emission.

Power generation using agriculture residues: As per Tamil Nadu state policy on biomass power projects, the State Nodal agency will issue licenses for biomass power project per district. Two biomass based power projects have been implemented and the cumulative capacity of these plants is 30 MW¹⁹. Moreover, the size of biomass based power project is from 7.5 to 18 MW because the available biomass potential in the district is limited. In view of this, it is not advisable option for the size of the plant i.e. 58.15 MW.

It is evident from the above analysis that the only plausible baseline scenarios is power generation by using coal, Natural gas with different technology (Gas

¹⁹ <http://www.teda.gov.in/page/biomass.pdf>

Engines) & proposed project not implemented under CDM activity and these are considered for comparison of financial indicators. The details are furnished in the subsequent sections.

Step 1b: Consistency with mandatory laws and regulations:

All the credible and realistic alternatives identified above are consistent with mandatory laws and regulations.

The baseline emission factor has been considered from the Central Electricity Authority (CEA) (which is an official source of Ministry of Power, Government of India) have worked out baseline emission factor for various grids in India and made them publicly available i.e. “CO2 Baseline Database version 4.0, September 2008”

<http://www.cea.nic.in/planning/c%20and%20e/Govtment%20of%20India%20website.htm>

Actual emission reductions will be calculated based on the actual monitored monthly net electricity export to grid readings certified by TNEB and project emissions & leakages will be evaluated based on the natural gas consumption recorded by GAIL at project site.

Step 2: Identification of the economically most attractive baseline scenario alternative

According to AM0029 version 03, the economically most attractive baseline scenario has to be identified by using investment analysis

As mentioned in “The tool for demonstration and assessment of additionality (version 05.1)”, the levelized cost of electricity generation has been identified as the most suitable financial indicator for this project activity. The levelized cost computation takes into consideration of investment cost, fuel costs, operation and maintenance costs for plausible alternatives identified that have been identified as realistic and credible. The critical techno-economic parameters and assumptions used in computing the financial indicators are given below:

Parameters	Coal based	Natural Gas	
		Turbine	Engine
Rate of interest on domestic loan	11% p.a.		
Loan period	10 Years		
Moratorium period	1 Year		
Discount rate	12%		
Capital cost (Rs. Million/MW)	40.0	39.94	33.23
Heat rate Kcal/kWh	2400	1980	1983
Price (Rs./Ton or Rs/1000scm)	1269	4200	4200
Plant Load Factor	85%	85%	85%

CV (Kcal/Kg., Kcal/Sm3)	3750	8775	8775
O&M cost (Rs.mill/MW)	1.04	1.98	0.946
O&M cost escalation	4.0%	4.0%	4.0%
Auxiliary consumption	9%	4%	3%

Step 2a: Calculation of Levelized cost of generation:

The levelized cost of generation computed for the baseline alternatives over a period of 10 years²⁰. Assumptions and input data used are uniform for other alternative considered in the analysis. The results are summarized below. The detailed analysis of the options would be made available to the validator.

Financial Indicator	Coal	Natural Gas	
		Engine-CCPP	Turbine-CCPP
Levelized cost Rs./kWh	2.27	2.35	2.38

The project activity with out considering the CDM revenue i.e. Gas turbine CCPP is least attractive financial indicator (cost of generation) and coal based option has the most attractive indicator among the alternatives. A sensitivity analysis has been performed to confirm the conclusion regarding the financial indicator.

Step 2b: Sensitivity analysis:

Sensitivity has been conducted to ascertain the robustness of the baseline case to reasonable variations in critical assumptions. Two critical factors - very sensitive to the operating results of the project are

- Fuel price
- Power Load Factor

Both these factors were subject to 5% & 10% variation on both the sides (increase as well as decrease), independently, to ascertain the sensitivity of the project's viability to such changes. The impact of the sensitivity analysis is summarized in the following table:

	-10%	-5%	Base Case	+5%	+10%
Plant Load Factor					

²⁰ Though the life of the gas engine is 15 years, a 10 year analysis period is adopted since the terms of the fuel supply agreement is valid only for 10 years beyond which it may be revised. However, as per EB guidance on investment analysis, the fair value of assets has been accounted in the cash flow.

VCS Project Description

Coal	2.41	2.34	2.27	2.21	2.15
Natural Gas with Gas Engines	2.49	2.42	2.35	2.28	2.22
Natural Gas with Gas Turbine	2.53	2.45	2.38	2.31	2.25
Fuel Price					
Coal	2.17	2.22	2.27	2.32	2.37
Natural Gas with Gas Engines	2.24	2.29	2.35	2.40	2.45
Natural Gas with Gas Turbine	2.28	2.33	2.38	2.43	2.48

From the foregoing sensitivity analysis it is evident that the levelized Cost would continue to be low in the case of project using coal as fuel. The sensitivity analysis confirms the result obtained in the investment analysis. *Project activity not implemented as a VCS project activity has the lowest financial indicator and continues to remain so even under sensitivity analysis involving variation of critical parameters. Therefore, “Coal based power generation” is the economically most attractive baseline scenario. This is further confirmed by TNEB experience²¹.*

At present, the price of gas for domestic use, Fertilizer and Power sectors are still under Administered Pricing Mechanism (APM). Once the APM is dismantled, which is likely to happen any time, the price would go up²². In the above background, it should be evident that cost of power generation using coal is the cheapest option and it is likely to remain as the most economically attractive baseline scenario.

2.5 Description of how the emissions of GHG by source in baseline scenario are reduced below those that would have occurred in the absence of the project activity (assessment and demonstration of additionality):

The project proponent shall in the VCS PD, in addition to describing how the project meets the VCS methodology, demonstrate that the project is additional based on one of the tests, the project test, the performance test, and technology test.

As per the methodology, the project proponent has to establish that GHG reductions due to project activity are additional to those that would have occurred in the absence of the project activity. The approved baseline methodology has suggested three main steps for testing Additionality of the project. These are discussed in the context of the proposed VCS project activity.

Test 1- The project test:

²¹ TNEB Vision statement – Statistics At A Glance 2004-05; pp 75

²² Presently, ONGC charges Rs.6740 for thousand standard cubic meters of gas supplied to sectors other than power and fertilizers (Financial Express May 28, 2005). This is the price, which ONGC is likely to charge, once the APM is dismantled.

Step 1: Regulatory Surplus

As per the Voluntary carbon standard (VCS-2007.1), in this step it is required to be proved that the project shall not be mandated by any enforced law, statute or other regulatory framework.

There is no National Legislation that requires the production of power generation through Gas resources. Additionally, the Government regulation has not imposed any target for Gas power plants.

The implementation of the gas based power project activity is a voluntary step undertaken by the project proponents with no direct or indirect mandate by law.

Step 2: Implementation barriers

In this step, as per the VCS 2007.1 it is required to show that the project faces one or more distinct barriers compared with barriers faced by alternative projects.

Investment barrier:

Determine whether the proposed project activity is not:

- (a) The most economically or financially attractive; or
- (b) Economically or financially feasible, without the revenue from the sale of certified emission reductions (VERs).

To conduct the investment analysis, used the following Sub-steps:

Sub-step a: Determine appropriate analysis method

As per “Tool for the demonstration and assessment of additionality” there are three options are available to demonstrate the investment analysis.

- Option I : Simple cost Analysis
- Option II. : Investment comparison analysis
- Option III. : Benchmark analysis

The PP has chosen option III to prove investment barrier.

Sub-step b.: Benchmark analysis

The project has dual revenue streams, electricity for sale to the state utility grid and voluntary emission reductions, from the definition of alternatives in sub-step a we are restricted to the proposed project activity not undertaken as a VCS project.

Internal Rate Return (IRR) is the most commonly used financial indicator by the Bankers and Investors alike to assess the intrinsic viability of the project. The IRR thus computed, has to be compared with a benchmark indicator.

“Additionality Tool Ver. 5 states that the Discount rates and benchmarks, shall be derived from, inter alia Government bond rates, increased by a suitable risk premium to reflect private investment and/or the project type, as substantiated by an independent (financial) expert or documented by official publicly available financial data. Accordingly, PP has computed the benchmark return, detailed calculations of which are given in the worksheet. The benchmark return works out to 13.75%”.

Appropriateness of choosing benchmark:

As per the guidance note issued by CDM EB at its 41st meeting “In case where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average cost of capital (WACC) are appropriate benchmarks for a project IRR” (annex 45, page No.3, item 11 Selection and Validation of Appropriate Benchmarks - EB 41). Based on this the PP has taken into account the Weighted Average Cost of capital as the Benchmark Return. Project IRR is used to demonstrate the additionality of the project.

Project IRR has been computed for the project on post-tax basis based on Weighted Average Cost of Capital (WACC). While estimating WACC the cost of debt is based on lending rate and the lowest return on equity is considered based on the return (Published data) earned by Central sector undertakings (CSUs) as estimated by CAS (A division of CRISIL). The assumptions considered for financial analysis are based on the Detailed Project Report (DPR), prevailing fuel prices and the Power Purchase Agreement (PPA) executed with TNEB.

Calculation of Benchmark WACC:

The WACC is the weighted average of the cost of equity and cost of debt used for financing. As per the additionality tool, standard parameters (and not project specific ones) are required to be used for arriving at the benchmark rate. In India, a debt to equity ratio of 70:30 is considered as the norm for financing power sector projects²³. Accordingly the WACC has been calculated based on a 70:30 debt to equity ratio.

Accordingly, the weighted average cost of capital applicable to the project type has been considered. Weighted average cost of capital (WACC) is calculated as weighted average cost of equity and cost of debt as illustrated below:

$$\text{WACC} = \text{Debt} \times \text{Cost of Debt} + \text{Equity} \times \text{Return on Equity}$$

Lowest return on equity (conservatively) is considered based on the return (Published data) earned by Central sector undertakings (CSUs) as estimated by CAS (A division of CRISIL)

<http://cercind.gov.in/rep1304.pdf>

²³ <http://www.cercind.gov.in>

ROE (CRISIL)	
NLC	16.30%
NTPC	17.60%
PGCIL	20.60%
NHPC	20.90%
NEEPCO	18.90%
Average	18.86%

The project IRR in baseline scenario is working out to 9.05%. The investment estimated to be incurred on the project activity along with assumptions made for estimation of IRR are furnished as soft copy for verification of the DOE. The IRR is less compared with prevailing bench mark which is considered at 13.75% at the time of implementation.

The assumptions of the main input parameters for the IRR analysis as follows:

Fuel Parameters	Units	
Contract capacity with TNEB	MW	52.8
Aux. Consumption	%	4
Installed capacity	MW	58.15
Gross electricity generation	MW	55.0
PLF	%	85
No. of hour per annum		8760
Total electricity generation	GWh	409.53
Aux. Consumption	GWh	16.38
Net exportable power	GWh	393.15
Station heat rate	Kcal/KWh	1980
Average calorific value of fuel used	Kcal/scm	8775
Units generation per unit fuel	KWh/scm	4.43
Price	Rs./1000 scm	4200
Financial Parameters		
Total Project cost	Rs, million	2322.58
Equity	Rs, million	760.00
Term loan	Rs, million	1562.58
Tariff	Rs/Kwh	2.2798
Electricity duty	Rs/Kwh	0.114
O&M cost	Rs.mill/MW	0.946
O&M cost escalation	% p.a.	4.0%
Depreciation	% p.a.	7.66%
Loan tenor	Years	10
Moratorium	Years	1
Rate of Interest		
- on term loan		11%
- on working capital		16%

Income Tax (MAT)		7.69%
Income Tax (Regular)		35.88%

Sub-step c: Calculation and comparison of financial indicators:

Based on the assumptions, the project IRR works out to 9.05%, which is less than the benchmark rate of 13.75%. Detailed computations of financial indicator are furnished in the worksheet. A comparison of the project IRR with the benchmark rate would reveal that the project is not financially attractive.

Sub-step d: Sensitivity analysis

The robustness of the conclusion drawn above has been tested, by subjecting the critical assumptions to reasonable variations

PP has identified the critical factors are power generation, project cost, fuel cost, tariff and O& M expenses. Accordingly, the critical assumptions have been subjected to a 10% variation on either side. The outcome of the sensitivity analysis is given below:

Factor	Variation %		
	-10%	0%	+10%
Generation	7.03%	9.05%	11.00%
Project cost	11.11%	9.05%	7.33%
Tariff	5.24%	9.05%	12.68%
Fuel cost	10.75%	9.05%	7.29%
Bench Mark*		13.75%	

The foregoing analysis proves beyond doubt that the project is additional and would continue to remain additional, thus the project justifies the need of VCS benefits for the project activity, which will help in improving the project competitiveness and financial sustainability. Therefore, VCS benefits are imperative for the project to become financially attractive.

Technological barrier:

The main disadvantage of independent gas turbine based power plant is that the power generation would drop down to zero should there be a problem in the turbine. In contrast, the combination of both turbine and engine based power plant has the capability to sustain the power generation even in case one stream malfunctions.

Step 3: common Practice

In the first place, generation of power using natural gas as fuel is of recent phenomenon. It is not quite common in the country. Power Generation statistics as on 31st March 2004, reveals that natural gas, as fuel in power generation accounted only 15.2% of the total thermal power generated in the country. The report also reveals region-wise variance in the use of natural gas based power generation. In the Southern region, natural gas based power

generation accounted for 15.5% of the total thermal power generation. The details are given in the following table:

POWER GENERATION – REGION-WISE ²⁴
(In MW)

Region	Coal	Gas	Diesel	Total	Gas as % to total
Northern	15914.50	3213.20	14.99	19142.69	16.8%
Western	20691.50	5035.72	17.48	25744.70	19.6%
Southern	13492.50	2650.40	949.29	17092.19	15.5%
Eastern	14527.38	190.00	71.25	14788.63	1.3%
North Eastern	330.00	750.59	119.82	1200.41	62.5%
Total	64955.88	11839.91	1172.83	77968.62	15.2%

Even after two years, the natural gas has not become a common fuel for power generation in the country as could be seen from the following data:

POWER GENERATION – FUEL-WISE ²⁵

Fuel	Capacity MW	Percentage, %
Coal	68518.88	58.02
Multi-fuel & diesel	1201.75	1.02
Liquid fuel/natural gas	12689.92	10.75
Hydropower	32325.76	27.37
Nuclear	3360.0	2.85
Total	118096.3	100.00

It could be seen from the above data that thermal power plants (consisting of coal and lignite) account for more than 58% of the power generated in the country. Power generated through multi fuel and diesel account for a little over 1%. Thus, CO₂ emitting power plants account for almost 60% of the power generated in the country. The less pollutant hydropower and liquid fuel/natural gas account for only about one third of the power generated. Thus,

²⁴ http://www.cea.nic.in/power_sec_reports/general_review/0304/chap-2.pdf

²⁵ Page No. 4 of Review of Growth of Indian Electricity Sector vide web link http://www.cea.nic.in/power_sec_reports/general_review/0405/ch0.pdf

it is evident that gas based power Project is not a common practice in the country.

3 Monitoring:

3.1 Title and reference of the VCS methodology (which includes the monitoring requirements) applied to the project activity and explanation of methodology choices:

Baseline methodology:

Title: Approved Baseline Methodology AM0029 (Version 03, 16th May 2008) - “Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas”.

“Tool to calculate the emission factor for an electricity system²⁶” (Version 01.1, EB 35).

Monitoring Methodology:

Title: Approved monitoring methodology AM0029 (Version 03, 16th May 2008) - “Grid Connected Electricity Generation Plants using Non-Renewable and Less GHG Intensive Fuel”

3.2 Monitoring, including estimation, modelling, measurement or calculation approaches:

- *Purpose of monitoring*
- *Types of data and information to be reported, including units of measurement*
- *Origin of the data)*
- *Monitoring, including estimation, modelling, measurement or calculation approaches*
- *Monitoring times and periods, considering the needs of intended users*
- *Monitoring roles and responsibilities*
- *Managing data quality*

The purpose of the monitoring is to verify the project activity and check if it meets the facts which were meant for the Voluntary Carbon Units that being reduced by the project activity.

The monitoring plan, which will be implemented by the project proponent describes about the monitoring organisation, parameters to be monitored, monitoring practices, quality assurance, quality control procedures, data storage and archiving.

Data and Information for reporting:

- Amount of Gas Consumption during the power generation (scm).

²⁶ http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf

- Net calorific value of Natural gas used for generation of power (kcal/scm or GJ/scm)
- Gross electricity generation (kWh) by the project activity.
- Electricity Import from the grid system (kWh).
- Net quantity of Electricity generated (exported) to the grid by the project activity (kWh).
- Emission factor for Natural gas (tCO₂/GJ).
- Oxidation factor of the fuel
- Emission factor for upstream fugitive methane emissions of natural gas from production, transportation and distribution (tCH₄/GJ)
- Emission factor of the plants included in the build margin (tCO₂/GWh)
- Periodical calibration of monitoring equipments

Monitoring Equipments:

- Main Meter and Check meters for metering the exported electricity to the grid & imported electricity from grid system.
- Energy meters for metering Gross electricity generation and Auxiliary power consumption.
- Flow meter for consumption of natural gas in the project.

Monitoring Roles & Responsibilities

The responsibilities of various personnel in the organization in implementing the monitoring plan are as follows:

1	Shift in-charge/ Supervisor	Shift in-charge will monitor the plant parameters including the monitoring parameters as described in the PDD. He will collect the data recorded in log sheets and prepare the consolidated report on electricity generation, export to grid, fuel consumption, plant shut down time, etc. for every shift. These reports would be submitted to the Plant Manager for review.
2	Plant Manager	Review of the monitored parameters for correctness, corrective measures in case of minor errors in the monitored data and preparation of a daily summary on project operation and electricity generation to the General Manager on daily basis.
3	General Manager	Summarization of data and preparation of report. Report will be sent to Board of Directors. The responsibility of storage and archiving of information in good condition also lies with the General Manager. He would also co-ordinate to

		obtain audit reports as per the monitoring plan from Internal auditors.
5	Board of Directors	Review Data report and to take necessary corrective actions. The authority and responsibility for registration, monitoring, measurement, reporting and reviewing of the data rests with the Board of Directors.
4	TNEB Personnel	Metering the electricity export to grid and electricity import from Grid.

The General Manager will prepare the Monitoring report incl. emission reduction calculations and submit to the Managing Director for review and finalization of Monitoring report.

Managing Data Quality

The General Manager /Plant Manager would prepare the report pertaining to the recorded values of the monitored parameters as by the shift-in-charge.

The recorded parameters would be documented every day in the standard log books maintained at the plant.

The day to day records would be verified by Plant Manager, compiled and documented for preparation of internal audit reports.

The company will introduce an internal audit system for documentation and safe storage of data. Internal auditing would be carried out as per the monitoring plan and whenever necessary. An internal audit report would be prepared for review by the higher authorities not less than the rank of General Manager. The internal auditor could be an outside entity or one of the higher authority of the company. The internal auditor would be required to verify the records independently with reference to the power exported and imported with respect of grid. The reports would be submitted periodically to the designated.

Internal audit reports are the basic documents for the monitoring and storage of plant operational data.

Methodology proposed to be adopted for determining base line emission factor is the combined margin of the generating mix in the Southern grid system, which represent the intensity of carbon emissions of the grid system. The baseline emission factor would be adopted from the “CO2 Baseline Database” published by CEA for the latest available year for the southern grid and the same would be used for the future projection and would be reviewed each year based on data published by CEA

All the data items monitored under the monitoring plan would be kept for 2 years after the end of crediting period or till the last issuance of VCU/VERs for this project activity whichever occurs later.

3.3 Data and parameters monitored / Selecting relevant GHG sources, sinks and reservoirs for monitoring or estimating GHG emissions and removals:

VCS Project Description

Data / Parameter:	FC_f
Data unit:	scm
Description:	Annual quantity of Natural gas consumed in the project activity
Source of data to be used:	Reading of Gas flow meters; The gas supplied to the project shall be metered at project site and accordingly billed by Gas Authority of India.
Value of data applied for the purpose of calculating expected emission reductions	92406769 (anticipated)
Description of measurement methods and procedures to be applied:	Natural gas consumption will be measured on daily basis at project site. The total gas consumption will be monitored by GAIL and PEL and will be cross verified by PEL fortnightly.
QA/QC procedures to be applied:	The meter would be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing at least once in year to ensure accuracy. The readings will be double checked by the gas supply company.
Any comment:	Proportion of data monitored will be 100% and archived electronically / on paper as available. The archived data will be stored up to two years from the the end of crediting period or the last issuance, which ever occurs later.

Data / Parameter:	NCV_{f,y}
Data unit:	GJ/m ³ (or Kcal/scm)
Description:	Net calorific value of natural gas (Fuel f)
Source of data to be used:	The calorific value of natural gas is provided by the gas supplier in the fortnightly invoices. This will be converted into the units required for estimation of project emissions i.e. TJ/scm. Besides Invoices of GAIL, the NCV will also be measured periodically independent of GAIL.
Value of data applied for the purpose of calculating expected emission reductions	8775 kcal/scm
Description of measurement methods and procedures to be applied:	The calorific value of the gas would be provided by the supplier in the gas invoice and recorded and verified by the project participant
QA/QC procedures to be applied:	Additional QA/QC procedure is not planned
Any comment:	The data will be archived electronically/ on paper as available. The archived data will be stored up to two years from the end of crediting period or the last issuance, which ever occurs later.

Data / Parameter:	EG_{Gross}
Data unit:	KWh

VCS Project Description

Description:	Total quantity of Electricity generated from the project activity during the year y
Source of data to be used:	On-site measurements from the readings of meter installed at plant site.
Value of data applied for the purpose of calculating expected emission reductions	409530000(anticipated)
Description of measurement methods and procedures to be applied:	Measured daily using calibrated meters and aggregated monthly.
QA/QC procedures to be applied:	The consistency of metered electricity generation will be cross-checked with the quantity of fuel fired. The Meters used for reading the Gross electricity generation will be calibrated as per industry standards of host country (India) and calibration of meters are carried out annually.
Any comment:	Data archived: Crediting period + two years.

Data / Parameter:	EG_{Import}
Data unit:	KWh
Description:	Onsite electricity consumption of the project activity imported from the grid system during the year y
Source of data to be used:	Main meters and Check meters provided by project proponent at Project site.
Value of data applied for the purpose of calculating expected emission reductions	0 (projected)
Description of measurement methods and procedures to be applied:	Measured monthly using calibrated meters of accuracy class 0.2 and aggregated annually. Meters will be calibrated as per industry standards/PPA. Sales records to the grid and other records are used to ensure consistency.
QA/QC procedures to be applied:	Electric power imported from grid will be measured by Main Meter and Check Meter by both project proponent and TNEB as specified in the PPA and records maintained. To be cross-checked with monthly invoices or receipts of payments.
Any comment:	Data archived: Crediting period + two years.

Data / Parameter:	EG_{PJ,y}
Data unit:	KWh
Description:	Net quantity of electricity generated (exported) to the grid by the project activity.
Source of data to be used:	Main meters and Check meters provided by project proponent at Project site.
Value of data applied for the purpose of calculating expected emission reductions	393148800(anticipated)
Description of measurement methods and procedures to be applied:	Measured monthly using calibrated meters of accuracy class 0.2 and aggregated annually. Meters will be calibrated as per industry standards/PPA. Sales records to the grid and other records are used to ensure consistency.
QA/QC procedures to be applied:	Electric power imported from grid will be measured by Main Meter and Check Meter by both project proponent and TNEB as specified

VCS Project Description

	in the PPA and records maintained. To be cross-checked with monthly invoices or receipts of payments
Any comment:	Data archived: Crediting period + two years.

Data / Parameter:	EF_{CO₂NG,y}
Data unit:	tCO ₂ /GJ
Description:	Emission factor of Natural Gas
Source of data to be used:	IPCCC Default Value or Appendix B of vide web link CEA database Version 04 , Sep 2008
Value of data applied for the purpose of calculating expected emission reductions	54.3
Description of measurement methods and procedures to be applied:	The data published in CEA is the authenticated and represents the national average values. Hence, the emission factor value is considered from CEA.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied.
Any comment:	The above value would be applied for estimation of project emissions during the crediting period.

Data / Parameter:	OXID_{NG}
Data unit:	-
Description:	Oxidation factor of Natural gas
Source of data to be used:	Latest IPCC default value
Value of data applied for the purpose of calculating expected emission reductions	1.0 (Source: IPCC 2006)
Description of measurement methods and procedures to be applied:	100% of the data would be monitored annually
QA/QC procedures to be applied:	Since IPCC default value is used, no additional QA/QC procedures need to be applied.
Any comment:	

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 and distribution.
Source of data to be used:	IPCC Values as indicated in Table 2 of AM0029 ver.3
Value of data applied for the purpose of calculating expected emission reductions	160 [Production : 72 Processing, transport and distribution: 88]
Description of measurement methods and procedures to be applied:	As the fuel supplier (GAIL) adopted international standards ²⁷ like American Society of Mechanical Engineers (ASME) and

²⁷ <http://www.blonnet.com/2005/04/23/stories/2005042301550200.htm>

http://gail.nic.in/gailnewsite/investorzone/investorzone_annualreports.html

VCS Project Description

	European Norms for laying pipelines for transportation of natural gas, pipeline coating, a gas metering system, etc.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied since it is a officially published data
Any comment:	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 ¹⁵ . Also GAIL conducts the regular safety audits to maintain the international safety standards with some reputed international firms ²⁸

Data / Parameter:	EF_{BL,upstream,ch4}
Data unit:	tCO ₂ /GWh
Description:	Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation
Source of data to be used:	Latest CEA data Base CEA database Version 04 , Sep 2008
Value of data applied for the purpose of calculating expected emission reductions	13.61
Description of measurement methods and procedures to be applied:	EF _{BL,upstream,CH4} is calculated for power plants included in the Build Margin of Southern Regional grid, inline with the baseline emission factor selection. Therefore in line with the AM0029 requirement of ex-post determination of the Build Margin, the Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation (tCH ₄ or tCO ₂ e/MWh) will also be determined ex-post.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied since it is a officially published data
Any comment:	This will be monitored ex-post as required by the methodology

Data / Parameter:	EF_{BL,CO2,y}
Data unit:	tCO ₂ /GWh
Description:	Emission factor of the plants included in the build margin
Source of data to be used:	Latest CEA data Base CEA database Version 04 , Sep 2008
Value of data applied for the purpose of calculating expected emission reductions	713.3
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

²⁸ <http://www.energymanagertraining.com/eca2005/Award2005CD/AwardBook/Petroleum%20Pipeline.pdf>

	for the Indian Power Sector. When published data for the ex-post calculation of emission factor is not available for a particular year, the factor calculated for the previous year would be adopted
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied since it is an officially published data
Any comment:	This will be monitored ex-post as required by the methodology

3.4 Description of the monitoring plan

The Monitoring and Verification (M&V) procedures define a project-specific standard against which the project's performance (i.e. GHG reductions) and conformance with all relevant criteria will be monitored and verified. It includes developing suitable data collection methods and data interpretation technique for monitoring and verification of GHG emissions with specific focus on technical performance parameters. It also allows scope for review, scrutiny and benchmarking of all this information against reports pertaining to M & V protocols.

The M&V Protocol provides a range of data measurement, estimation and collection options/techniques in each case indicating preferred options consistent with good practices to allow project managers and operational staff, auditors, and verifiers to apply the most practical and cost-effective measurement approaches to the project. The aim is to enable this project have a clear, credible, and accurate set of monitoring, evaluation and verification procedures. The purpose of these procedures would be to direct and support continuous monitoring of project performance/key project indicators to determine project outcomes, greenhouse gas (GHG) emission reductions.

The project revenue is based on the units exported as measured by energy meters installed at project site. The monitoring and verification system would mainly comprise of these meters as far as net electricity export to grid is concerned. The natural gas input will also be monitored. The export of electricity will also counter checked with sales bills/receipts. The invoices, based on meter readings will also be covered in the regular finance audit.

The measurement of the quantity of natural gas used will produce evidence that the energy is being generated with reduced CO₂ emissions as compared to selected grid emissions. The project employed latest 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 quantity of emission reduction units claimed by the project will be only a fraction of the total generated emissions, which depends on the actual generation in a particular year. Required information about the performance of power generation units of Southern grid (which includes both private and public sector generation units of the grid) is available in the yearly publication of Central Electric Authority (CEA) of India. Hence, authentic data related to the measurements, recording, monitoring and control of the generation mix of the Southern network will be ensured.

The CEA report contains all information regarding type of generation like hydro, thermal, nuclear, renewable etc., installed capacity, de-rated capacity, performance of generating unit, actual generation, capacity additions during the year, etc. which will be used for verification of generation mix and emission factors for baseline calculation for a particular year.

Emission reductions: The project activity will reduce the CO₂ emissions. The emission reduction is directly proportional to the PLF. If the project operates at high efficiency level and exports more electricity to the grid, the project would contribute to more emission reduction. The sophisticated DCS would measure; collect data on various process parameters, records, monitor and control on a continuous basis.

Therefore, the verification would involve

- Verification of various measurement and monitoring methods.
- Verification of instrument calibration methods
- Verification of data generated by DCS
- Verification of measurement accuracy
- Verification of invoices raised by TNEB and GAIL

The above verification would enable to arrive at the exact quantity of Natural gas used, efficiency and heat rate of the power plant, total power generation and auxiliary consumption, and power exported to the grid.

a) Direct off-site Emission:

Direct off-site emissions are those emissions, which are significant and reasonably attributable to the project activity, but are not included in the project boundary. These emissions are also called as leakages. As per the boundary defined for the project, direct on-site emission arises during the transport of natural gas. However, in the baseline of power generation, fuel transport will take place, which has to be taken into account. On an average, the distance over which fuels have to be transported will be larger for fossil fuel-fired power stations, contributing to baseline emissions because of a large distance to coal mines and ports. As against natural gas transportation (by pipeline) will contribute to negligible emission of CO₂ (due to operation of gas blowers at gas terminal point). Transport emissions of the baseline will be

much more than the transport emissions related to the project activity. To provide a conservative estimate of the emission reductions, the reduction in transport emissions in the project compared to the transport emissions in the baseline is not taken into consideration for CO₂ emission reduction estimate of the project. Transport emissions are therefore not taken into account.

b) Indirect On-Site Emissions:

The indirect on site GHG source is the consumption of energy and the emission of GHGs involved in the construction of natural gas based combined cycle power plant. Considering the life cycle assessment of the total power generated and the emissions to be avoided in the life span of 15 –20 years, emissions from the above-mentioned source are too small and hence neglected. No other indirect on-site emissions are anticipated from the project activity.

d) Indirect Off-Site Emissions:

The indirect off-site GHG source is the emission of GHGs that are involved in the process, construction and erection of the transmission lines from the nearest sub station, up to the point from where the project wheels the power. This is an emission leakage. Considering the life cycle assessment of the total power generated and the emissions to be avoided in the life span of project, emissions from this source is also too small and hence neglected. The electricity generated, less the auxiliary consumption, will be exported to the southern grid through TNEB to meet the increasing demand of electricity services, and there will be no creation of new activities or demand in other places / sites caused by the project.

4 GHG Emission Reductions:

4.1 Explanation of methodological choice:

Emission reductions from the proposed project can be calculated based on the AM0029: “Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas”. To calculate the emission reductions the equations below have been applied:

According to the approved baseline methodology AM0029 ver .3, the emission reductions ER_y by the project activity is calculated using the following equation

$$ER_y = BE_y - PE_y - L_y \dots\dots\dots (6)$$

Where:

ER_y : Emissions reductions in year y (tCO₂e)

BE_y : Emissions in the baseline scenario in year y (tCO₂e)

PE_y : Emissions in the project scenario in year y (tCO₂e)

LE_y : leakage in year y (tCO₂e)

Baseline emissions (BE_y):

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

$$BE_y = EG_{PJ,y} * EF_{BL,CO_2,y} \dots \text{Equ. (2) of AM 0029 Ver.3}$$

Where:

BE_y : Baseline emissions in year y.
 EG_{PJ,y} : Electricity generated in the project plant J in year y.
 EF_{BL,CO₂,y} : Baseline CO₂ emission factor in year y.

For construction of large new power capacity additions under the CDM/VCS, there is a considerable uncertainty relating to which type of other power generation is substituted by the power generation of the project plant. As a result of the project, the construction of an alternative power generation technology could be avoided or the construction of a series of other power plants could simply be delayed. Furthermore, if the project were installed sooner than these, other projects might have been constructed and its near-term impact could be largely to reduce electricity generation in existing plants. This depends on many factors and assumptions (e.g., whether there is a supply deficit) that are difficult to determine and it changes over time. In order to address this uncertainty in a conservative manner, project participants have been advised to use EF_{BL,CO₂,y}, the lowest emission factor among the following three options for the first crediting period:

Option 1: The build margin calculated according to “Tool to calculate emission factor for an electricity system”,

Option 2: The combined margin, calculated according to “Tool to calculate emission factor for an electricity system”, 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:

$$EF_{BL,CO_2}(tCO_2/MWh) = \frac{COEF_{BL}}{\eta_{BL}} * 3.6GJ/MWh$$

... Equ. (3) of AM 0029 Ver.3

Where,

$COEF_{BL}$: fuel emission coefficient (tCO₂e/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.

According to the methodology, the combined margin and the build margin of the regional grid calculated in accordance with the “Tool to calculate emission factor for an electricity system” have to be compared with the emissions factor of the power plant defined as the baseline scenario. The combined margin and the build margin for the Southern Grid are derived from the Central Electricity Authority (CEA) database available at <http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>

Option 1: The build margin calculated according to “Tool to calculate emission factor for an Electricity system”:

Build margin (BM): The build margin reflects the average CO₂ intensity of newly built power stations that will be (partially) replaced by a CDM project. In accordance with AM0029, the build margin is calculated in this database as the average emissions intensity of the 20% most recent capacity additions in the grid based on net generation. Depending on the region, the build margin covers units commissioned in the last five to ten years.

Build Margin (tCO₂/GWh) (incl. Imports) for Southern Region Grid (FY 2007-08)

Build Margin (BM)	713.3	tCO ₂ / GWh
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Option 2: The combined margin, calculated according to “Tool to calculate emission factor for an Electricity system”, using a 50/50 OM/BM weight

Simple operating margin (OM): The operating margin describes the average CO₂ intensity of existing stations in the grid, which are most likely to reduce their output if a CDM project supplies electricity to the grid (or reduces consumption of grid electricity). “Simple” denotes one out of four possible variants listed in AM0029 for calculating the operating margin. The simple operating margin is obtained by dividing the region’s total CO₂ emissions by the net generation of stations serving the region excluding low-cost/must-run sources. In other words, the total emissions are divided by the total net generation of all thermal power stations. Hydro and nuclear qualify as low-cost/must-run sources, and their net generation is therefore excluded from the denominator.

The Simple Operating Margin (tCO₂/GWh) (Incl. Imports) for Southern Grid is derived as follows:

Most recent three years	2005-06	2006-07	2007-08
Operating Margin* (OM) in t CO ₂ / GWh	1005.67	999.12	990.62
Average of 3 years	998.47		

Source: CDM Carbon dioxide Baseline Data base, Version 4.0, September 2008.

<http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>

Applying the build margin as reported above, the **Combined Margin** is

Combined Margin (CM)	855.89	tCO₂/GWh
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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:

The emission factor of the standard coal power plant identified as the baseline scenario is calculated as follows:

$$EF_{BL,CO_2}(tco_2 / Mwh) = \frac{COEF_{BL}}{\eta_{BL}} * 3.6GJ / MWh$$

The power plant emits 92.5 tonnes CO₂ /ton of coal used. Its average efficiency is 31.3%. Thus EF_{BL CO₂}

$$= 92.5 \times 3.6 / (31.3/100) = 1064 \text{ t CO}_2/\text{GWh}$$

As the BM factor of current generation mix (713.3 tCO₂/ GWh) is lower than the other two options, it is selected as baseline emission factor.

Project emissions (PE_y):

The project activity is on-site combustion of natural gas to generate electricity and no start up fuels is required. The CO₂ emissions from electricity generation (PE_y) are calculated as follows:

$$PE_y = \sum_f FC_{f,y} * COEF_{f,y} \quad \dots \text{Equ. (1) of AM 0029 Ver.3}$$

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 (m³ or similar) in year(s) y.

$COEF_{f,y}$: Is the CO₂ emission coefficient (tCO₂/m³ or Similar) in year(s) for each fuel and is obtained as:

$$COEF_{f,y} = \sum NCV_y * EF_{CO2f,y} * OXID_f$$

... Equ. (1a) of AM 0029 Ver.3

$NCV_{f,y}$: Is the net calorific value (energy content) Per volume unit of natural gas in Year 'y' (GJ/m³) as determined from the fuel supplier, Wherever possible, otherwise from local or national data;

$EF_{CO2f,y}$: Is the CO₂ 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

Leakage (LEy):

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 CH₄ emissions and CO₂ emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered²⁹:

- 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;

The leakage emissions are calculated as follows:

²⁹ The EB is undertaking further work on the estimation of leakage emission sources in case of fuel switch project activities. This approach may be revised based on outcome of this work.

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

... Equ. (4) of AM 0029 Ver.3

Where

LE_y : Leakage emissions during the year y in tCO₂e

$LE_{CH_4,y}$: Leakage emissions due to fugitive upstream CH₄ Emissions in the year y in tCO₂e.

$LE_{LNG,CO_2,y}$: Leakage emission due to fossil fuel combustion/ Electricity consumption associated with the Liquefaction, transportation, re-gasification and compression of LNG in to natural gas transmission or distribution system during the year y in the t CO₂e.

Since, the proposed plant is based on use of natural gas directly from wells of ONGC, which would be piped to the project site and that there will be no consumption of LNG in the project activity, the equation 5 in the approved methodology AM0029 will be a simple equation and represented by.

$$LE_y = LE_{CH_4,y}$$

For the purpose of estimating fugitive CH₄ (methane) emissions, the quantity of natural gas consumed by the project in year 'y' is multiplied with an emission factor for fugitive CH₄ emissions ($EF_{NG,upstream, CH_4}$) from natural gas consumption and subtract the emissions occurring from fossil fuels used in the absence of the project activity as per the following formula:

$$LE_{CH_4,y} = \{FC_y * NCV_y * EF_{NG,upstream,CH_4} - EG_{PJ,y} * EF_{BLUpstream,CH_4}\} * GWP_{CH_4}$$

... Equ. (5) of AM 0029 Ver.3

Where:

$LE_{CH_4,y}$: Leakage emissions due to fugitive upstream CH₄ emissions in the year y in t CO₂e.

FC_y : Quantity of natural gas combusted in the project plant during the year y in m³

$NCV_{NG,y}$: Average net calorific value of the natural gas combusted during the year y in GJ/m³

$EF_{NG, upstream, CH_4}$: Emission factor for upstream fugitive methane LNG, emissions of natural gas from production, transportation, distribution, and, in the case of liquefaction, transportation, re gasification and compression into a transmission or distribution system, in t CH₄ per GJ fuel supplied to final consumers

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

$EF_{BL, upstream, CH_4}$: Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH₄ per MWh electricity generation in the project plant, as defined below.

GWP_{CH_4} : Global warming potential of methane valid for the relevant commitment period.

The emission factor for upstream fugitive CH₄ emissions occurring in the absence of project activity has been calculated consistent with the baseline emission factor, i.e., Option I Build margin.

Option 1:
Build
Margin:

$$EF_{BL, upstream, CH_4} = \frac{\sum_j FF_{j,k} \cdot EF_{k, upstream, CH_4}}{\sum_j EG_j}$$

Where

$EF_{BL, upstream, CH_4}$: Emission factor for upstream fugitive Methane emissions occurring in the absence of the project activity in tCH₄ per MWh electricity generation in the project plant

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

$EF_{k, upstream, CH_4}$: Emission factor for upstream fugitive methane emissions from production of the fuel type k (coal or oil type) in t CH₄ per MJ fuel produced

EG_j : Electricity generation in the plant j included in the build margin in MWh/a

For $EF_{BL, upstream.CH_4}$ and $EF_{k, upstream.CH_4}$, 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 comparable with US/Canada, The gas supply company i.e. Gas Authority of India Limited (GAIL) is maintaining all its processing plants and gas transmission lines are matching the International Standards. In 2005, GAIL formed a special cell to maintain the gas infrastructure standards inline with the “**American Petroleum Institute and European Standards**” GAIL had received **ISO 9002, ISO 14001 and OHSAS 18001** quality and environmental management certificates for its gas infrastructures GAIL has won Five Star Safety Awards by **British Safety Council**.

<http://www.blonnet.com/2005/04/23/stories/2005042301550200.htm>
<http://www.energymanagertraining.com/eca2005/Award2005CD/AwardBook/Petroleum%20Pipeline.pdf>,

In the above back ground, the project proponent has considered the default value i.e. 160 tCH₄/PJ for USA and Canada as mentioned in Table 2 of AM0029 Ver.3.

Upstream fugitive emissions occurring in the absence of the project activity electricity generation has been calculated using the Build Margin power plants. Therefore in line with the AM0029 requirement of ex-post determination of the Build Margin, the Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation (tCH₄/MWh) will also be determined ex-post.

4.2 Quantifying GHG emissions and/or removals for the baseline scenario:

Emissions Reductions are calculated as explained in section 4.1 above are summarized as below.

Annual Emission Reduction calculations are as follows:

Baseline emissions (BE_y):

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

$$= 393.15 \times 713.3 = 280433 \text{ tCO}_2\text{e}$$

Project emissions (PE_y):

The project activity is on-site combustion of natural gas to generate electricity. The CO₂ emissions from electricity generation (PE_y) are calculated as follows:

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

Natural gas consumed = 92406769 m³

Average calorific value of Natural gas = 8775 kcal/ m³

Emission factor for gas = 36.7 x 10⁻⁶ TJ/ m³
= 54.3 tCO₂/TJ

Oxidation factor of gas = 1

CO₂ Emission Coefficient = 0.0019912 tCO₂/m³

CO₂ Emission factor for
Natural gas = 92406769 x 0.0019912
= 184002 tCO₂e

Leakage (LE_y)

Fugitive Methane Emission

$$LE_{CH_4,y} = \{FC_y * NCV_y * EF_{NG,upstream,CH_4} - EG_{PJ,y} * EF_{BL,Upstream,CH_4}\} * GWP_{CH_4}$$

Natural gas consumed = 92406769 m³

Avg. calorific value of gas used, = 8775 kcal/ m³

Net electricity export to grid = 393.15 GWh

Combined fugitive emission factor
(Coal, oil & gas) = 13.60 t CO₂/MU

$$= \{92406769 \times (8775 \times 4.18 / 10^6) \times 160 - 393.15 \times 13.60\} \times 21$$

$$= 6092 \text{ tCO}_2\text{e}$$

Emission Reductions (ER_y)

$$ER_y = BE_y - PE_y - LE_y$$

$$= 280433 - 184002 - 6092$$

$$= 90339 \text{ tCO}_2\text{e.}$$

4.3 Quantifying GHG emissions and/or removals for the project:

The GHG emissions from the project activity are not other than the project emission & leakage due to the combustion of the natural gas for the power generation which are accounted as shown in the section 4.2 above.

4.4 Quantifying GHG emission reductions and removal enhancements for the GHG project:

Summery of the quantifying GHG emission reductions for the project activity are furnished below.

Year	Estimation of project activity emissions (tCO ₂ e)	Estimation of baseline emissions (tCO ₂ e)	Estimation of leakage (tCO ₂ e)	Estimation of overall emission Reductions (tCO ₂ e)
1 st July 2006-30 th June 2007	280433	184002	6092	90339
1 st July 2007-30 th June 2008	280433	184002	6092	90339
1 st July 2008-30 th June 2009	280433	184002	6092	90339
1 st July 2009-30 th June 2010	280433	184002	6092	90339
1 st July 2010-30 th June 2011	280433	184002	6092	90339
1 st July 2011-30 th June 2012	280433	184002	6092	90339
1 st July 2012-30 th June 2013	280433	184002	6092	90339
1 st July 2013-30 th June 2014	280433	184002	6092	90339
1 st July 2014-30 th June 2015	280433	184002	6092	90339
1 st July 2015-30 th June 2016	280433	184002	6092	90339
Total (tonnes of	2804330	1840020	60920	903390

CO ₂ e				
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5 Environmental Impact:

A summary environmental impact assessment when such an assessment is required by applicable legislation or regulation

As per the Indian Government rule and regulations, the project activity should get an environmental clearance in the form of “No Objection Certificate” from the Tamil Nadu Pollution Control Board. Besides, the project site should be approved from the environmental angle.

A comprehensive environmental impact assessment study has been conducted for the project and the study reveals that the impact of the project activity on the environment is not significant. The major findings of the study are given below:

Topography: The present topography of the study area is a coastal plain sandy terrain and nearly 30% of the buffer zone is occupied by sea. In the core zone, few small sand dunes are noted. The construction of the proposed combined cycle power project will affect the existing land surface of 18.89 acres acquired by Penna Electricity Limited. Planting of a thick canopy of trees at a width of 5 mtrs. Along the periphery of the core zone and proper formation of roads and other infrastructural facility would upgrade and preserve topography. *Due to the proposed project, there will not be any change in the topography of the buffer zone.*

Climate: Normally, the regional factors such as monsoon and depressions are the main factors that govern the climatic conditions like temperature variations, wind direction and velocity, rainfall and humidity. The proposed gas based power generation will not tend to influence the existing climatic conditions. Though exit gas temperature through the stack is slightly higher than the atmospheric temperature, it will not affect the local climate due to high dispersion through suitably designed stack.

Air Environment: Dispersion of different pollutants released into the atmosphere have significant impacts on surrounding environment of any industrial project and forms an important part of impact assessment studies. The collection of baseline information with respect to air pollutants comprises of Suspended Particulate Matter (SPM), Oxides of Nitrogen (NO_x) and Carbon Monoxide (CO). Anticipated impacts with respect to air pollutants have been super imposed on the present ambient air quality parameters to find out the net impacts in the air environment.

Air Pollution Potential – Fugitive emissions: Since the proposed fuel for the power generation, natural gas, is being transported through pipeline from the nearby ONGC gas gathering station, *there is no chance of fugitive dust generation to raw material transportation.* However to avoid dust generation,

all roads inside the power plant would be concreted. In addition, water spray would be done regularly to avoid fugitive dust generation.

Air Pollution Potential – Impact due to the usage of natural gas: The gaseous emission generated during the ignition process is exhausted through a 34.50 mtr. main stack. Natural gas comprises Methane, which is the combustible component. The natural gas is an environmental friendly fuel and hence the quantum of emission would be negligible and there would be no impact on air quality.

Air Pollution Potential – Air quality model and predictions: The study reveals that the increase in Ground Level Concentration value for the pollutant NO_x is very low and well within the prescribed standards for ambient air quality. When compared to other fuels such as coal, furnace oil, LSHS, the natural gas does not generate any solid waste. Though by virtue of its gaseous fractions, the emitted flue gas contains the gaseous pollutants such as NO_x, the anticipated increase in the ground level concentration of SO₂ and NO_x is well below the standard prescribed by CPCB/TNPCB.

Noise Environment- Noise pollution potential: Generally, GT, STG and GEs are noise generating. These are housed in concrete hollow block civil structure, which would be suitably located on the site to ensure compliance with the industrial noise norms of 55 DB (A) during day time and 45 DB (A) during night time. The noise level outside the plant would be lower because noise intensity decreases as the distance from the noise source increases. The time of exposure to these noise levels outside plant premises will be less than for the workers inside the plant. Thus, the impact of the project on the ambient environment and consequently on the human will be minimal.

Land Use: About 18.89 acres of uncultivable land has been purchased by Penna Electricity Limited (PEL) for the proposed power generation projects. 34% of the land will be utilized for project activities and 30% for developing green belt. Since there are no vehicle movement either for supply of raw material or for transportation of finished goods, the fugitive emissions from the project activity is nil. Since the project activity would be using radiator type cooling, noise generation would also be very low. The green belt around the power plant would reduce the noise propagation around the proposed power plant. The green belt would also reduce, to a certain extent, the air pollution impact.

Ecological Factors: The core zone does not present a picture of natural species of vegetation due to the limitation in the agricultural activities. Hence, except for change in land use, there will be no perceptible effect by the proposed project. Use of natural gas for power generation would not generate any suspended particulate matter, gaseous pollutants, and solid waste and hence the question of project activity affecting the available cropland or vegetations over the buffer zone is nil. More over, since natural gas will not discharge any metal pollution, oil pollution, pesticide pollution and microbiological pollution, the project would not affect the biosphere.

Socio Economic Environment: The project activity will go to augment the power supply of the State through relatively clean and efficient technology for power generation without significantly affecting the environment. The project activity would provide employment to a few skilled workers and also push other industrial/commercial avenues in the region.

Environmental Pollution: The project activity will not generate any trade effluent. The waste water generated will be from the domestic usage of water and DM plant reject. This effluent will also be treated to meet the standard prescribed by CPCB and the same will be used for green belt development. Hence, there will not be any deterioration in water quality. Since the project activity would be utilizing most eco-friendly natural gas for power generation, though there will be a marginal increase in the gaseous pollutant such as NO_x, it would be well within the limit prescribed by the CPCB.

During the construction phase, there would be a chance for noise propagation due to the movement of vehicles and construction activities. However, the noise propagation would be controlled through regulated movement of vehicles. During the operational phase, the proposed development of green belt would reduce the noise level. GT, STG & GE shall be located in a hollow brick walled construction would ensure the noise level is maintained within the prescribed limit.

6 Stakeholders comments:

Relevant outcomes from stakeholder consultations and mechanisms for on-going communication.

The project activity involving setting up of a combined cycle gas turbine based power plant would emit very small quantity of CO₂ as compared to other fossil fuel based power plants. The suspended particulate matters in the stack gas are nil. The project, in other words, is an eco-friendly project. However, as required by the regulations, a stakeholders meeting was called through a news paper advertisement (Indian Express dated 13.07.2002) at District Collector's office, Ramanathapuram. Copy of the public notice along with minutes of the stake holder's meeting is furnished to the DOE. The stakeholders for the project include

- District Collector
- District Environmental Engineer
- Member of Legislative Assembly from the constituency
- Local Municipal councillor
- Department of Environment(State Pollution Control Board)
- Local people

As could be seen from the above, the composition includes state government representatives, local government representatives, and local population.

A public hearing was convened by the project proponent on August 19, 2002, which was attended by all the aforementioned stakeholders. About 25 public attended the meeting. The project proponent explained the project and its salient features. After the explanation, the stakeholders were invited to make their comments. The entire proceedings of the public hearing have been minuted and signed by all those present. The detailed report of stakeholder consultation will be made available to the validator.

The public recommended the project and requested the project proponent to take the following steps:

- Provide continuous ambient air quality monitoring and stack air quality monitoring.
- Provide requisite acoustic measures, like double wall system in machineries room, noise absorbent medium on the surface of the walls and roofs in machinery room and suitable foundation to mitigate the noise pollution in the machinery rooms, to contain the noise pollution within the limits prescribed by the Board.
- Prepare onsite and off site emergency preparedness plan and to plant adequate trees.
- Obtain the Gas Pipe line monitoring system to be adopted by GAIL and furnish it to the TNPCB.
- educate the nearby villages regarding the project so as to avoid unnecessary complaints

Based on the comprehensive environment impact assessment study and public hearing, the TNPCB approved the setting up of the project and issued “No Objection Certificate” Besides the NOC from the TNPCB, other statutory and non-statutory clearances obtained by the project include

- Clearance from the Tamil Nadu Forest Department, Govt. of Tamil Nadu
- Consent from Tamil Nadu Electricity Board. Govt. of Tamil Nadu
- No Objection Certificate from the Eastern Naval Command, Govt. of India
- No Objection Certificate from Airports Authority of India, Govt. of India
- Approval from Ministry of Environment & Forests, Govt. of India
- Permission from Town & Country Planning Dept.
- Permission from Valatharavai Municipal Council

All stakeholders have issued their approvals/consents/licenses for setting up the project and no adverse comments were received on the project.

7 Schedule:

Chronological plan for the date of initiating project activities, date of terminating the project, frequency of monitoring and reporting and the project period, including relevant project activities in each step of the GHG project cycle.

Chronology of Events of Penna Electricity Limited

- a) Sanction letter from the Nodal agency : Mar 2002
- b) Agreement/P.O.s for plant equipment : Sep 2002
- c) Detailed project report [DPR] : Jun 2003
- d) Consent order for establishment from PCB : Oct 2003
- e) Loan sanctions from banks
 - National Punjab Bank : May 2003
 - UCO Bank : May 2003
 - Rural Electrification Corp. Ltd. : May 2004
- f) Power Purchase Agreement [PPA] with TNEB : Aug 2004
- g) License from Inspector of Factories : Jun 2006
- h) Copy of synchronization/Test certificate : Jul 2006
- i) Appointment of DOE : Oct 2008

8 Ownership:

8.1 Proof of Title:

Provide evidence of proof of title through one of the following:

- *a legislative right;*
- *a right under local common law;*
- *Ownership of the plant, equipment and/or process generating the reductions/removals;*
- *A contractual arrangement with the owner of the plant, equipment or process that grants all reductions/removals to the proponent*

For the ownership details of the project activity following may be referred:

- Letter of Memorandum from Ministry of Company Affairs for Certificate incorporation consequence upon change of Company's name
- Consent for operation from the State Pollution Control Board

The same is provided to the DOE for verification.

8.2 Projects that reduce GHG emissions from activities that participate in an emissions trading program (if applicable):

Project proponents of projects that reduce GHG emissions from activities that:

- are included in an emissions trading Program; or
- take place in a jurisdiction or sector in which binding limits are established on GHG emissions;

VCS Project Description

Shall provide evidence that the reductions or removals generated by the project have or will not be used in the Program or jurisdiction for the purpose of demonstrating compliance. The evidence could include:

- a letter from the Program operator or designated national authority that emissions allowances (or other GHG credits used in the Program) equivalent to the reductions/removals generated by the project have been cancelled from the Program; or national cap as applicable or;
- Purchase and cancellation of GHG allowances equivalent to the reductions/removals generated by the project related to the Program or national cap.

Not applicable for the project activity

Enclosure - I

BASELINE INFORMATION

From Carbon Dioxide Baseline Data base, **Version 4, September 2008** published by Government of India, Ministry of Power Central Electricity Authority, Government of India.

(<http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20web%20site.htm>)

Data and Calculation Approach

This section gives an overview on the base data, annual data as well as the approaches used to calculate station-level and unit-level CO₂ emissions.

Base Data

The following base data parameters were collected for all the stations listed in the CO₂ database:

Station Nos.

Station Numbers start at 1 in each regional grid. The numbering has been introduced for unambiguous referral to each station and to allow for the insertion of additional station in a region without having to change the numbers of other regions. All units of a station have the same station number. Numbers may change in future database versions.

Station Name

Name of the power station

Unit Number

The units of a station are numbered serially starting with 1. Stations are attributed with unit number 0 for the purpose of calculations.

Commissioning Date

The commissioning date is provided for each unit. Commissioning dates are important for the determination of the build margin.

Capacity:

Capacity data is based on declared rated capacities in MW for each unit as of 31st March 2008.

Region

Regional grid to which the station is connected to. Table below gives the codes for different regions used in the database:

Table 3: Codes of Regional Grids used in CO₂ Database

Name of the Region	Code
North East West North-Eastern Region	NEWNR
Southern Region	SR

State

State where the power station is located.

Sector

This denotes whether the stations is operated by the central sector, the state authorities, or the private sector.

System

A list of the systems including abbreviations and full names is provided in Appendix A.

Type

The type of the station, viz., thermal, nuclear, hydro.

Fuel

Fuel 1 and Fuel 2 indicates the main fuels used for power generation at each station. For example, in coal based stations, Coal is indicated as Fuel 1 and Oil as Fuel 2.

From Carbon Dioxide Baseline Data base, Version 4, September 2008 published by Government of India, Ministry of Power Central Electricity Authority, Government of India.

(<http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>)

Fuel Emission Factors (EF) (Source: Coal/Lignite - Initial National Communication, Gas/Oil/Diesel/Naphtha - IPCC 2006, Corex - own assumption)

	Unit	Coal	Lignite	Gas	Oil	Diesel	Naphtha	Corex
EF based on NCV	gCO ₂ /MJ	95.8	106.2	54.3	75.5	72.6	69.3	0.0
Delta GCV NCV	%	3.6%	3.6%	10%	5%	5%	5%	n/a
EF based on GCV	gCO ₂ /MJ	92.5	102.5	49.4	71.9	69.1	66.0	0.0
Oxidation Factor	-	0.98	0.98	1.00	1.00	1.00	1.00	n/a
Fuel Emission Factor	gCO ₂ /MJ	90.6	100.5	49.4	71.9	69.1	66.0	0.0

n/a = not applicable (i.e. no assumptions were needed)

Assumptions at Station Level (only where data was not provided by station)

	Unit	Coal	Lignite	Gas-CC	Gas-CC	Oil	Diesel-Eng	Diesel-CC	Naphtha	Hydro	Nuclear
Auxiliary Power Consumption	%	8.0	10.0	3.0	1.0	3.5	3.5	1.0	3.5	0.5	10.5
Gross Heat Rate	kcal /KWh (gross)	2,500	2,713	2,013	3150	2,117	1,975	3,213	2,117	n/a	n/a
Net Heat Rate	kcal /KWh (net)	2,717	3,014	2,075	3,182	2,193	2,047	3,330	2,193	n/a	n/a
Specific Oil Consumption	ml /KWh (gross)	2.0	3.0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
GCV	kcal /kg (or m3)	3,755	n/a	8,800	n/a	10,100	10,500	10,500	11,300	n/a	n/a
Density	t /1,000 t	n/a	n/a	n/a	n/a	0.95	0.83	0.83	0.70	n/a	n/a
Specific CO ₂ emissions	tCO ₂ /MW/h	1.04	1.28	0.43	0.66	0.66	0.59	0.96	0.61	n/a	n/a

n/a = not applicable (i.e. no assumptions were needed)

Assumptions at Unit Level (by capacity; only for units in the BM, where data was not provided by station)

	Unit	67.5 MW	120 MW	200-250 MW	500 MW
Gross Heat Rate	kcal /KWh	2,750	2,500	2,500	2,425
Auxiliary Power Consumption	%	12.0	9.0	9.0	7.5
Net Heat Rate	kcal /KWh	3,125	2,747	2,747	2,622
Net Efficiency	%	28%	31%	31%	33%
Specific Oil Consumption	ml /KWh	2.0	2.0	2.0	2.0
Specific CO ₂ Emissions	tCO ₂ /MW/h	1.19	1.05	1.05	1.00
	Unit	75 MW	125 MW	210/250 MW	
Gross Heat Rate	kcal /KWh	2,750	2,560	2,713	
Auxiliary Power Consumption	%	12.0	12.0	10.0	
Net Heat Rate	kcal /KWh	3,125	2,909	3,014	
Net Efficiency	%	28%	30%	29%	
Specific Oil Consumption	ml /KWh	3.0	3.0	3.0	
Specific CO ₂ Emissions	tCO ₂ /MW/h	1.22	1.23	1.23	
	Unit	0-49.9 MW	50-99.9 MW	>100 MW	
Gross Heat Rate	kcal /KWh	1,950	1,910	1,970	
Auxiliary Power Consumption	%	3.0	3.0	3.0	
Net Heat Rate	kcal /KWh	2,010	1,969	2,001	
Net Efficiency	%	43%	44%	42%	
Specific CO ₂ Emissions	tCO ₂ /MW/h	0.42	0.41	0.42	
	Unit	0.1-1 MW	1-3 MW	3-10 MW	>10 MW
Gross Heat Rate	kcal /KWh	2,350	2,250	2,100	1,975
Auxiliary Power Consumption	%	3.5	3.5	3.5	3.5
Net Heat Rate	kcal /KWh	2,435	2,332	2,176	2,047
Specific CO ₂ Emissions	tCO ₂ /MW/h	0.70	0.67	0.63	0.59
	Unit	All sizes			
Increment to Gas Heat Rate	%	2%			
Gross Heat Rate	kcal /KWh	2,117			
Auxiliary Power Consumption	%	3.5			
Net Heat Rate	kcal /KWh	2,193			
Specific CO ₂ Emissions	tCO ₂ /MW/h	0.61			

Combined Margin	Unit	
Weight CM	%	50%
Weight BM	%	50%

Conversion Factors	Unit	
Energy	kJ /kcal	4,1868
	MJ /KWh	3.6

Oil		
Specific Emission	gCO ₂ /ml	2.89

APPENDIX B: Grid Emission Factor**TABLE B: Values for all regional for FY 2005-06 to Until FY 2007-08, Excluding inter –regional and cross- border electricity transfers**

Note: values are rounded off two decimals see the web link given above for addition Decimal Place

Weighted Average Emission Rate (tCO₂/MWh) (excl. Imports)

	2005-06	2006-07	2007-08
NEWNE	0.8407	0.8287	0.8195
South	0.7341	0.7163	0.7223
India	0.8151	0.8010	0.7961

Simple Operating Margin (tCO₂/MWh) (excl. Imports)

	2005-06	2006-07	2007-08
NEWNE	1.0246	1.0163	1.0123
South	1.0057	0.9991	0.9906
India	1.0205	1.0124	1.0074

Build Margin (tCO₂/MWh) (excl. Imports)

	2005-06	2006-07	2007-08
NEWNE	0.6725	0.6313	0.5977
South	0.7067	0.7013	0.7133
India	0.6908	0.6495	0.6253

Combined Margin (tCO₂/MWh) (excl. Imports)

	2005-06	2006-07	2007-08
NEWNE	0.8498	0.8238	0.8050
South	0.8562	0.8502	0.8520
India	0.8508	0.8305	0.8164

**TABLE B : Values for all regional for FY 2005-06 to Until FY 2007-08,
Including inter-regional and cross-border electricity transfers**

Weighted Average Emission Rate (tCO₂/MWh) (incl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	0.8388	0.8243	0.8121 *
South	0.7341	0.7163	0.7223 *
India	0.8128	0.7972	0.7898

Simple Operating Margin (tCO₂/MWh) (incl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	1.01949	1.00835	0.99917 *
South	1.00567	0.99912	0.99062 *
India	1.0168	1.0063	0.9973

Build Margin (tCO₂/MWh) (not adjusted for imports)			
	2005-06	2006-07	2007-08
NEWNE	0.6725	0.6313	0.59771
South	0.7067	0.7013	0.713
India	0.6808	0.6495	0.6253

Combined Margin in tCO₂/MWh (incl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	0.8460	0.8198	0.7984
South	0.8562	0.8502	0.8520
India	0.8487	0.8274	0.8113

Annex-2

Abstract sheet for levelised cost for the project activity and other alternate plausible scenarios.

		Coal		Natural Gas		
Fuel Parameters				Gas Engines	Gas Turbine	
Station heat rate	Kcal/KWh	2400		1983	1980	
Secondary fuel consumption	ml/KWh	2				
Average calorific value of fuel used		3755	Kcal/Kg	8775	8775	Kcal/scm
Units generation per unit fuel		1.56	KWh/kg	4.43	4.43	KWh/scm
Price		1269	Rs./Ton	4200	4200	Rs./1000 scm
Financial Parameters						
Plant Load Factor (maximum)	%	85.0%		85.0%	85.0%	
Auxiliary power consumption	%	9.0%		3.0%	4.0%	
O&M cost	Rs.mill/MW	1.04		1.98	0.946	
O&M cost escalation	% p.a.	4.00%		4.00%	4.00%	
Depreciation	% p.a.	3.60%		7.66%	7.66%	
Debt: Equity ratio		67.3:32.7		67.3:32.7	67.3:32.7	
Loan tenor	Years	10		10	10	
Moratorium	Years	1		1	1	
Rate of Interest - on term loan		11%		11%	11%	
- on working capital		16%		16%	16%	
Post tax return on equity		14%		14%	14%	
Capital cost	Rs. Mill./MW	40.00		33.23	39.94	
Secondary fuel price	Rs./Lit	26.62		-	-	
Discount rate		12%		12%	12%	
Corporate Tax rate	Percent	34%		34%	34%	