# Voluntary Carbon Standard 2007.1
# Project Description

**[Date of VCS PD: 01/02/2010]**

## Contents

# 1 Description of Project:

**1.1 Project title**

Natural Gas based grid connected power project at Peddapuram, A.P. by Gautami Power Limited

Version Number: 02
Date of document: 15/05/2010

**1.2 Type/Category of the project**

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

Clean Development Mechanism (CDM) under United Nation Framework on Climate Change (UNFCCC) is one of the GHG programs which have been approved by the VCS board. The project activity is categorized according to the most recent version of categorization under GHG program -CDM Reference: This CDM project activities available at the URL
**http://cdm.unfccc.int/methodologies/PAmethodologies/approved**
The categorization is as follows:

| | |
|---|---|
| **Type** | : I- Renewable energy projects |
| **Category** | : AM0029 ("Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas") |
| **Version No** | : 03, EB 39 |
| **Sectoral Scope** | : 01 Energy Industries (renewable/non-renewable) |

- *Specify here if the project is a Grouped project.*

As per the definitions and requirements set out in VCS program guidelines 2007.1 (Clause 4.1.2 and Clause 5.2), ***"Any combination of GHG projects or project categories that meet the requirements of VCS 2007.1"*** is treated as a grouped project, and can be registered as a grouped project.

The project activity is a single GHG project activity that aims at reducing or removing GHG emissions. **The project activity is not a grouped project.**

Project activity is a non-AFOLU project and non - Agricultural Land Management (ALM) project is focusing exclusively on emissions reductions of $CO_2$ & $CH_4$.

## 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 estimated GHG emission reductions for the project activity are 1,293,422 tonnes of $CO_2$ per annum. The project activity has chosen the crediting period of 10 years with option of renewal of one time. The total estimated emission reductions over the crediting period of 10 years are 12,934,220 tonnes of $CO_2$ equivalent.

The project falls under the category of Mega Project as the emission reduction is more than 1,000,000 tonnes of $CO_2$ equivalent emission reductions per year.

## 1.4 A brief description of the project:

The proposed project activity is commissioning and operation of a new, green field 469 MW Natural Gas fired, gas turbine based combined cycle power plant. The proposed project activity is being installed by GVK Gautami Power Ltd. (GPL)[1] at Industrial Development Area, Peddapuram, near Samalkot in East Godavari district, Andhra Pradesh, India. The project activity uses relatively cleaner fuel, natural gas instead of most common fuel in the grid i.e. coal for power generation. Thus, the project activity will avoid significant emission compared to the usual practice in coal dominated Indian power sector.

**Purpose of the project activity:**

The purpose of the project activity is commissioning and operation of 469 MW natural gas fired power plant. The project activity will be less emission intensive compared with the common coal based power and average fuel mix in the grid. Thus, the project activity aims at reducing the GHG emission reduction by use of a relatively lesser GHG intensive fuel i.e. natural gas.

This being a green field project activity, the pre-project scenario would be electricity generation using the current fuel mix in the grid.

[1] GVK Gautami Power Ltd. is the new name of PP as per order dt. 08/09/2009 (letter from 'Registrar of Companies, Andhra Pradesh' submitted to DOE)

Project history: A power plant (where the project activity exists) was taken up for development by Satyam Constructions Ltd. in 1995 (300 MW liquid fuel based) and PPA was signed in 1997 with APSEB. Another 227 MW liquid fuel based power plant envisaged by Nagarjuna Construction Co. Ltd. also signed PPA in same time. In 2000, Government of Andhra Pradesh decided to convert all short gestation period power plants to be natural gas based and approached for gas supply to these plants. These two plants (and holding companies Gautami Power Private Limited and NCC Power Corporation Ltd. were merged by the High Court order in 2001 and the later company ceased to exist ). The PPA for 464 MW CCPP using NG was approved by APERC on 12/04/2003. This is the major requirement (approved PPA) to apply for loans and to envisage setting up the power plant. All other earlier milestones are feasibility studies and due diligence/ approval processes. Thus, any of these can not be taken as the investment decisions as before achieving financial closure, the project plant can not come up.

**Project participant:**
GVK Group is involved in development of various infrastructure projects in the areas of Power, Roads, Airports, Urban Infrastructure, Coal and Special Economic Zones. GVK Group is also involved in the hospitality industry, manufacturing industry and also in bio-sciences.

**Baseline scenario:**

PP has applied AM0029 Version 03 to the project activity and the baseline has been identified in accordance with the applied methodology. The identified baseline scenario is:
In the absence of the project activity, the equivalent amount of electricity would have been generated in the coal based power plants or naphtha based power plants (existing and future additions) connected to the southern grid of India.

A detail discussion of the identification of the baseline scenario is provided in the section 2.4 of the PD.

**Reduction of greenhouse gas emissions:**

The project activity replaces anthropogenic emissions of greenhouse gases (GHGs) in to the atmosphere, which is estimated to be 1,293,422 $tCO_2e$ per year, by displacing the equivalent amount of electricity generation through the operation of existing fuel mix grid comprising mainly fossil fuel based power plants and future capacity expansions connected to the southern grid of India.

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

## 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 469 MW combined cycle power plant is located at Industrial Development Area, Samalkot, near the port town Kakinada, Andhra Pradesh. The site is 15 km from the sea port at Kakinada and 3 km from the Samalkot railway station. The geographical coordinates of the Samalkot are 17°03'03" N and 82°07'04" E.


(Source: www.mapsofindia.com)

Figure 1: Location of the project activity (a) in India (b) in West Godavari District

## 1.6 Duration of the project activity/crediting period:

- *Project start date: Date on which a financial commitment was made to the project and the project reached financial closure.*
- *Crediting period start date: the date the first monitoring period commenced*
    - *VCS project crediting period:* A maximum of ten years which may be renewed at most two times

As per the policy announcement made by VCS Association on 10 September 2007, start date of the project activity is considered as the date on which the project began reducing GHG emissions. The commissioning date for the project activity is June 05, 2009 (05/06/2009).

**Crediting period start date:** 05/06/2009
**VCS project crediting period:** 10 years with a renewal of one time.

| **Years** | **Estimation of annual emission reductions in tonnes of $CO_2e$** |
|---|---|
| 2009 | 1,293,422 |
| 2010 | 1,293,422 |
| 2011 | 1,293,422 |
| 2012 | 1,293,422 |
| 2013 | 1,293,422 |
| 2014 | 1,293,422 |
| 2015 | 1,293,422 |
| 2016 | 1,293,422 |
| 2017 | 1,293,422 |
| 2018 | 1,293,422 |
| Total estimated reductions (tonnes of $CO_2e$) | 1,293,422 |
| Total number of crediting years | 10 |
| Annual average of the estimated reductions over the crediting period ($tCO_2e$) | 12,934,220 |

**1.7 Conditions prior to project initiation:**

Since the project activity is a Greenfield project, no energy generation units existed at the project activity site in the pre-project scenario.

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

In the absence of the project activity the project proponent would have opted for a coal based power plant.

The project activity thus reduces anthropogenic GHG emissions into the atmosphere due to the use of relatively lower GHG intensive fuel (Natural Gas) and much higher efficient power generation due to combined cycle operation in comparison to coal.

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

The project activity is commissioning and operation of a new natural gas fired grid-connected electricity generation using combined cycle power plant.

The scenario existing prior to the start of the implementation of the project activity:
This being a green field project activity, the pre-project scenario would be electricity generation using the current fuel mix in the grid.

**Project Activity:**

A new 469 MW natural gas based combined cycle power plant is installed under the project activity. The proposed project activity was executed under the Engineering, Procurement and Construction (EPC) contracts basis to achieve the project commissioning within the normal period stipulated under the typical PPA. The EPC contract was awarded to Alstom (Switzerland) Ltd. and Alstom Projects India Limited. The Operation and Maintenance of the project is proposed to be carried out by GVK Power & Infrastructure Limited, a GVK group company. A long term spares supply agreement for the gas turbines is entered with Alstom to cover certain operational risks.

The power generation components of the project activity comprise of two gas turbine generators (GTG), two heat recovery steam generators (HRSG) and one steam turbine generator (STG). The combustion turbine module consists of a 21-stage compressor and 5-stage turbine. The turbine unit has annular type combustors. The combustion of air fuel mixture takes pace in the combustors. The accessory module is mounted on a separate base frame and houses the mechanical and the control elements required for the combustion turbine operation. The major components located in the auxiliary block are lubricating oil system with lube oil reservoirs and lube oil coolers. The combustion turbine is started by operating the generator as a variable speed motor. The variable frequency power required for this purpose is generated by the static frequency converter system from station auxiliary power systems (only during start up). This electricity usage is accounted in the total auxiliary consumption for calculation of net export. The combustion turbine is a single shaft machine with the compressor and turbine installed in a single casing.

The heat recovery steam generator (HRSG) is a triple pressure, unfired, horizontal gas flow type with internal thermal insulation, platforms and ladders. Feed water and steam sampling arrangements are provided as required. The water circulation through the evaporator is by means of natural circulation set up by thermo symphonic action. Steam from HRSG is supplied to a condensing type non-reheat steam turbine through steam piping.

The steam turbine generator (STG) is triple pressure condensing type. The steam entry to the turbine is through the emergency stop and control valves, which govern the speed/ load on the machine. The turbine control system is electro-hydraulic type. The STG is complete with lube oil and control oil system, governing system, protection system and gland sealing steam system. The turbine is provided with low speed barring gear, which rotates the coupled shaft. The turbine is also provided with a rotor jacking oil system. The steam turbine has a condenser for condensing the exhaust steam from the steam turbine.

The generators (210 MVA) are coupled to gas turbines and steam turbine. They deliver the power at 15.75 kV with 0.8 PF; 3 phase; 50 Hz at site ambient conditions of 29°C and a relative humidity of 70%. In absence of the project activity, this electricity would have been generated with the current fuel mix in the carbon intensive grid. The project proponent could have opted for a coal based power plant, which is used as a baseline for the project activity emission reduction calculations here. CO2 is considered as the major emission source in both the baseline and project activity. Leakage and project activity emissions are due to fugitive emissions from extraction to distribution of NG.
The main equipments are as follows

- Gas Turbine Generator
- Heat Recovery steam Generator (HRSG)
- Steam Turbine Generator (STG)

The details of the equipments are summarized in the table below.

| S.N. | Equipment | Specifications |
|---|---|---|
| 1 | Gas turbine (GT) | Two (2) nos. Alstom Power make (Type - GT13E2) heavy duty industrial gas turbines equipped with the lean premix dry low NOx EV burners; holds 21-stages compressor and 5-stage |

| | | |
|---|---|---|
| | | turbine blades;<br>Capacity- 2 x 152.438 MW at site conditions of 29 deg C, 70% RH and 50Hz frequency |
| 2 | Heat recovery steam generators (HRSG) | Make -ALSTOM Power, Triple Pressure<br>Capacity: High Pressure (HP)/ Intermediate Pressure (IP)/light Pressure (LP)<br>Flow: 56.95/ 11.1/ 9.7 kg/s<br>Temp: 508.3/ 506/ 151.2 deg C<br>Pressure: 96.35/ 24.6/ 4.8 bar |
| 3 | Steam turbine generator (STG) | ALSTOM Power, Triple Pressure<br>Capacity- 164.235MW at site conditions of 29 deg C, 70% Relative Humidity (RH) and 50Hz frequency |

The power generated at 15.75 kV is stepped-up to 400kV through step-up transformers. The step-up transformers are connected to project switchyard by overhead transmission lines. The 400kV project switchyard is connected to APTRANSCO's 400kV sub-station.

The project activity has an expected life time of 15 years. The heat rate of the plant would be 1850 kcal/kWh on Gross Calorific value (GCV) (or 1682 kcal/kWh on NCV). The power plant will deliver annual 3387 GWh exportable electricity and consume 1.88 million Standard Cubic Centimeters per Minute (SCCM) natural gas per day. The gas supply agreement with the Gas Authority of India Ltd. (GAIL) is signed for supply of 1.96 million SCCM gas. The monitoring for the project activity constitutes the electricity exported, quantity of natural gas consumed and its Net Calorific Value (NCV). The electricity exported in measure at the project switchyard dispatch station by two separate meters (main and check). The quantity of gas is monitored at the gas suppliers' terminal at the project site and also checked before the usage at GT. The supplier terminal also measures continuous NCV of the gas being fed.

The project activity uses a comparatively lesser GHG intensive fuel than the common coal based power plants and reduced the average emission per unit electricity generated in the grid. The project activity is a green field project, so nothing existed at the project site in the pre-project scenario. The equivalent electricity would have been generated in the grid using current fuel mix in the absence of the project activity.

The technology for the power generation is best available in the category. The choice of the technology will further reduce the GHG emission associated with the most probable alternative choice – coal fired thermal power plant and open cycle option. In addition, the emissions of CO, particulates (fly ash) will also be reduced compared to the identified alternate. The project activity will abide by all the regulatory norms of the pollution control board and will maintain environmentally clean and sound process.

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

Under the EPC contract, all the major units were imported from Alstom Europe for the project activity. The initial training of the employees for the operation and maintenance has taken place as part of the EPC. The training was on the project activity site as well as the EPC contractor’s European offices.

The project technology was the best available at the time of EPC. It includes advanced features like dry low NOx EV burners for reducing the emissions of NOx (http://www.power.alstom.com/home/equipment_systems/turbines/gas_turbines/gt13e2). The project proponents will not replace the units in the project activity more efficient technology within the project period.

The baseline is identified by analyzing various options that deliver similar output and services. The alternatives discussed include 469 MW proposed project activity not taken as VCS project, gas based open cycle power plant, gas plant in the cogen mode, Power generation using coal as the energy source, Power plant using coal as fuel, hydro electric power plant (reservoir and/or run-off-the-river), wind power, cluster of Diesel Engine based power plants, nuclear power plant, electricity imports from other grids and coal fired super critical power plant.

In absence of the project activity, the project proponent could have chosen a coal fired power plant of similar power output resulting in substantially higher GHG emissions. Thus, the southern grid would have continued to generate the electricity generated by the project activity using existing carbon intensive fuel mix. The GHG emission sources considered in the baseline and the project activity are CO2 due to fuel combustion and leakage in the project scenario due to the extraction to distribution of natural gas. The net GHG emission reduction is calculated in a conservative manner after taking into account all the emission in the project activity.

**Environmental safe technology**
Natural gas is often described as the cleanest fossil fuel, producing less carbon dioxide per joule delivered than either coal or oil.[2] Natural gas burns more cleanly than other fossil fuels, such as oil and coal, and produces less carbon dioxide per unit of energy released. For an equivalent amount of heat, burning natural gas produces about 30% less carbon dioxide than burning petroleum and about 45% less than burning coal.[3]

The technology used in the project, which has been used worldwide, is environmentally safe and the usage of this technology for power generation has no negative impacts on the ecosystem.

**Technology Transfer**
There is no transfer of technology from Annex I countries.

### 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 is not mandated by any local or national laws.[4] The project proponent has obtained the necessary approvals from Statutory bodies.

| S.N. | Statutory clearance/ agreement | Date/ Availability |
|---|---|---|
| 1 | PPA with Transmission Corporation of AP Ltd. (Now APTransco) | 18/06/2003 |
| 2 | Gas Supply contract with GAIL | 09/10/2000 |
| 3 | Environmental Clearance from MOEF, GoI, New Delhi | 09/01/2001 |
| 4 | Amended Environmental Clearance from MOEF, GoI, New Delhi | 23/11/20005 |
| 5 | Term sheet for purchase and sale of NG with Reliance Industries Ltd. | 09/06/2007 |
| 6 | Consent to COD from AP Power | 05/06/2009 |

[2] http://www.naturalgas.org/environment/naturalgas.asp#greenhouse/

[3] http://www.naturalgas.org/environment/naturalgas.asp#greenhouse/

[4] http://www.powermin.nic.in/acts_notification/electricity_act2003/pdf/Setting%20up%20of%20generating%20station.pdf

| | | |
|---|---|---|
| | Coordination Committee | |
| 7 | Latest Consent to Operate from APSEB | 07/01/2010 |

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

The purpose of the project activity is commissioning and operation of a new 469 MW natural gas based power plant which is one of the cleanest source of energy

In the absence of the project activity the project proponent would have opted for a coal based power plant as described in the section. The project activity thus reduces anthropogenic GHG emissions into the atmosphere due to the use of relatively lower GHG intensive fuel (Natural Gas) and much higher efficient power generation due to combined cycle operation in comparison to coal.

**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 project is a voluntary initiative implemented to reduce GHG emissions by way of commissioning and operation of a new 469 MW natural gas based power plant. The Management of GVK Group took a decision to implement the project activity was to reduce GHG emissions from the grid rather than with any intention to create GHG emissions.

**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 proponent (GVK Gautami Power Limited) has taken initiatives to register the same project activity under the Clean Development Mechanism of UNFCCC. Presently, the project is under CDM validation process. The project proponent has provided a commitment letter stating that the benefits from VCS would be availed till the date the project activity gets registered under UNFCCC-CDM.

In the event of project activity getting registered under CDM, GVK Gautami Power Limited Group will retire their account from VCS registry for the period starting from the date of registration under UNFCCC-CDM.

Central Electricity Regulatory Authority (CERC), Govt. Of India has introduced Renewable Energy Certificate scheme[5] to facilitate and promote the development of market in electricity based on renewable energy sources under which renewable energy generators can trade the certificates and is applicable only under certain conditions.
However PP is not eligible to avail the REC benefit, as it has entered into the Energy Wheeling Agreement (EWA) and Power Purchase Agreement (PPA) with TNEB that provides preferential tariff for the exported energy.

In addition, PP is not availing benefits from any other schemes/programmes introduced by the Govt. of India.

### 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.*

Not applicable.
The project has not been rejected by other GHG programs.

The project is under validation for CDM and the link to webhosted PDD is
http://cdm.unfccc.int/Projects/Validation/DB/T75O751QXNTM82IQ0KN5FUQNSRZ155/view.html

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

GVK Gautami Power Limited, Hyderabad is the project proponent for this proposed activity has been promoted by GVK Group.[6]

**The following table gives the contact information of the project proponent.**

| | |
|---|---|
| **Organization:** | GVK Gautami Power Limited, Hyderabad |

[5] http://cercind.gov.in/Regulations/CERC_Regulation_on_Renewable_Energy_Certificates_REC.pdf

[6] www.gvk.com

| | |
|---|---|
| **Street/P.O.Box:** | 156-159, Sardar Patel Road |
| **Building:** | Paigah House |
| **City:** | Secunderabad |
| **State/Region:** | Andhra Pradesh |
| **Postfix/ZIP:** | 500003 |
| **Country:** | India |
| **Telephone:** | 040-27902663 |
| **FAX:** | 040-27902665 |
| **E-Mail:** | Issac@gvk.com |
| **URL:** | www.gvk.com |
| **Represented by:** | |
| **Title:** | Director (Finance) |
| **Salutation:** | Mr. |
| **Last Name:** | George |
| **Middle Name:** | Issac |
| **First Name:** | A. |
| **Department:** | Finance |
| **Mobile:** | - |
| **Direct FAX:** | 040-27902665 |
| **Direct tel:** | 040-66262103 |
| **Personal E-mail** | - |

**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.):**

**Contribution of the project activity to sustainable development**

Ministry of Environment and Forests, Govt. of India has stipulated the social well being, economic well being, environmental well being and technological well being as the four indicators for sustainable development in the interim approval guidelines host country approval eligibility criteria for Clean Development Mechanism projects[7].

**Social well-being:**

- Industry - the proposed project is with an investment of ₹ 14.5 billion and will have a significant positive impact on the industrial growth in the region as well as in the country
- Infrastructure - the region around the proposed project site does not have very good infrastructural facilities. Near the project site, the facilities

[7] http://cdmindia.nic.in/host_approval_criteria.htm

for public transport, water supply, telecommunication, education, public health etc. are inadequate. With the setting up of major industry like this, the region will naturally help directly and indirectly in the development of civil infrastructure

- Employment – the proposed project activity has provided direct employment to about 525 persons during the construction and 140 during the normal operation. In addition it is expected that up to 30 persons will be directly benefited through casual work, subcontracts, trading etc.

**Environmental well being:**

- The electricity generated by project activity will be supplied to Southern grid, which otherwise would have been generated by fossil fuels. Hence, the project activity will help in reduction of the greenhouse gases emission and other air pollutants (especially NOx and $SO_2$)
- The project activity helps in conservation of coal which at present are predominantly used for power generation

**Economic well being**

- This project will helps in raising finance for power generation from relatively cleaner fuel in coal dominated economy

**Technological well being**

- The project uses the best available technology in the form of combined cycle
- The space requirement per MW capacity is lower compared to the conventional coal fired power plants

### 1.17 List of commercially sensitive information (if applicable):

NOT 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.*

# 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.*

Clean Development Mechanism (CDM) of United Nation Framework on Climate Change (UNFCCC) is one of the GHG programs which are approved by the VCS board. The project activity uses methodology approved by UNFCCC-CDM GHG program http://cdm.unfccc.int/methodologies/PAmethodologies/approved.

**Title:** AM0029, Ver.03 "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas"

**Reference:** http://cdm.unfccc.int/methodologies/PAmethodologies/approved

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

The project activity is commissioning and operation of a new, green field natural gas based power plant for supply to the grid.

The chosen project category of the project activity is:

**Project Category:** AM0029, Ver.03 "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas"

**Title: "Tool for the demonstration and assessment of additionality"**
Version 05.2
EB 39

**Title: "Tool to calculate emission factor for an electricity system"**
Version 02
EB 50

**The choice of the project category AM0029 is justified below:**

**Table 2.2.1: Justification of the applicability of AM0029 Version 03 to the project activity**

| S. No. | Applicability condition of AM0029 | Project activity condition | Remark |
|---|---|---|---|
| 1 | The project | The project | The |

| | | | |
|---|---|---|---|
| | activity is the construction and operation of a new natural gas fired grid-connected electricity generation plant | activity is the construction and operation of a new natural gas fired grid-connected electricity generation plant. Natural gas is the only fuel of the project activity and no other fuel will be used as start up or in co-firing. | applicability condition is met |
| 2 | The geographical/ physical boundaries of the baseline grid can be clearly identified and information pertaining to the grid and estimating baseline emissions is publicly available | The physical boundaries of the baseline grid i.e. southern grid are clearly identified and its information is publicly available from Central Electricity Authority, Government of India | The applicability condition is met |
| 3 | Natural gas is sufficiently available in the region or country, e.g. future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in the project activity | Natural gas is abundantly available in region and country, as will be shown in Appendix [8] 1. Also, the future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in | The applicability condition is met |

[8] Submitted to DOE

| | | | |
|---|---|---|---|
| | | the project activity | |

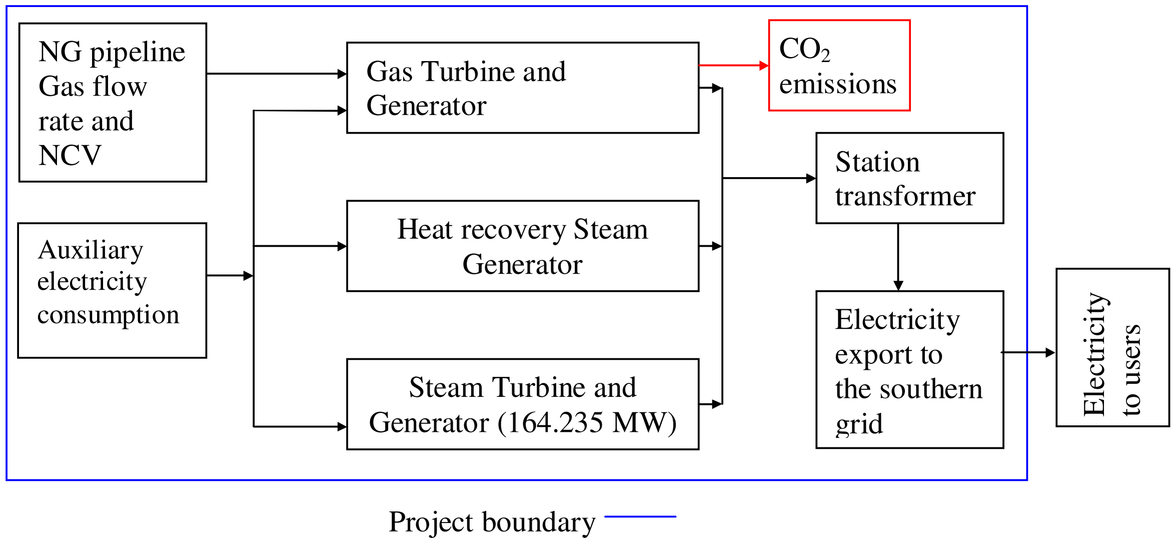
Since the project activity meets all the applicability criteria as required by the project category the choice of the project category AM0029, version 03, the selection of methodology is justified.

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

According to AM0029, 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 the emission factor for an electricity system." According to the Tool to calculate the emission factor for an electricity system, for the baseline emission factor, the spatial extent of the project boundary includes the project site and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

Since the VCS project is connected to the regional grid it is also preferred to take the Southern regional grid as project boundary than the state boundary. It also minimizes the effect of interstate power transactions, which are dynamic and vary widely. Thus the project boundary comprises the project site and all power plants connected physically to the southern grid. The specific components and facilities included in the project boundary are (1) Gas Turbine –one (2) Heat recovery steam generator – one (3) steam turbine generator – one (4) Station transformers (5) Auxiliary equipments of Gas Turbine and Generator, Heat Recovery Steam Generator and Steam Turbine and Generator; meters (gas, electricity) and gas supply pipelines.

| | **Source** | **Gas** | **Included/ Excluded** | **Justification/ Explanation** |
|---|---|---|---|---|
| Baseline | Power Generation in baseline | $CO_2$ | Included | Main emission source |
| | | $CH_4$ | Excluded | Excluded for simplification. This is conservative. |
| | | $N_2O$ | Excluded | Excluded for simplification. This is conservative. |
| Project Activity | On-site fuel combustion due to the project activity | $CO_2$ | Included | Main emission source |
| | | $CH_4$ | Excluded | Excluded for simplification. |
| | | $N_2O$ | Excluded | Excluded for simplification. |




**The project boundary is represented by the following flow**
**Figure 2.3.1: Project boundary**

| | **Source** | **Gas** | **Included/ Excluded** | **Justification/Explanation** |
|---|---|---|---|---|
| Baseline | Power Generation in baseline | $CO_2$ | Included | Main emission source |
| | | $CH_4$ | Excluded | Excluded for simplification. This is conservative |
| | | $N_2O$ | Excluded | Excluded for simplification. This is conservative |
| Project Activity | On-site fuel combustion due to the project activity | $CO_2$ | Included | Main emission source |
| | | $CH_4$ | Excluded | Excluded for simplification. This is a minor emission source. |
| | | $N_2O$ | Excluded | Excluded for simplification. This is a minor emission source. |

## 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 project activity is commissioning and operation of 469 MW natural gas fired combined cycle power plant for supplying to grid. The alternatives will be of similar scale power plants and are discussed below.

The following is a flow chart indicating the flow of various steps involved in identifying and describing baseline scenario in accordance with AM0029.

Step -1: Identification of

↓

Step 2: Identification of the economically most attractive

Further, for the purpose of identifying the economically most attractive baseline scenario alternative the following sub-steps are involved.

*Sub-step 1:* Calculating suitable financial indicator for identified

↓

*Sub-step 2:* Sensitivity analysis of identified

Baseline scenario identification as per the requirements of AM0029 leads us to the following assessment at the start of the project activity.

**1. Identify plausible baseline scenarios**

As required under AM0029 Version 03, the approach 48 (b) of CDM modalities and procedures *“Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment”* is being used to determine the baseline scenario.

The purpose of the project activity is to generate electricity and deliver it to the southern grid to cater to the base load power requirement of the grid.

The various possible alternatives available with the project proponent at the time of the starting date of the project activity, which is considered as the awarding of EPC Contract (September 2003), include the following:

| SN | Alternative to project activity | Discussion |
|---|---|---|
| 1 | The | The purpose of the project activity is to |

| | | |
|---|---|---|
| | project activity i.e. 469 MW NG based Combined Cycle power plant with an efficiency of 50%-55% and with a lifetime of 15 years not taken as a VCS project activity | generate electricity from the Natural Gas and deliver it to the Southern Grid to meet the base load power requirement of the grid. This alternative is in compliance with all the applicable legal and regulatory guidelines. Hence this option can be a part of the baseline scenario. |
| 2 | Power generation using Natural Gas as the fuel but with different alternative technologies | The different possible technologies that are available with the project proponent to generate power using natural gas as the fuel include<br><br>b.1) Power generation using Combustion Turbine with an installed capacity of 469 MW (ISO Conditions) with an efficiency of 38% using Open cycle mode of operation with a lifetime of 20 years.<br><br>This alternative generates electricity using Natural Gas as the fuel and can cater to the base load demand of the southern grid but has lower system efficiency compared to the project activity. As the option has lower system efficiency in comparison to the power generation using Combined Cycle mode of operation, it is not a realistic and credible alternative to the project proponent to opt for open cycle mode of operation for high capacities such as the case of project activity. A report of the CEA's 'Performance Review of Thermal Power Stations 2006-07 Section-10' shows that not a single NG based power plant is commissioned using open cycle after 2000. The similar report in 2007-08 says 'Use of combined cycle operation in the field of Gas |

| | | |
|---|---|---|
| | | Turbines is being promoted for energy conservation.[9]' Having lower efficiency will result in higher fuel consumption making operations unviable even compared to the project activity.<br>Thus, open cycle based power plant is not a credible alternative. Therefore this alternative cannot be a part of the baseline scenario.<br><br>b.2) Power generation using Gas Turbine in Cogeneration mode of operation.<br><br>This alternative generates both steam and electricity from Natural Gas, though the thermal efficiency is very high in this mode of operation (60%) [10] the electrical efficiency is low (26%)[11] in comparison with the Combined Cycle Mode of Operation (50-55%). The Cogeneration mode of operation is mainly used to provide electricity and steam for industrial facility. The purpose of the project activity is to deliver the power to the grid, whereas, this option does not deliver the similar output/ services comparable to the project activity. Hence, this is also not a credible and realistic alternative for the Project Proponent and therefore this alternative cannot be a part of the baseline scenarios.<br><br>This alternative is in compliance with all the applicable legal and regulatory guidelines. |
| 3 | Power generation using energy sources other than Natural | The various alternative energy sources that can generate power other than natural gas include:<br><br>3a) Power generation using coal as the energy source with an efficiency of 34%-36%[12] with a life of 25-30 years[13]<br>This is a realistic and credible |

[9] Reports provided to DOE

[10] www.opet-chp.net/download/wp6/Task_6_2_Paper_1.pdf

[11] www.opet-chp.net/download/wp6/Task_6_2_Paper_1.pdf

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

[13] www.cercind.gov.in/160502/comp_bidding.pdf

| | | |
|---|---|---|
| | Gas | alternative to the project proponent which delivers base load power to the grid. Hence, this is a plausible baseline scenario.<br><br>3b) Power generation using wind as the energy source with an average PLF of 20% with a life of 20 years [14].<br>Power generation from wind does not meet the base load requirement for the grid on a continuous basis as wind is seasonal in nature and the capacity utilization factor is very low. Due to the high uncertainty of wind, it is not a credible and realistic option for the project proponent for such high capacity comparable to the project activity.<br><br>3c) Power generation using hydro electric power plant with an average PLF of 60%[15].<br>The different types of hydro power projects available with the project proponent include:<br><br>3c.1) Reservoir storage based hydro power plants:<br>This is not a plausible baseline scenario as it delivers peak-load power to the grid and not the base load power[16].<br>3c.2) Run-of-river based hydro power projects<br>Power generation from hydro is not a feasible alternative to the project activity as it involves high gestation periods and also cannot meet the base load power requirement for the grid on a continuous basis due to the uncertainty of monsoons. Moreover, the hydro power projects are not credible and realistic alternative to the project proponent due to the following reasons.<br>• Hydro power projects generally entail a |

[14] Maharashtra Electricity Regulatory Commission, Wind Project Tariff Order, 18/09/2003 http://www.mercindia.org.in/pdf/Annexures.pdf

[15] This is based on the reassessment (the first assessment was carried out during 1953-1959) of hydropower resources carried out by CEA in 1980s.

[16] The Base Load Fallacy, Author: Mark Diesendorf; http://www.cana.net.au/documents/Diesendorf_TheBaseLoadFallacy_FS16.pdf

<table>
<tr>
<td></td>
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<td>long gestation period. In addition to this, these projects are comparatively capital intensive. In the context of resource shortages and continuing power shortages, thermal projects (coal, liquid fuel and gas), which need a relatively short gestation period, have been getting priority in fund allotments[17].<br>• The existing tariff formulation norms for hydro projects (based on a cost plus approach) with no premium for peaking services and the provision for 12% free power to distressed states from the initial years are also proving to be deterrents[18].<br>Hence, the above alternative cannot be an option for baseline scenario.<br><br>This alternative is in compliance with all the applicable legal and regulatory guidelines.</td>
</tr>
<tr>
<td>4</td>
<td>Power generation using cluster of Diesel Engine based power plants with an efficiency of 42% and a lifetime of 15 years[19]. The following table gives the list of various Diesel Engine</td>
<td>
<table>
<tr><th>Power Plant</th><th>Owner</th><th>City</th><th>State</th><th>Capacity (MW)</th><th>Year</th></tr>
<tr><td>Chennai Vasavi</td><td>CMS India Ltd.</td><td>Chennai</td><td>Tamil Nadu</td><td>4 × 50 MW</td><td>1998-1999</td></tr>
<tr><td>VVNL Yelahanka</td><td>Karnataka SEB</td><td>Bangalore</td><td>Karnataka</td><td>127.92</td><td>1993-1994</td></tr>
<tr><td>Kozhikode</td><td>Kerala SEB</td><td>Kozhikode</td><td>Kerala</td><td>128</td><td>1999</td></tr>
<tr><td>Samayanallur</td><td>Balaji Power Corp. Ltd.</td><td>Samayanallur</td><td>Tamil Nadu</td><td>106</td><td>2001</td></tr>
<tr><td>Samalpatti</td><td>Samalpatti Power Corp.</td><td>Samilpatti</td><td>Tamil Nadu</td><td>105.65</td><td>2001</td></tr>
<tr><td>Bellary DG</td><td>Shrirayalaseeme Ltd.</td><td>Bellary</td><td>Karnataka</td><td>25.2</td><td>2000</td></tr>
<tr><td>Belgaum</td><td>TATA</td><td>Belgaum</td><td>Karnataka</td><td>3 × 27.3</td><td>2001</td></tr>
<tr><td>Kasargode</td><td>RPG</td><td></td><td>Kerala</td><td>21.84</td><td>1999</td></tr>
</table>
<br>The above table shows that all the plants</td>
</tr>
</table>

[17] Hydro Power Development in India Chapter IV.

[18] As per the decision taken by the Central Government in 1990, 12% of power from the energy generated by the power station would be supplied free of cost to those states.

[19] http://mnes.nic.in/baselinepdfs/annexure2c.pdf.

| | | |
|---|---|---|
| | based power plants connected to the Southern grid[20]. | were installed before 2001 and lately the independent power producers (IPP) are not going for the liquid fuel based generation due to the increase in the fuel costs. The State Electricity Boards are also discouraging the IPPs to go for Liquid fuel based power plants for the same reason. The prices of petroleum products have long since been controlled by the Government of India (GoI) under the Administered Pricing Mechanism (APM) to reduce the burden on the consumers. However, in April 2002 the GoI dismantled the APM on the oil derived fuels (petrol, diesel etc.) after which there has been sharp increase in their prices to match international parity prices. Hence the option is not an economically viable alternative to any individual IPP with such a large capacity as it was mandated by the Central Government that sanction of IPPs should be through the competitive bidding mechanism[21]. Moreover, the rupee dominated tariffs also fail to attract investors as observed in the Indian power sector particularly relating to the short gestation liquid fuel projects[22]. Therefore this alternative cannot be a part of the baseline scenario. |
| 5 | Power generation using Nuclear Fuel | This scenario is available only to Nuclear Power Corporation of India Limited, a 100% Government of India owned company[23], whose capacity additions are driven by the Government of India's initiatives based on its long term strategic programmes and not by the project activity. Hence, this option is not available for any of the stakeholders including the project activity. Therefore this alternative cannot be a part of the baseline scenario. |

[20] www.cea.nic.in/thermal/List of Thermal Power Stations in the Country.pdf

[21] cercind.gov.in/160502/comp_bidding.pdf

[22] cercind.gov.in/160502/comp_bidding.pdf

[23] Atomic Energy Act, 1962 & news letter issued by Business Lin http://www.blonnet.com/2006/05/22/

stories/2006052202930300.hmt

| | | |
|---|---|---|
| 6 | Electricity imports from other grids: | This is not a realistic alternative as all the other grids are themselves facing shortages in meeting the energy demands and especially at the peak demand. The monthly average peak deficit for the year 2004-05 being: Northern Region - 9.1% deficit; Eastern Region - 2.5% deficit; North-Eastern Region -13.6% deficit; Southern Region - 2.5% deficit and Western Region - 20.3 % deficit[24]. This alternative also does not deliver the same output comparable to the project activity due to the high transmission losses. Hence, this alternative cannot be a part of the baseline scenario. This alternative is in compliance with all the applicable legal and regulatory guidelines. |
| 7 | Coal fired supercritical power plant: | The coal fired supercritical power plant is new advanced technology. However, the technology was not available in India in 2003 (at the time of project activity decision was made). The first supercritical power plant in India was being built in 2006 [25, 26]. This alternative is in compliance with all the applicable legal and regulatory guidelines. |

From the above discussion it is evident that the plausible baseline scenarios identified by the Project Proponent include:

a) The project activity i.e. 469 MW NG based Combined Cycle power plant with an efficiency of 50%-55% in combined cycle mode of operation and with a lifetime of 15 years not taken as a VCS project activity.
b) Power generation using coal as the energy source with an efficiency of 35%-38% with a life of 25-30 years

**2. Identify the economically most attractive baseline scenario alternative.**

[24] www.cea.nic.in

[25] Suresh et al., 2006. Advances in Energy Research. http://www.ese.iitb.ac.in/aer2006_files/papers/031.pdf

[26] http://goliath.ecnext.com/coms2/summary_0198-211733_ITM

*Sub Step -1: Calculating levelized cost of electricity production in "₹/kWh" for identified plausible baseline scenarios*

The levelized cost for the alternative (a) i.e. implementing the project activity without the consideration of VCS revenue is calculated by the following assumptions:

The following table details the assumptions used for the financial calculations. All the assumptions used in the financial model are based on the inputs that were used in the financial closure obtained by the project activity.

**Techno Economic parameters of the project activity**

| **Parameter** | **Value** | **Unit** | **Reference** |
|---|---:|---|---|
| Installed Capacity | 469 | MW | EPC Contract-performance guarantee |
| Total Investment | 14,500 | Mn ₹ | Common Loan Agreement (CLA) pg. 125 |
| Debt: Equity | 70: 30 | % | CLA Pg. 125 |
| Rupee Debt | 5,182.28 | Mn ₹ | |
| US Dollar Debt | 4,968 | Mn ₹ | |
| Exchange rate | 1 USD | 46 ₹ | |
| O&M Costs | 3.76% | of the capital Cost | Detailed Project Appraisal (DPA) Pg. 36 |
| Plant Load Factor | 85 | % | |
| Auxiliary Consumption | 3 | % | CERC Regulations, 2001; pg. 8 |
| Total Units Sold | 50,811 | Million kWh for 15 years | calculated |
| Gross Calorific Value | 9382 | kcal/SCM | |
| Station Heat Rate | 1850 | kcal/ kWh | PPA, Pg. |
| Fuel Charges | 4205 | ₹ / 1000 SCM | Detailed Project Appraisal, pg. 100 |
| Transmission Charges | 481.44 | Mn ₹ | |
| Escalation in Transmission | 3 | % | |

| | | | |
|---|---|---|---|
| Charges | | | |
| **Book Depreciation Rate** | | | |
| Plant and Machinery | 7.84 | % | Detailed Project Appraisal, pg. 100 |
| Book Depreciation up to (% of asset value) | 90 | % | |
| **Income Tax** | | | |
| Income Tax rate | 35 | % | Detailed Project Appraisal, pg. 100 |
| Minimum Alternate Tax | 7.5 | % | |
| Surcharge | 2.5 | % | |
| Dividend Distribution Tax | 12.5 | % | |
| **Working capital** | | | |
| Receivables | 30 | No. of days | Detailed Project Appraisal, pg. 100 |
| Working capital interest rate | 11 | % | |
| Working Capital Margin | 25% | of the working capital | |
| Working Capital Loan | 75% | of working capital | |

The levelized cost of electricity generation using Natural gas as the energy source calculated using the above values comes out to be 2.09 ₹/kWh.

The assumptions considered for calculating the levelized cost of generation for the alternative (b) i.e. power generation using coal as the energy source are described in the table below. For coal based power plant, the nearest capacity in the standard available TG Set i.e. 500 MW which is used for comparison. This 500 MW plant at 85% PLF and 9% auxiliary consumption will generate 3,387,930 MWh electricity. Whereas, a 469 MW gas based unit at 85% PLF and 3% auxiliary consumption will generate 3,387,409 MWh electricity. The difference is only 0.02% (higher for the coal based unit) between the baseline and project plant.

| **Techno Economic parameters for power generation using coal as the energy source** | | |
|---|---|---|
| Installed Capacity | 500 MW | Nearest block size |
| Total Investment | 19,974.41 | Million ₹ - |

| | | |
|---|---|---|
| | | Estimated from TEC available to other thermal projects[27] |
| Debt : Equity | 70:30 | CERC Regulations, 2001; pg. 38 |
| Total Debt | 13,982.08 | Million ₹ at standard D/E |
| Total Equity | 5,992.32 | Million ₹ |
| Exchange rate | 1 USD = 46 ₹ | |
| O&M Costs + Insurance Charges | 2.5% of the capital Cost + 6% escalation/ year | CERC Regulations, 2000; pg. 92 |
| Plant Load Factor | 85% | kept same as that of the project activity |
| Auxiliary Consumption | 9.5% | CERC Regulations, 2001; pg. 8 |
| Total Units Sold | 67,432 Million kWh for 20 years | calculated |
| Return on Equity | 16% | CERC Regulations, 2001; pg. 27 |
| Gross Calorific Value | 4760.50 kcal/kg | Price Notification from The Singareni Collieries Co. Ltd |
| Station Heat Rate- Stabilization | 2600 kcal/ kWh | CERC Regulations, 2001; pg. 7 |
| Station Heat Rate- Post Stabilization | 2500 kcal/ kWh | |
| Fuel Charges | 1357 ₹/1000 kg | Price Notification from The Singareni Collieries |

[27] Close to 40 ` million/ MW in 2002 (http://www.cea.nic.in/Thermal/Project%20Appraisal/central-state-thermal.pdf)

| | | |
|---|---|---|
| | | Co. Ltd. |
| **Depreciation rate for revenue calculation (Straight Line Method basis)** | | |
| Plant and Machinery | 7.84% | Kept same as the project activity |
| Book Depreciation up to (% of asset value) | 90% | |
| **Book Depreciation Rate (Straight Line Method basis)** | | |
| Civil Works | 3.34% | Kept same as the project activity |
| Plant and Machinery | 5.28% | |
| Book Depreciation up to (% of asset value) | 95% | |
| Surcharge | 2.5% | |
| Dividend Distribution Tax | 12.5% | |
| **Working capital** | | |
| Receivables (no of days) | 60 | |
| Working capital interest rate | 11% | |
| Working Capital Margin | 25% of the working capital | |
| Working Capital Loan | 75% of working capital | |

The levelized cost of electricity generation using Coal as the energy source calculated using the above values comes out to be 1.93 ₹/kWh.

The below table summarizes the levelized cost of electricity generation for various alternatives.

| Sr. No. | **Baseline Scenario** | **Levelized Cost of generation (₹/ kWh) at 85% PLF** |
|---|---|---|
| (a) | Project activity implemented as a project without the VCS revenue | 2.09 |
| (b) | Power generation using coal as the energy source | 1.93 |

Thus, the economically attractive baseline scenario as identified by the investment analysis using the levelized cost of electricity generation (in ₹/kWh) as the financial indicator is the alternative (b) which is power generation using coal as the energy source.

*Sub Step -2:* A sensitivity analysis is performed for all alternatives; to confirm that the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions i.e. the fuel price and the plant load factor.

The project activity had a Techno Economic Clearance from the Central Electricity Authority before the investment decision and hence this price is not subjected to the sensitivity, as time delay will only have an upward revision of the project capital cost.

| **Sensitivity analysis considering variation in fuel price** | | |
|---|---|---|
| Price of fuel change | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source | 1.96 | 2.22 |
| Levelized cost of electricity generation for power generation using coal as energy source | 1.82 | 2.05 |

| **Sensitivity analysis considering variation in Plant Load Factor** (PLF) | | |
|---|---|---|
| PLF change | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source | 2.18 | 1.94 |
| Levelized cost of electricity generation for power generation using coal as energy source | 2.01 | 1.87 |

| **Sensitivity analysis considering variation in capital cost** | | |
|---|---|---|
| Capital cost change | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source | 2.06 | 2.12 |
| Levelized cost of electricity generation for power generation using coal as energy source | 1.90 | 1.97 |

The sensitivity analysis confirms that the economically most attractive baseline scenario identified in the sub-step 1 is robust to reasonable variations in the critical assumptions (i.e. fuel prices and PLF).

As specified in the approved methodology AM0029 Version 03, the assessment and demonstration of additionality is to be carried by the following steps.

**Step 1: Benchmark investment analysis**

Demonstrate that that the proposed VCS project activity is unlikely to be financially attractive by applying sub-steps 2b (Option III: Apply benchmark analysis), Sub-step 2c (Calculation and comparison of financial indicators), and 2d (Sensitivity Analysis) of the latest version of the "Tool for the demonstration and assessment of additionality" agreed by the CDM Executive Board.

For determining the benchmark, project proponent has taken into consideration all the financial parameters relevant to the project activity and has also conducted sensitivity analysis to gauge the impact of probable realistic fluctuation of key parameters. According to the Tool for the demonstration and assessment of additionality, V 05.2, levelized cost of electricity generation can be used as financial indicator for the Benchmark Investment Analysis. This parameter is appropriate for this project activity, as all thermal electricity generation projects in the baseline grid are allowed return of 16% on equity investment in determining their cost for tariff purposes.

Also the CERC had implemented Availability Based Tariff (ABT) in all the five regions of the country at the inter-state level. The ABT facilities merit order dispatch of various generating stations having different variable costs. Hence in such a competitive bidding scenario it is very important for the IPP to have a low cost of power generation. Thus the levelized cost of generation is the most appropriate benchmark.

The levelized cost of electricity generation for the project activity and the levelized cost of electricity generation of the baseline scenario (i.e. power generation using Coal as the energy source) are compared with the average cost of generation in central sector coal stations in 2004[28] . The following table summarizes the results of the comparison.

| Sr. No. | Alternatives | Levelized Tariff (₹/kWh) at 85% PLF |
|---|---|---|
| (a) | Project activity implemented as a project without the VCS revenue | 2.082.11 |
| (b) | Power Generation using coal as the energy source (Baseline Scenario) | 1.931.47 |
| (c) | Average cost of generation in central sector coal stations in 2004 | 1.42[29] |

[28] www.indiastat.com (original data provided to DOE)

[29] www.indiastat.com (original data provided to DOE)

From the above table it can be seen that Coal based power generation is the most financially attractive alternative. Also it can be seen that project activity without VCS revenue is not the most financially attractive option making it uncompetitive.

Sub-step 2(d)
A sensitivity analysis is performed to confirm that the conclusion regarding the financial attractiveness is robust to reasonable variations in the critical assumptions i.e. the fuel price and the plant load factor.

| **Sensitivity analysis considering variation in fuel price** | | |
|---|---|---|
| Price of fuel | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source (Project activity not implemented as VCS Project) | 1.96 | 2.21 |
| Benchmark - Average cost of generation in central sector coal stations in 2004 | 1.42 | |

| **Sensitivity analysis considering variation in Plant Load Factor** (PLF) | | |
|---|---|---|
| PLF | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source (Project activity not implemented as VCS Project) | 2.17 | 1.96 |
| Benchmark - Average cost of generation in central sector coal stations in 2004 | 1.42 | |

| **Sensitivity analysis considering variation in capital cost** | | |
|---|---|---|
| Capital cost change | -10% | +10% |
| Levelized cost of electricity generation for power generation using natural gas as energy source (Project activity not implemented as VCS Project) | 2.06 | 2.11 |
| Benchmark - Average cost of generation in central sector coal stations in 2004 | 1.42 | |

The sensitivity analysis also confirms that under all the possible scenarios, the levelized cost of electricity generation of the project activity is much higher than the benchmark and the baseline scenario both and hence making the project activity uncompetitive without VCS revenue.

Hence from the above it can be concluded that the Baseline scenario - Coal based power generation is the most financially attractive option and the project activity - Natural gas based power generation without VCS revenue is not the most financially attractive option.

**Step 2: Common Practice Analysis.**
**Prevalence of NG based power plants in the Indian scenario:**

The following table represents the total installed capacity in India and the share of the coal based power plants and natural gas based power plants[30].

| Region | Total Thermal Power Generation, (MW) | Generation using Coal as fuel (MW) | % generation using coal as fuel of the thermal power generation | Generation using gas as fuel (MW) | % generation using gas as fuel of the total installed capacity |
|---|---|---|---|---|---|
| Northern | 21775.68 | 18,327.50 | 84.2 | 3433.19 | 15.8 |
| Western | 30120.7 | 23502.5 | 78.0 | 6600.72 | 21.9 |
| Southern | 20708.12 | 23502.5 | 113.5 | 3568.3 | 17.2 |
| Eastern | 15357.08 | 15149.88 | 98.7 | 190 | 1.2 |
| North Eastern | 1244.24 | 330 | 26.5 | 771.5 | 62.0 |
| Island | 70.02 | 0 | 0.0 | 0 | 0.0 |
| All India | 89275.84 | 73492.38 | 82.3 | 14581.71 | 16.3 |

As it can be seen from the table, the share of the gas based power generation in India is 16% of the total installed thermal power capacity and that of coal based power plants is 82%. The total percentage of installed capacity of the gas based power plants in Southern Region is only 17.2% of the total installed capacity. This corroborates the fact that Natural Gas based power generation is not commonly carried out practice in India.

According to the 'Tool for the demonstration and assessment of additionality', analysis of any other

[30] $CO_2$ baseline database for the Indian power sector, User guide, Version 3.0, December 2007, Central Electricity Authority, Government of India, p. 2.

activities implemented previously or currently underway that are similar to the proposed project activity needs to be performed to describe whether and to which extent similar activities have already diffused in the relevant region. Similar project activities include Natural gas based Grid Connected Power Plant

- of similar scale
- that takes place in a comparable environment with respect to regulatory framework, investment climate, and access to technology etc., in the state of Andhra Pradesh with the tariff determined through the International Competitive Bidding Process (ICB).
- those activities that are implemented previously or currently underway

To arrive at the power plants that fall under the above said criteria, an analysis is conducted including all the power plants connected to grid that are operational having similar or comparable capacity (200- 500 MW) at the time of investment decision. They include

| **S.NO** | **Power generation units** | **Unit No.** | **Capacity** | **Fuel used** |
|---|---|---|---|---|
| 1 | K_gudem new | 1 | 250 | Coal |
| 2 | K_gudem new | 2 | 250 | Coal |
| 3 | Vijaywada | 1 | 210 | Coal |
| 4 | Vijaywada | 2 | 210 | Coal |
| 5 | Vijaywada | 3 | 210 | Coal |
| 6 | Vijaywada | 4 | 210 | Coal |
| 7 | Vijaywada | 5 | 210 | Coal |
| 8 | Vijaywada | 6 | 210 | Coal |
| 9 | Rayal seema | 1 | 210 | Coal |
| 10 | Rayal seema | 2 | 210 | Coal |
| 11 | R_gundem stps | 1 | 200 | Coal |
| 12 | R_gundem stps | 2 | 200 | Coal |
| 13 | R_gundem stps | 3 | 200 | Coal |
| 14 | R_gundem stps | 4 | 500 | Coal |
| 15 | R_gundem stps | 5 | 500 | Coal |
| 16 | R_gundem stps | 6 | 500 | Coal |
| 17 | Simhadri | 1 | 500 | Coal |
| 18 | Simhadri | 2 | 500 | Coal |
| 19 | Peddapuram ccgt | 1 | 220 | Natural gas |
| 20 | Jegurupadu I | 1 | 235.4 | Natural gas |
| 21 | Spectrum Godavari | 1 | 208 | Natural gas |

Among the above mentioned power plants S.No 19, 20 and 21 are NG based power plants. Although this may use a similar fuel as compared to the project activity, the tariff structure of GPL is different as compared to that of the NG based power plant mentioned above. These power plants have a two part tariff system in which the capital cost was approved by CEA and they are entitled for a fixed return of equity[31]

In contrast to that the Power Purchase Agreement for the project activity was signed with APTRANSCO with the tariff that was fixed for the short gestation projects (Natural Gas Based Power Generation Projects) selected under the International Competitive Bid Process (ICB). The other fixed charges was fixed at ₹ 0.699 per unit of cumulative available energy and the Foreign Debt Service Charge was fixed at US $ 0.006 per unit of cumulative available energy payable at the current exchange rate. The Foreign Debt Service Charges are payable only in respect of period ending on 11th annual anniversary of the COD of the project activity[32].

The tariff fixed for the project activity was to match the tariff fixed for the Natural Gas based Power Projects which have participated in the International Competitive Bid Process. The Natural Gas based power plants that have participated in the process and won the bid for the similar tariff include

1. 370 MW Vemagiri Power Project promoted by GMR Group.
2. 445 MW Konaseema Power Project promoted by Konaseema Gas Power Limited.
3. 228 MW Combined Cycle Natural Gas based grid connected power plant promoted by GVK Industries Ltd., Hyderabad

All these projects are in different stages of CDM registration process and the first two have already been approved for Host Country Approval.

1) Vemagiri Power PCN from CDM India
cdmindia.nic.in/cdmindia/projects/PCN%20183.pdf
2) Konaseema Power
cdmindia.nic.in/cdmindia/projects/PCN_357_06.pdf

[31] http://www.ercap.org/TariffOrders/TO_2001-02.pdf (Page 45)

[32] Red Herring prospectus of GVKPIL page 84 (Released on 19/01/2006)

The third project has GVK Power and Infrastructure Ltd. as one of the promoters and the plant is also under the CDM registration process (it was web hosted for global stakeholders' comments in June 2008).

The plants that existed from earlier days in the vicinity namely Spectrum Power Generation and another project from the same project promoters is based on a different tariff structure to include a guaranteed 16% return on equity[33].

Thus, all the projects with similar tariff structures are in different stages of CDM registration Process.

The multifuel power plants came up in a different investment scenario and have fuel pass through PPA i.e. cost of fuel is paid to the plant under the PPA signed. The project activity PPA does not have any such arrangement and two part tariff is discussed in PDD. Naptha power plants cannot be considered in common practice.

# 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:

The project activity uses AM0029 monitoring methodology approved by CDM-EB under UNFCCC. UNFCCC Clean Development Mechanism is one of the approved GHG programs by the VCS board. The monitoring methodology applied to the project activity is as follows:

| | |
|---|---|
| **Type** | : AM0029 |
| **Category** | : "Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas") |
| **Version No** | : 03, EB 39 |
| **Sectoral Scope** | : 01 Energy Industries (renewable/non-renewable) |

### 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)*

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- *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*

Monitoring methodology and monitoring plan for the project activity has been prepared using the guidelines provided in Approved monitoring methodology AM0029, V-03, EB 39.

Title –Grid Connected Electricity Generation Plants using Non-Renewable and Less GHG Intensive Fuel.

As per the methodology, the baseline emissions will be monitored per "Tool to calculate emission factor for an electricity system", if and as applicable. For the project emissions, a record of (1) Annual fuel consumption in project activity (2) Net Calorific Value of the fuel used in the project activity (3) Fuel emission factors for fuel used in the project activity.

The applicability of this methodology to the proposed project activity has been discussed in Section 2.4 above.

All the data monitored for the estimation of project, baseline and leakage emissions for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

As part of monitoring leakage, the existing user of natural gas for electricity generation will be monitored through out the crediting period for non-diversion. Similarly, to check whether the future capacity addition is prohibited due to the project activity power plant, future gas allocations to power plants, start of construction and start of operations of new NG based power plants will be monitored for about double the capacity of the project activity power plant. In each monitoring period, if all existing users operated their power plants using NG, it will be concluded as non-diversion. Leakage will be only applied if these users operated using any other fuels than NG. The future capacity addition will be monitored only for next 900 MW (about double the capacity of the project activity power plant) capacity gets allocation of gas or starts construction.

As explained in the section 3.3 & 3.4 below, project proponent ***"has established and applied quality management procedures to manage data and information,***

***including the assessment of uncertainty, relevant to the project and baseline scenario. Also care has been taken to reduce as far as in practical uncertainties related to the quantification of GHG emission reductions or removal enhancements"*** thus meeting requirements stipulated in ***ISO 14064-2:2006, clause 5.9.***
**Calculation approaches have been discussed in detail in the section 4.**

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

*Describe each data and parameter using this table.*

| **Data / Parameter:** | **$EG_{PJ,y,}$** |
|---|---|
| Data unit: | kWh |
| Description: | Electricity exported by the project plant |
| Source of data to be used: | The readings taken from the export meter present in the Tariff metering room present in the switch yard. The readings are stored in power plant log book. |
| Value of data applied for the purpose of calculating expected emission reductions | 3492 |
| Description of measurement methods and procedures to be applied: | The data represents the electricity measured by the Cumulative Energy Meter. The meter is a 3 phase 4 wire meter and of an accuracy of 0.2 class. This represents the summation of the readings measured by the energy meter line-1 and energy meter line-2. This energy meter is present in the Switch Yard, Tariff metering room. The readings are taken manually every day at 00 hrs. The readings are stored in the power plant electricity generation log book. The readings are taken by the shift engineers and are cross checked by the site main controller and are recorded in the log book. |
| QA/QC procedures to be applied: | The data measured by the cumulative meter is cross |

| | |
|---|---|
| | checked with the summation of the electricity measured by the energy meter line-1 and energy meter line-2. The calibration of the instruments would be done every 6 months at CPRI, Hyderabad/ ETDC Chennai/ Bangalore. The readings are taken by the shift engineers and are cross checked by the site main controller and are recorded in the log book. |
| Any comment: | Electricity generation is estimated from installed capacity and PLF as per EPC i.e. 469 x 24 x 365 x 85%/ 1000 = 3492 GWh |

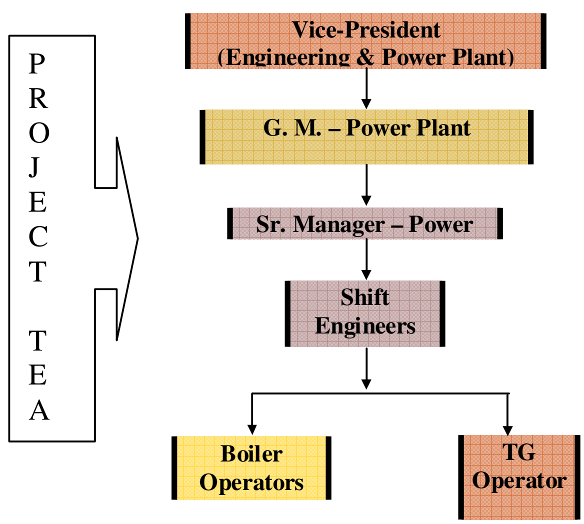
| **Data / Parameter:** | $Q_{NG}$ |
|---|---|
| Data unit: | SCM |
| Description: | Quantity of NG consumed in the project activity |
| Source of data to be used: | The readings are recorded manually at 00 hrs and are stored in the power plant log book. |
| Value of data applied for the purpose of calculating expected emission reductions | 685,321,088 |
| Description of measurement methods and procedures to be applied: | The quantity of Natural Gas is measured by the gas flow meter which would be installed by GAIL at their terminal |
| QA/QC procedures to be applied: | The quantity of natural gas is cross checked with the invoices that are obtained from the GAIL and it is also tallied with the quantity of Natural Gas measured by the gas flow meter that is installed by the project proponent for internal purposes. The meter installed by GAIL will be calibrated according to the standard procedures |
| Any comment: | Estimated based on design electricity generation, heat rate and fuel NCV |

| **Data / Parameter:** | **$NCV_{NG}$** |
|---|---|
| Data unit: | kcal/SCM |
| Description: | Net Calorific Value of Natural Gas |
| Source of data to be used: | Invoice from the supplier |
| Value of data applied for the purpose of calculating expected emission reductions | 8,570 |
| Description of measurement methods and procedures to be applied: | The Supplier provides the value of the NCV in the invoice that is being given to the project proponent. The NCV is measured by the Gas calorimeter that would be installed by GAIL at their terminal. |
| QA/QC procedures to be applied: | The NCV of natural gas is cross checked with the invoices that are obtained from the GAIL. The meter installed by GAIL will be calibrated according to the standard procedures. |
| Any comment: | -- |

| **Data / Parameter:** | $COEF_{f,y}$ |
|---|---|
| Data unit: | $tCO_2/ m^3$ |
| Description: | Calculation of CO2 Emission Co-efficient of natural gas |
| Source of data to be used: | Calculated |
| Value of data applied for the purpose of calculating expected emission reductions | 0.0020 |
| Description of measurement methods and procedures to be applied: | Calculated with formula given in applicable methodology AM0029<br>$COEF_{f,y} = \Sigma NCV_{f,y} * EF_{CO2,f,y} * OXID_f$ |
| QA/QC procedures to be applied: | None as accepted under applicable methodology AM0029 |
| Any comment: | The values of $EF_{CO2,f,y}$ and $OXID_f$ will be used as per IPCC Guidelines and NCV as monitored in the monitoring plan as actual<br>8570 kcal/SCM * 4.186 * 10-9 * 56.1 t CO2 / TJ * 1 = 0.0020 $tCO_2/ m^3$ |

### 3.4 Description of the monitoring plan

The project activity is operated and managed by the project proponent through GVK Power and Infrastructure Limited. The individual plants record data related to their respective project activity. The natural gas based power project abides and will abide by all regulatory and statutory requirements as prescribed under the state and central laws and regulations. A monitoring team has been established at the plant site. The project team is entrusted with the responsibility of storing, recording the data related to the project activity. The project team is also responsible for calculation of actual creditable emission reduction in the most transparent and relevant manner. Installed meters are calibrated according to the maintenance schedule programmed at the start of the operation and recalibrated according to the plant's performance requirement. All the monitoring data will be stored, recorded and kept under safe custody of the Project Executor and Head (Power Plant and Utilities) at the plant site for the full crediting period + 2 years. Also any change within the project boundary, such as change in spare and or equipments will be recorded and any change in the emission reduction due to such alteration will also be studied and recorded.




| Designation | Responsibilities |
|---|---|
| Vice-President (Engineering & Power Plant) | Registration<br>Project Execution |
| G. M. – Power Plant | Operation<br>Verification of data<br>Inspection of data whenever necessary to independently check the authenticity of data and take corrective actions wherever required.<br>Storage of data |

| | |
|---|---|
| Sr. Manager – Power Plant | Operation, Monitoring and Verification of Data<br>Data Recording<br>Storage of data |
| Shift Engineers and Operators (Operation and Maintenance) | Operation and Maintenance<br>Storage of data<br>Data Recording<br>Data Collection<br>Archiving of data<br>Observation, Monitoring |

As the project activity registration may not coincide with the JMR date (both monitoring period start and the end), (1) the net electricity export for this period will be monitored from the check meter/ DCS readings from the PP's monitoring system. OR (2) the crediting period will be taken from the subsequent JMR date after the registration date'.

The date of completion of the application of the methodology to the project activity study is 30/05/2008.

**DATA BACK UP**

The natural gas meter shall be tested for accuracy at least once in six months against an accepted laboratory standard meter in accordance with prescribed standards. The meters shall be deemed to be working satisfactory if the errors are within specifications for meters. The consumption registered by the main meter will hold well as long as the error in the meters is within the permissible limits. In any case, the gas supplier data in the gas bills/ invoices will be used for the emission reduction calculation.

**QA & QC PROCEDURES**

The calibration of the instruments would be done every 6 months at CPRI, Hyderabad/ ETDC Chennai/ Bangalore.
The meter installed by GAIL will be calibrated according to the standard procedures
The meter installed by GAIL will be calibrated according to the standard procedures.
Detailed information is provided in the section 3.3.

**EMERGENCY PLAN**

An emergency plan is prepared to account for monitoring equipments failure and accidental release of GHGs in the project activity plant.

1) Both electricity meters (main and check) failure: As per PPA dt. June 2003, Article 4: Metering, clause 4.4 and 4.5, following provision are available and will be followed for the monitoring plan.
    (A) Errors in main meters – If main meter check indicates error beyond prescribed limit, but no such error is noticed in the check meter, billing for the month will be done on the basis of check meter. Also, the main meter will be calibrated or replaced immediately.
    (B) Errors in main meter and check meters: If both the main and check meter show error during quarterly check, both meters will be sent for calibration and replaced with new meters for further monitoring. The error found in the main meter calibration will be applied to the electricity measurement values for the period from last check.
2) Failure of gas flow meter: In case gas flow meter of the supplier (GAIL) which is main meter is found o have error more than ±2% or if the meter is out of service, the gas quantity will be computed using (a) using check meter of the PP if installed and accurately registering (b) applying main meter error factor to readings from last calibration (c) estimating the volume of gas delivered by comparison with deliveries during the period under similar conditions when seller's meter was registering accurately (In same order of preference among a, b and c. Refer clause 8.04 of the gas supply agreement with GAIL).
3) Gas leakage detection: Emergency gas alarm system is installed at GAIL supply terminal near the project plant to detect gas in case of leakage.
4) Complete power failure scenario: In case of complete power failure, the GAIL terminal will get indication on the gas flow control panel and the gas flow valve will be shut when the power plant will have to be shut down. Thus, the accidental release of gas is avoided in any case.

**INTERNAL AUDIT AND PERFORMANCE REVIEWS**

An internal audit team shall be constituted for verifying and auditing of the data recorded and archived with respect to VCS monitoring plan. The audit team shall also verify and audit the calibration plan and calibration record of the instruments with respect to the VCS monitoring plan. The audit team shall meet once in three months (quarterly) to verify and audit the data collected, the process followed and the quality control and assurance measures. They shall report any non-conformity to the Head -CCPP, PP and he shall take appropriate steps to rectify the non-conformity.

The internal audit team shall also certify the annual consolidated data for the verification of VER. The team shall also certify the calculations for arriving at actual VER.

Verification: The quantitative details indicating the net exported electrical energy, natural gas consumed and the net calorific value audited by the internal audit team constituted for the purpose shall be used, for verification of the VERs. Further, the joint energy meter reading jointly signed by PP and APTransco and the invoices raised by PP on APTransco shall be the base audit document for verification protocol.

# 4 GHG Emission Reductions:

## 4.1 Explanation of methodological choice:

**EMISSION REDUCTION CALCULATION FOR THE PROJECT ACTIVITY COMPONENT:**

According to the approved methodology AM0029, Version 3

According to the approved methodology AM0029 Version 3

**Project emissions**

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

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

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

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

$$\mathbf{COEF_{f,y} = \Sigma NCV_{f,y} * EF_{CO2f,f,y} * OXID_f}$$

Where:

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

The supplier of NG gives NCV in the invoice and this will be used for the ER calculation.

$EF_{CO2,f,y}$: is the $CO_2$ emission factor per unit of energy of natural gas in year 'y' ($tCO_2/GJ$) as determined from the fuel supplier, wherever possible, otherwise from local or national data;

$OXID_f$: is the oxidation factor of natural gas

**Baseline emissions**

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

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

According to the approved methodology AM0029, project participants shall use for $EF_{BL,CO2,y}$ 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"; and

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:

$$EF_{BL,CO2}(tco2/Mwh) = \frac{COEF_{BL}}{\eta_{BL}} * 3.6GJ/MWh$$

where,

$COEF_{BL}$ = the fuel emission coefficient ($tCO_2e/GJ$), based on national average fuel data, if available, otherwise IPCC defaults can be used

$\eta_{BL}$ = the energy efficiency of the technology, as estimated in the baseline scenario analysis above.

For the option 1, the build margin is calculated by the Central Electricity Authority (CEA, Version 05) India according to the procedures prescribed in the approved methodology ACM0002. We have referred the same value for the baseline calculation.

For option 2, the combined margin is calculated with a 50/50 OM/BM weights. The Operating Margin (OM) and the Build Margin (BM) has been calculated by the Central Electricity Authority (CEA,) India according to the procedures prescribed in the approved methodology ACM0002. We have referred the same value for the baseline calculation.

For option 3, coal fired power plant using conventional i.e. sub-critical technology has been identified in section 2.4. as the economically most attractive baseline scenario alternative due to its lowest levelized electricity generation cost, whose emission factor are calculated in accordance with and as per equation 4 of AM0029.

**Leakages**

As per the approved methodology AM0029, leakage emissions are calculated as follows:

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

where:

$LE_y$ Leakage emissions during the year y in $tCO_2e$

$LE_{CH4,y}$ Leakage emissions due to fugitive upstream $CH_4$ emissions in the year y in $tCO_2e$

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

Fugitive methane emissions

According to the approved methodology AM0029, the fugitive methane emissions are calculated as follows:

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

where:

$LE_{CH4,y}$ Leakage emissions due to fugitive upstream $CH_4$ emissions in the year y in t $CO_2e$

$FC_y$ 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

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

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

$EF_{BL,upstream,CH4}$ Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in t $CH_4$ per MWh electricity generation in the project plant, as defined below

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

As the baseline emissions are calculated based on option 1 i.e. the build margin calculated by CEA in accordance with the procedures in ACM0002, the emission factor for upstream fugitive $CH_4$ emissions occurring in the absence of the project activity is derived using the flowing equation:

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

$EF_{BL,upstream,CH4}$ = Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in t $CH_4$ per MWh electricity generation in the project plant

$j$ : = Plants included in the build margin

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

$EF_{k,upstream,CH4}$: = Emission factor for upstream fugitive methane emissions from production of the fuel type $k$ (a 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/year

Thus, the emission factor for upstream fugitive $CH_4$ emissions is consistent with the baseline emission factor calculation as per option-1.

During the crediting period for fugitive $CH_4$ emissions associated with NG, default values provided in Table 2 of the approved methodology AM0029 are used, as reliable and accurate national data are not available. The default values to be used in relation to NG production, processing, transport and distribution from Table 2 of AM0029 is US/Canada values for NG the gas transportation and distribution facilities would be built in near future and would be built as per the international standards.

$LE_{LNG,CO2,y}$ = 0

As there are no Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in $tCO_2e$.

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 ($tCH_4$ /MWh) will also be determined ex-post.

**Emission Reductions**

**ERy = BEy – PEy – LEy**
Where:
*ERy*: emissions reductions in year y ($tCO_2e$)
*BEy*: emissions in the baseline scenario in year y ($tCO_2e$)
*PEy*: emissions in the project scenario in year y ($tCO_2e$)
*LEy*: leakage in year y ($tCO_2e$)

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

**Calculation of emission reductions:**

**1. Calculation of baseline emissions**
To calculate the baseline emissions the lowest of the three values amongst the build margin, combined margin and the emission factor for the most likely baseline scenario is taken as the baseline $CO_2$ emission factor.

**A) Build margin**
The build margin is calculated by the Central Electricity Authority (CEA) India according to the procedures prescribed in the "Tool to calculate emission factor for an electricity system". Thus, the value taken is 817.9 $tCO_2e$/GWh.

**B) Combined margin**
The combined margin is calculated with a 50/50 OM/BM weights. The Operating Margin (OM) and the Build Margin (BM) has been calculated by the Central Electricity Authority (CEA,) India according to the procedures prescribed in the "Tool to calculate emission factor for an electricity system". The Operating margin is fixed ex-ante and is taken as the average of the recent three years of data given by the CEA at the time of PDD

submission (i.e. for the years, 2006-2007 and 2007-2008, 2008-2009). The value applied for Operating Margin is 987.6 $tCO_2$/GWh. The value applied for the build margin is 817.9 $tCO_2e$/ GWh. The value applied for the combined margin is 902.8 $tCO_2e$/GWh.

**C) Emission factor of the most likely baseline scenario.**
Calculated as per equation 3 of AM 0029 where the most likely baseline scenario is identified as the coal based power plant
Values of sub-variables are as follows

Fuel $CO_2$ emission co-efficient ($COEF_{BL}$): 0.0958$tCO_2e$/GJ
Energy Efficiency of technology ($\eta_{BL}$): 33.3%

Thus,
$EF_{BL,CO2}$ = 0.0958 t $CO_2e$/GJ* 3.6 GJ/MWh *1000/0.333 = **1036**t $CO_2$/GWh

Therefore, according to AM0029, the lowest value among the three options is **817.9** t $CO_2$/GWh (i.e. Build Margin) is chosen as baseline emissions factor $EF_{BL,CO2,y}$.

Project activity's electricity generation (i.e. net evacuation to the grid) EGy is estimated as 3387.4 GWh per year. The value is arrived from the installed capacity 469 MW operating 24 hrs a day, 365 day a year at 85% PLF and 3% auxiliary consumption (i.e. 469 x 24 x 365 x 85% x (100-3)% / 1000 =3387 GWh

Therefore, the estimated annual baseline emissions ($BE_y$) will be (as per equation 3 of AM0029)
$BE_y$ = 3387.4 GWh * 817.9 $tCO_2$/GWh = **2,770,562** $tCO_2$

**2. Calculation of Project Emissions ($PE_y$)**
Calculated as per equation 2 of AM0029 as contained in part A (procedure followed for estimating emissions in the project scenario) of section B.6.1 "Explanation of Methodological Choices".
The value of project emissions is 1,379,231 t $CO_2e$/ year

Values of sub-variables are as follows
Volume of fuel combusted in project plant in year y ($FC_{f,y}$) : 685,321,088 SCM
$CO_2$ emission coefficient of fuel ($COEF_{f,y}$) : 0.0020 t $CO_2$/ $m^3$ of natural gas
Based on the above, the estimated annual project emissions ($PE_y$) will be
$PE_y$ = 0.0020 $tCO_2$/SCM * 685,321,088 SCM = 1,379,231$tCO_2$/ year

Sub-variables are calculated as follows

**Calculation of $CO_2$ Emission Co-efficient of natural gas ($COEF_{f,y}$)**

Calculated as:

$CO_2$ Emission Co-efficient of natural gas is calculated as per equation number-2a of AM 0029 Values of sub-variables:

1) Net Calorific Value of gas ($NCV_y$): 8570 Kcal/SCM
2) $CO_2$ emission factor ($EF_{CO2,f,y}$): 0.0561 t $CO_2$/GJ
3) Oxidation factor of gas ($OXID_f$): 1

8570 kcal/SCM * 4.186 * $10^{-9}$ * 56.1 t $CO_2$ / TJ * 1 = **0.0020 $tCO_2/m^3$**

**3) Calculation of Leakages ($LE_y$)**

Leakages are calculated as per equation number-5 of AM 0029 as contained in part C (procedure followed for estimating Leakages) of section B.6.1 "Explanation of Methodological Choices", which is **97,910** $tCO_2e$

1) Leakage emission due to fugitive upstream $CH_4$ emissions ($LE_{CH4,y}$): **97,910**$tCO_2e$.
2) Leakage emissions due to fossil fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO_2,y}$) : 0 $tCO_2$ in the present case

Based on the above, the estimated annual leakages (LEy) will be
= **97,910**+ 0 t $CO_2$ e = **97,910** $tCO_2e$

**3A) Calculation of leakage emissions due to fugitive upstream $CH_4$ emissions ($LE_{CH4,y}$)**

Calculated as:

Leakage emissions due to fugitive upstream $CH_4$ emissions are calculated as per equation 6 of AM0029:

Quantity of natural gas combusted in the project plant ($FC_y$): 685,321,088 SCM

Average net calorific value of natural gas ($NCV_{NG,y}$): 8570 kcal/SCM

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

($EF_{NG,upstream,CH4}$): 296 t $CH_4$/ PJ

Electricity generated in the project plant ($EG_{PJ,y}$) :
3492 MU
Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity
in t $CH_4$ per MWh electricity generation in the project plant ($EF_{BL, upstream, CH4}$) : 16.11 t $CO_2$e/MU

= [(685,321,088 * 8570* 1000 * 4.186 * $10^{-15}$ * 296)* 21 – (3492 * 15.72)] = **97,909** t$CO_2$e.

**3B) Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re –gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO2,y}$)**

In the current context LNG is not being used in the project activity hence, $LE_{LNG,CO2,y} = 0$.
In future, if the LNG will be used, the leakage will be calculated as described below:

Calculated as per the methodology, AM0029
Quantity of natural gas combusted in the project plant ($FC_{LNG\ y}$) (For $CO_2$ emissions from LNG):
Q SCM
Calorific Value of Natural Gas: 8570 kcal/ SCM
Emission factor for upstream $CO_2$ emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($EF_{CO2, upstream,LNG}$) : 6 t $CO_2$/ TJ

Based on the above, the estimated Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system ($LE_{LNG,CO2,y}$) will be:

= Q SCM * 8570 Kcal/ SCM * 4.186 * 10^ (-9) * 6 t $CO_2$/ TJ
= $LE_{LNG,CO2,y}$ t $CO_2$

## 4.3 Quantifying GHG emission reductions and removal enhancements for the GHG project:

According to the approved Methodology AM0029 Version 3:

$$ERy = BEy - PEy - LEy$$

Where:
*ERy* : emissions reductions in year y (t $CO_2$e)

*BEy* : emissions in the baseline scenario in year y (t $CO_2$e)
*PEy* : emissions in the project scenario in year y (t $CO_2$e)
*LEy* : leakage in year y (t $CO_2$e)

**ERy = 2,770,562- 1,379,231 - 97,909 = 1,293,422 t$CO_2$e**

# 5 Environmental Impact

The project activity has obtained all the consents from the state pollution control board (Consent to Establish and Consent to Operate) and the clearance form the Ministry of Environment an Forests has also been obtained. The specific conditions from the 'Consent to Operate' are as summarized in the following table

**A. Management during construction phase**

The impact during the construction phase on the environment would be basically of transient nature and are expected to reduce gradually on completion of the construction activities. In order to mitigate them following measures are proposed:

1. Designation and demarcation of sites for construction camps and ensuring due provision of necessary infrastructural services.

a. During excavation and transportation over unmetalled roads near the proposed plant site, there is a scope of local dust emissions. Frequent water sprinkling in the vicinity of the construction activity should be done and it should be continued even after the completion of the plant construction, as there is scope for heavy truck mobility. The industry should make provision for water sprinklers.
b. Since there is likelihood of fugitive dust from the construction activity, material handling and from the truck movement in the premises of the proposed plant, the industry should go for green belt plantation programme along the boundaries of the proposed plant site.
c. The construction site should be provided with sufficient and suitable toilet facilities for workers to allow proper standards of hygiene. These facilities would be connected to septic tank and maintained to ensure minimum environmental impact.
d. Though the noise effect on the nearest inhabitants due to construction activity will be negligible it is

advisable that onsite workers using high noise equipment adopt noise protection devices. Noise prone activities should be restricted to the extent possible during night particularly during the period 10:00 PM to 6:00 AM in order to have minimum environmental impact.

e. It should be ensured that both gasoline and diesel powered construction vehicles are properly maintained to minimize smoke in the exhaust emissions. The vehicle maintenance area should be located in such a manner to prevent contamination of surface and ground water sources by accidental spillages of oil. Unauthorized dumping of waste oil should be prohibited
f. As soon as construction is over, the surplus earth should be utilized to fill up low lying areas, the rubbish should be cleared and all unbuilt surfaces reinstated. Appropriate vegetation should be planned and all such areas should be landscaped. Hazardous materials (e.g. acids, paints, explosives) should be stored in proper and designated areas.

2. To prevent unauthorized felling of trees by construction workers for their fuel needs, it should be ensured that the contractor provides fuel to the construction workers

**B. Management during the operational phase**

a. Air pollution control system: The air pollution control measures proposed for the project are described below:
   i. 70 m tall stack should be provided to ensure wider dispersion of pollutants
   ii. Appropriate system to control NOx emissions to 75 ppm should be provided
   iii. Green belt development in and around the plant premises should be undertaken
   iv. The proposed air pollution control equipment should be installed prior to commissioning of the plant
   v. Monitoring of stack emissions for NOx and $SO_2$ should be carried out regularly to meet all statutory requirements
   vi. All the internal roads should be asphalted to reduce the fugitive dust due to vehicle movement
b. Water pollution control system: The waste water will be originating from cooling system, plant service water system, filter backwash and sanitary effluents from plant. All these waste will be treated and discharged on the land to be utilized for green belt through a central monitoring basin.

Following effluent treatment and disposal systems are proposed to be installed:

i. Minimize quantity of effluents through reuse to the extent possible;
ii. Treatment of the DM plant waste through neutralization;
iii. Provision of oil separators; and
iv. Biological treatment for domestic waste from plant.

Effluent monitoring instruments namely pH meter, flow meter, etc., should be provided in the effluent discharge line. Flow integrators should be provided both at the plant intake and discharge point at central effluent holding pond

Apart from the proposed treatment schemes, some additional measures are given here under:

i. Minimize quality of effluents through reuse to the maximum extent feasible;
ii. The treatment scheme proposed should be constructed before the commissioning of the plant
iii. Sedimentation tanks should be cleaned regularly in order to avoid clogging. Sludge should be removed regularly and sufficient time should be given for proper settling of solids
iv. The treatment units viz., STP should be operated regularly
v. Monthly effluent samples should be collected and analysed at the inlet and outlet of the treatment plants to ascertain the efficiency of the treatment plants and to meet the statutory requirements.

c. Solid waste management plan: Solid wastes generated from the plant are basically from sedimentation tanks and sewage treatment plants. The solid waste does not contain any toxic matter and safe to dispose off on land.

The suitable landfill area should be identified taking in to consideration permeability of soil, distance from population area, etc. the collection, transport and disposal of solid wastes from different parts of the plant to the disposal area should be through sanitation contract package. The contractors deployed by the proponents are required to allow certain norms with respect to tools and safety equipments.

The waste brought to the landfill site would be unloaded immediately over the working face of the landfill and would be evenly separated and compacted by bulldozers/loaders. The top surface and the slopes of the refuse dumped would be covered progressively with a layer of soil or civil debris or any other sealing material. A daily inspection will be made for rodent burrows or insect infestations and appropriate control measures shall be taken.

The generating of leachate from the landfill area should not be a common phenomenon under Indian conditions. The compaction and provision of proper slope would prevent stagnation of water inside the landfill area, thereby minimizing leachates. In addition, a drainage system should be constructed around the landfill area. However two wells should be monitored near the landfill area.

d. Noise level management: The predominant noise levels will be confined to the work zones in the plant. The noise levels at the entire sources will not exceed 85 dB(A). Community noise levels are not likely to be affected because of proposed vegetation and attenuation due to the physical barriers.

i. The use of damping materials such as thin rubber/lead sheet for wrapping the work places like turbine halls, compressor rooms, DG sets, etc.;
ii. Shock absorbing techniques should be adopted to reduce impact;
iii. Efficient low techniques for noise associated with high fluid velocities and turbulence should be used;
iv. All the openings like covers, partitions should be acoustically sealed;
v. Inlet and outlet mufflers should be provided which are easy to design and construct;
vi. Reflected noise should be reduced by the use of absorbing material on roofs walls and floors;
vii. Ear plugs should be provided to the workers, and it should be enforced to be used by the workers;
viii. Increase the distance between source and receiver and by altering the relative orientation of the source and receiver;
ix. Provision of the separate cabins for workers and operators
x. The industrial compound should be thickly vegetated with species of rich canopy

e. Measures for improvement of ecology

i. Clearing of existing vegetation should be kept to minimum and should be done only when absolutely necessary. Even then clear felling of big trees should be kept to bare minimum.

ii. Plantation programme should be undertaken in all areas. This should include plantation in the proposed plant premises, along the internal and external roads
iii. Use of biogas, solar energy, etc. should be encouraged both at individual and at society levels
iv. People should be educated and trained in social forestry activities by local governmental and non governmental organizations

## 6 Stakeholders comments:

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

The important local stakeholders were identified as the locals residing in the neighbouring villages, local health officer, staff of neighbouring college, officials of state electricity board and pollution control board. Most of these are residents of the neighbouring areas in the project site and are likely to be affected, if at all. All the identified stakeholders were communicated by written invitation 15 days in advance before the meeting.

The meeting was held in the project activity premises on 30/11/2007. A total 25 people attended the meeting and the minutes of the meeting signed by the chairman will be made available during the time of validation.

The project activity was explained to the gathering and a brief presentation on climate change and the Clean Development Mechanism was made. The role of the project activity in the mitigation of climate change and local sociological benefits were explained. Then queries were invited from the local stakeholders. The summary of comments and the replies are presented in the following section. The stakeholders were given further 15 days time to contact project proponents for any further queries.

**Summary of the comments received:**
The details regarding the queries expressed by the members and the clarifications by PP are as follows.

| S.No | Name of the Member | Doubt Expressed | Clarification. |
|---|---|---|---|
| 1 | Sri. K.Jagannadham | The project may pose health and skin problems. | As this project depends on clean and pure natural gas there is no scope for any health and skin problems. |

| | | | |
|---|---|---|---|
| 2 | Sri. G.Venkata Rao | Is there any danger due to the leakage of natural gas/liquid fuel? | There is no need to store the natural gas as it is arranged to supply as per the need to the project. In case there is any leakage in liquid fuel, necessary arrangements are made to store such fuel to avert any danger. |
| 3 | Sri. Mohanty | (a)What are the safety arrangements that are maintained to face any accidents? | Necessary safety measures are taken after examining all possible safety arrangements that are required. Accordingly environmental impact and risk assessment reports have been prepared. |
| | | (b)Whether necessary employment opportunities are created to the people of surrounding villages? | Employment is provided as per the need to the residents of surrounding villages. Sri G. Venkata Rao, Honourable member has expressed his satisfaction in this aspect. |
| | | (c)Whether any community facilities were provided to the residents of nearby villages? | Compound wall and stage is provided to the school building at Hussainpuram. Further it is assured by the Vice president/ General Manager of the plant that as soon as the production is started from the plant, some more facilities will be provided as per the need of the villagers. |

# 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.*

The following table represents chronological order of the efforts/decisions (milestones of the project activity) undertaken by the project developer for the project activity development:

Table 6.1.Chronology of the VCS project activity

| S. N. | Date | Project Execution Step | CDM registration efforts | Evidence |
|---|---|---|---|---|
| 1 | 05/06/2009 | Commissioning of the project activity plant | - | COD approval from Andhra Pradesh Power Coordination Committee |
| 2 | 13/09/2009 | Appointment of present DOE | - | - |
| 3 | 30/12/2009 | PDD web hosted for global stakeholder comments | - | CDM validation web site[34] |

# 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*

Proof of title is the EPC contract signed, Certificate of Incorporation of company and PPA with APTransco.

[34] http://cdm.unfccc.int/Projects/Validation

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

The project activity takes place in India (STATE: Andhra Pradesh, DISTRICT: East Godavari). India has no binding limit for GHG emission reductions. Also the project activity doesn't participate in any emission trading program approved by VCS Board.

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;

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.

## Appendix –1

**Natural gas availability in the project activity region**

The spirit of emphasizing "sufficient availability" of NG in the methodology as an applicability criterion is:

(a) to ensure that NG from other users are not diverted and
(b) to ensure future power generation facilities of comparable size are not deprived due to NG being taken up by the project activity [Ref: footnote No. 2 of the AM0029, Version 3]

The points (a) and (b) above are borne out by the clarification [Ref: F-CDM-AM-Clar_Resp_ver 01.1 - AM_CLA_0091] issued by EB in response to a DOE query. In the response, EB also clearly mentions how the applicability condition pertaining to availability is to be implemented. In EB's view, a project activity to demonstrate that it meets the applicability condition will need to do so by resorting to appropriate monitoring. The relevant excerpt from EB's clarification– "*the monitoring should show that satisfying the project activity's demand for natural gas will not lead to shortages in supplies of the gas to other projects within the country*".

In other similar examples, recently registered projects from China in the applicable methodology AM0029, have shown 'LNG import agreements from other countries like Malaysia' (Project reference No.s 1381, 1343, 1344) in support of the NG availability. Thus, NG availability in the project activity region alone is not the applicability of methodology here. The same spirit of applicability allows new power plant even with imported NG to qualify for AM0029.

In this project we demonstrate that:
1) NG was sufficiently available in the source of supply so that other NG based projects do not get deprived and leakage does not occur.
2) Also future natural gas based power capacity addition also not constrained

The applicability condition in the methodology aims to avoid the diversion of natural gas from other future and existing users. It is evident from the AM0029 applicability condition on sufficient availability 'future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in the project activity'.

The PP chooses to demonstrate gas availability in the region of project activity i.e. state – Andhra Pradesh. Considering the source of gas for the project activity in KG basin and also the power purchaser in the state, the choice of region is appropriate.

India has about 0.4% of world's natural gas reserves[35]. However, India continued to be one of the least explored regions with 30% of its estimated gas reserves explored so far. Almost 70% of India's natural gas reserves are found in the Bombay High basin and the state of Gujarat[36]. Off shore reserves are also located in Andhra Pradesh coast (Krishna Godavari Basin) and Tamil Nadu coast (Cauvery Basin)[37]. Onshore reserves are located in Gujarat and the North Eastern states. Smaller reserves are also found in Rajasthan[38].

At the time of initiation of the project activity i.e. award of the EPC Contract, Natural gas was available for procurement and there have been no evident restrictions caused by the project activity's choice of natural gas as the fuel, on significant future capacity additions to the baseline grid comparable in size to the project activity, in choosing natural gas as fuel.

The abundant 'availability' of NG in the KG basin from where the gas is proposed (and secured by a fuel supply agreement with the Gas Authority of India Ltd. -GAIL) is established[8]. The agreement for the supply of 1.1 million SCM/ day (MCMD) gas (more than that required for the operation) is signed before the financial closure (the project start date).

The project activity is slated to draw NG coming out from a new source (not a source which was earlier supplying NG elsewhere.) The project activity has contracted NG supply for more than that required at the design PLF not from an existing gas source but from a new gas source i.e. KG Basin. The NG to be used in this project is therefore not a result of diversion of NG destined for other projects in any region. For the purpose of gas supply a priority list for allocation has been created by Gas allocation

[35] http://www.nedcap.org/index_files/Page2514.htm

[36] http://iea.org/textbase/papers/2000/oilgas.pdf

[37] http://www.sourcewatch.org/index.php?title=India's_oil_industry

[38] http://petroleum.nic.in/ng.htm

committee of MoP&NG. The fact that this project activity figures in the allocation list of NG supply, proves that the planned gas consumption of this project activity, will be met by the NG available from the new sources. The source of NG is a bonafide gas find as has been borne out by publicly available information - The Sankar Committee on Utilization of Natural Gas in Andhra Pradesh, constituted by the Government of Andhra Pradesh in May 2003 observed that the established reserves in KG basin as on April 1, 2002 was about 45.59 BCM[39].

Reliance Industries Limited (RIL) in October, 2002 found 9 Trillion cubic Feed (tcft) of gas reserves, the biggest gas find in India in three decades, in the exploration block called KGBDW-6 (renamed asKG-DWN-98/3) in deep waters, 150 km off the Andhra Pradesh Coast near Kakinada. Cairn Energy also announced discovery of about 1 tcft of gas in Krishna Godavari Basin. The present estimates indicate that RIL can supply 40 MMSCMD of gas per day after all the facilities are built and gas transported to landfall point near Kakinada. ONGC, Gujarat State Petroleum Corpn. Ltd and Reliance Industries Limited are further intensifying exploration for gas, both onshore and offshore in Krishna Godavari Basin and this is expected to result in considerable additions to gas availability[40]. Further planned projects and national NG grid and trans-national pipelines will make gas availability possible[41].

Further, the announcement of consideration of Lanco's Kondapalli[42] and ongoing 768 MW expansion[43] at Vemagiri power projects by Ministry of Petroleum (Government of India) for NG allocation, after NG allocation was committed to this project activity, prove that the project in question is not depriving any other future user. The fact that the two projects mentioned above are of comparable capacity to the concerned power project,

[39]http://www.infraline.com/ong/default.asp?URL1=/ong/naturalgas/utilisation/SankarCommRepUtilisNatGasMay03.asp&idCategory=4798#infra

[40] Department of Industries, Govt. of AP; http://www.apind.gov.in/indussectors.html

[41]http://www.pwc.com/extweb/pwcpublications.nsf/docid/5EBE732379E5428ECA257184005E7A2B/$file/oil_gas.pdf

[42] http://petroleum.nic.in/clip4151206.pdf

[43] http://asian-power.com/regulation/more-news/ge-supply-parts-and-services-vemagiri-plant; http://www.gmrgroup.in/corporate/pdf/GIL_Q3-FY_11_-_Press_Release_Ver3_0_Final.pdf

proves that future power projects of same scale have not been negatively affected by the NG to be used in VPGL.

**Evidence / Analysis / Justification supporting surplus availability of NG at the point of time**

- **Management took decision:**

  Indian Natural gas production had been increasing steeply in past 20 years before the investment decision. From production of 8 bcm (billion cubic meter) in 1985-86, it had increased to 26.4 bcm in 1997-98 (> 400% in 12 years) which became 31.9 bcm by 2003-04.

  The project activity power plant had signed a gas supply agreement for sufficient gas to operate at more than 85% PLF on 09/10/2000, before the investment decision (25/08/2003). The gas was to come from a new find in KG basin[44].

  The Sankar Committee on Utilization of Natural Gas in Andhra Pradesh, constituted by the Government of Andhra Pradesh in May 2003 observed that the established reserves in KG basin as on April 1, 2002 was about 45.59 BCM[45]. In the state of Andhra Pradesh, the demand from consumers having firm commitments for supply in the year 2001-2002 was 6.12 MCMD. Against this demand, the availability from GAIL for the year 2001-2002 was 7.50 MCMD.

  In October 2002, Reliance Industries Ltd. made India's largest gas discovery in three decades in KG basin off Andhra Pradesh coast. This gas reserve was estimated to have capacity of 9 trillion cubic feet (TCF). That gas would enable supply of 40 MMSCD against the demand in project activity of 1.64 MMSCD. Cairn Energy also had announced discovery of about 1 TCF of gas reserves in KG basin. The demand supply data of India available from[46] Ministry of Petroleum and Natural gas shows that the country's natural gas consumption has been less than the gross production as presented below:

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[44] Gas supply contract with GAIL dt. 09/10/2000 (and all later amendments) specified gas obtained from the fields of ONGCL at Tatipaka, Parsarlapudi, Kesnapalli, Mori and Ravva offshore. These fields are all in KG-basin of Andhra Pradesh and some with latest discoveries in the duration

[45] http://www.infraline.com/ong/default.asp?URL1=/ong/naturalgas/utilisation/SankarCommRepUtilisNatGasMay03.asp&idCategory=4798#infra

[46] A report on OIL & GAS by PricewaterhouseCoopers.

http://www.pwc.com/extweb/pwcpublications.nsf/docid/5EBE732379E5428ECA257184005E7A2B/$file/oil_gas.pdf

**Table I: Natural Gas Consumption & Production (Billion Cubic Meters - BCM)**

| | 99-00 | 00-01 | 01-02 | 02-03 | 03-04 | 04-05 | CAGR |
|---|---|---|---|---|---|---|---|
| Consumption | 26.88 | 27.68 | 28.03 | 29.96 | 30.90 | 30.77 | 2.74% |
| Gross Production | 28.45 | 29.48 | 29.71 | 31.40 | 31.96 | 31.80 | 2.25% |

Source: MoPNG

On 17th June 2005, GSPC discovered India's largest gas reserve in its KG # 8 well. Estimated at 20 TCF, it was expected to double the country's gas production.

- **Commissioning date:**

A new fuel supply term sheet was signed with Reliance Industries Ltd. (RIL) on 09 June 2007 for supply of NG from new discovery in KG basin[47] (KG—DWN-98/3) The project activity power plant started commercial operations in 05 June 2009[48]. The contracted capacity from the RIL under Agreement is also 1.1 million SCM/ day. The project activity power plant is currently receiving natural gas from this new source.

- **As on date:**

ONGC, Gujarat State Petroleum Corporation Ltd. and Reliance Industries Limited are further intensifying exploration for gas, both onshore and offshore in KG basin and this is expected to result in considerable additions to gas availability[49]. Further planned projects and national NG grid and trans-national pipelines will make gas availability possible[50].

A recent media release by RIL on 22 January 2010, has declared a 61 MMSCD demand and capacity of 80 MMSCD for the KG basin operations[51]. **Reliance Gas Transportation Infrastructure Ltd (RGTIL) has started commercial operations of east-west gas pipeline in April 2009. This is 1,385 km pipeline**

[47] Gas sale term sheet between PP and RIL, pg. 3

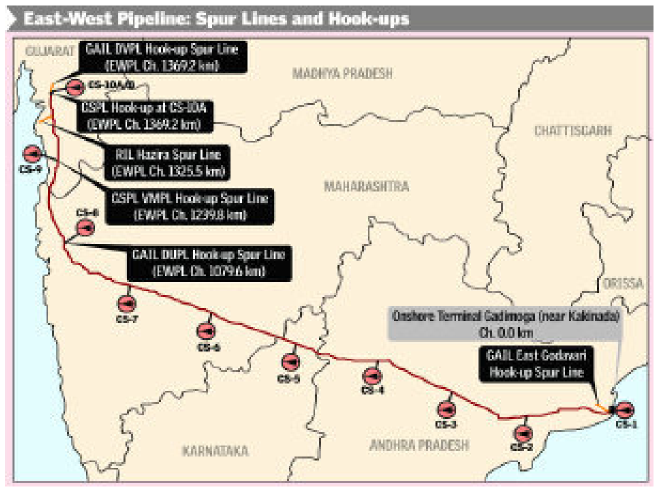
[48] Andhra Pradesh Power Coordination Committee Consent for COD letter after performance acceptance tests as per PPA

[49] Department of Industries, Govt. of AP; http://www.apind.gov.in/indussectors.html

[50] http://www.pwc.com/extweb/pwcpublications.nsf/docid/5EBE732379E5428ECA257184005E7A2B/$file/oil_gas.pdf

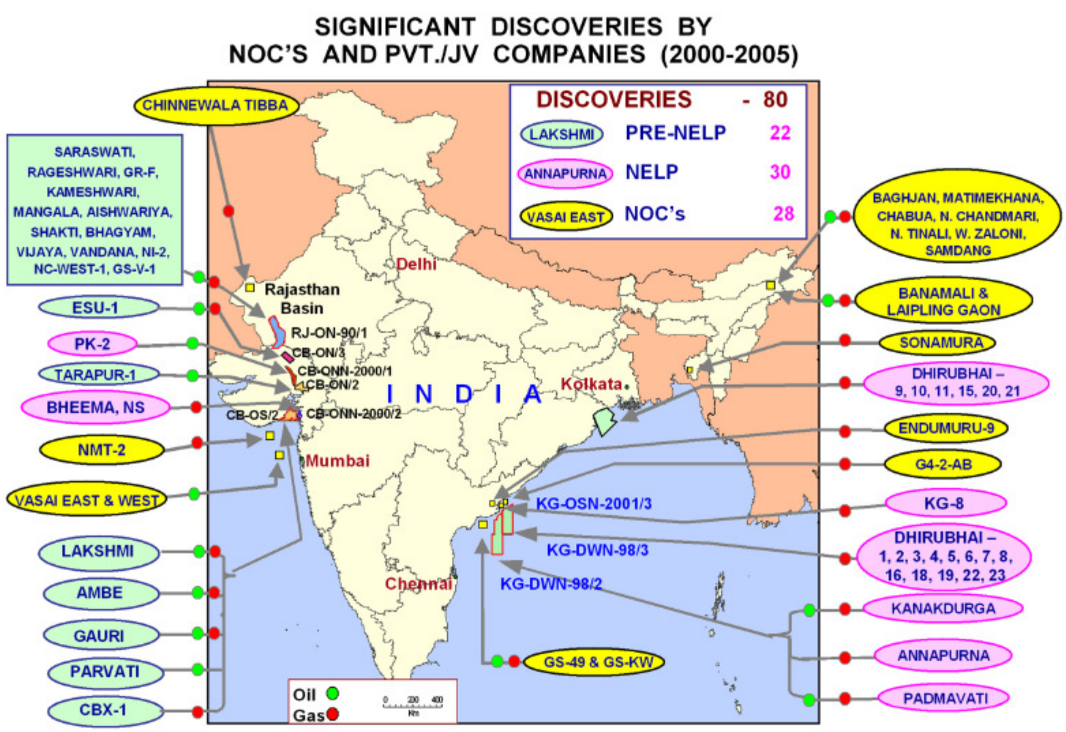
[51] http://www.ril.com/rportal/jsp/eportal/media/MediaHome.jsp

**traverses the four States of Andhra Pradesh, Karnataka, Maharashtra, and Gujarat.**




**The project activity plant has operated for more than 85% PLF in last about one year since COD and gas supply has never been disrupted.**

Following figure from Directorate General of Hydrocarbons, India summarizes major gas discoveries in India from 2000-05[52].

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[52] http://www.dghindia.org/pdf/Discovery.pdf


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(Under Ministry of Petroleum & Natural Gas, Govt. of India)
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Pravin Jadhav
Log out
My Profile | Change Password
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E&P Activities
Discoveries
Publications
Online Applications
Others
Purchase E&P Data
Destination India
Discoveries
Recent Discoveries

| Company | Number of Discoveries | Tag |
|---|---|---|
| British Gas Explo. & Prod.India Ltd. | 1 | FOREIGN |
| Cairn Energy India Pty.Ltd. | 27 | FOREIGN |
| Essar Oil Ltd. | 3 | INDIAN_PRIVATE |
| Focus energy Ltd. | 3 | INDIAN_PRIVATE |
| Gujarat State Petroleum Corporation Ltd. | 19 | STATE OIL |
| Hardy Exploration & Production (India) Inc. | 1 | FOREIGN |
| Hindustan Oil Exploration Company Ltd. | 2 | INDIAN_PRIVATE |
| Jubilant Oil & Gas Pvt. Ltd. | 4 | INDIAN_PRIVATE |
| Niko Resource Ltd. | 2 | FOREIGN |
| Oil & Natural Gas Corp. Ltd. | 12 | INDIAN NOC |
| Reliance Industry Ltd. | 41 | INDIAN_PRIVATE |
| Total | 115 | |

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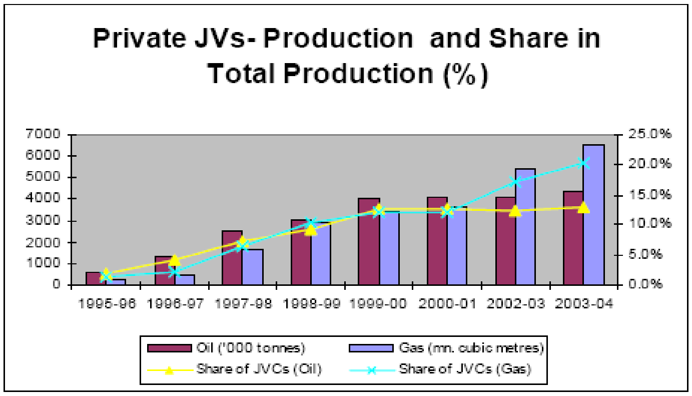
## Future prediction:

Natural gas supply to Indian market is managed through following approaches:

1. Increase production through private participation and encouragement of the existing gas producers
2. Make attractive exploration and licensing policy
3. Import gas through pipelines
4. LNG import

*1. Production trend:*

As described in earlier sections, Indian Natural gas production had been increasing steeply in past 20 years. From production of 8 bcm (billion cubic meter) in 1985-86, it increased to 26.4 bcm in 1997-98 (> 400% in 12 years) which became 31.9 bcm**Error! Bookmark not defined.** by 2003-04. Private participation in the form of Joint ventures had given a boost to this trend and it has been continuously increasing as presented below:




*Source: Ministry of Petroleum & Natural Gas*

*Gas Exploration and licensing policy:*

Government has introduced attractive fiscal terms and conditions in the oil and gas exploration policy. This has facilitated the major gas discovery by Reliance.

It has implemented a New Exploration and Licensing Policy (NELP) in 1997. Under this policy it awarded 90 blocks in a period of 5 years compare to 10 blocks awarded in 10 years prior to NELP. The result of the new policy was reflected in the series of gas reserve discovery between 2006 and 2008 (as presented in the section on 'gas reserve' earlier)

It is also encouraging sourcing the Coal Bed Methane (CBM) at its existing coal reserves. In the 200 Billion tones of present coal reserve it is believed to contain 800 billion cubic meters of methane. Till date 5 blocks have been awarded to 5 parties and 9 other blocks are in process of awardance.

*Gas imports through pipeline:*

Government is actively planning to import gas through following pipelines:

- Iran-Pakistan-India (IPI) pipeline – this plan to import 5.4 Bcf/d gas from Iran through a 1700 mile pipeline through Pakistan.
- Turkmenistan – Afganistan – Pakistan- India (TAPI) pipeline – this would source gas from Turkmenistan and import 3.2 Bcf/d gas through a 1050 mile long pipeline.
- Myanmar – Bangladesh- India pipeline – This would be sourcing gas from Swe field (of estimated reserve 7 Tcf) for India.

*LNG Import*Error! Bookmark not defined.*:*

Since 2004, India have been importing LNG and had set up two terminals in Gujarat (Hazira and Dahej).

Realising the ease of transporting natural gas as LNG and the growing demand for fuel in India, the GoI had set up a new company Petronet LNG, with GAIL, ONGC, IOC and Bharat Petroleum Corporation Limited (BPCL) as the main promoters. Petronet LNG has been entrusted with the task of developing terminals in the country for importing LNG. Petronet LNG has signed a gas purchase contract with Ras Gas, Qatar, for the import of 5 mmtpa of LNG at Dahej (Gujarat) and 2.5 mmtpa at Kochi (Kerala).

**Free market availability:** Petronet[53] is formed as a Joint Venture by the Government of India to import LNG and set up LNG terminals in the country and it involves India's leading oil and natural gas industry players. The promoters of company are GAIL (India) Limited (GAIL), Oil & Natural Gas Corporation Limited (ONGC), Indian Oil Corporation Limited (IOCL) and Bharat Petroleum Corporation Limited (BPCL).

Petronet's Dahej terminal has a nominal capacity of 10 million metric tones per annum (MMTPA) [equivalent to 40 million standard cubic meters per day (MMSCMD) of natural gas], the Kochi terminal will have a capacity of 2.5 MMTPA (equivalent to 10 MMSCMD of natural gas)[53]. It also plans to increase the Dahej terminal capacity to 15 MMTPA by 2012[54].

GAIL has 6196 km natural gas pipeline [55] and further planning Vijaywada-Vijaipur pipeline[56].
MOP&NG[57] statics also shows that free market availability of gas ("*Around 8.5 MMSCMD of gas is being directly supplied by the JVs/private companies at market prices to various consumers. This gas is outside the purview of the Government allocations.*") and also acknowledges that the further LNG imports will increase market availability.

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[53] http://www.petronetlng.com/

http://petroleum.nic.in/ng.htm

[54] http://www.reuters.com/article/idUSDEB00091720090824

[55] http://www.gailonline.com/gailnewsite/businesses/gastransmission.html

[56] http://www.hinduonnet.com/2009/04/25/stories/2009042551751600.htm

[57] Para 9 on natural gas page of MOP&NG website (http://petroleum.nic.in/ng.htm)

GAIL also estimated that the LNG imports could be 22-15 MMTPA in coming 5-6 years[58].

The gas transmission pipelines existing and proposed will interconnect all sources including LNG terminals and major user points. Following snapshot from GAIL presentation[59] gives existing and planned gas pipelines.

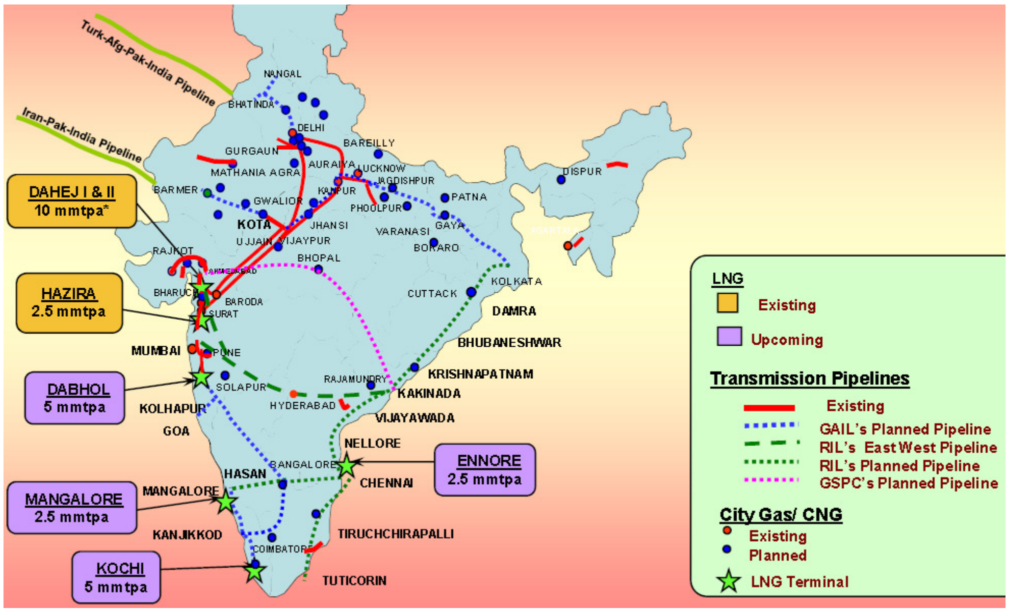


**Figure: Natural gas distribution pipelines- existing and planned in India**

**Justification /Evidence that Allocation for gas did not result in diversion of NG reserves (or) Monitoring plan to monitor leakage:**

The project activity power plant had a fuel supply agreement, approved by a Central Government Committee before the start date. When the plant is commissioned, it has started receiving gas from a new gas find by Reliance Industries Ltd. (discussed above). The same supplier has recently declared surplus capacity more than the present demand. Thus, the natural gas being used in the power plant is not diverted either from the present users and

[58] http://www.gailonline.com/gailnewsite/businesses/lngandrlng.html

[59] http://petrofed.winwinhosting.net/upload/IAI/NGP/I_Mathur_GAIL.pdf

excess capacity from the gas supplier than demand shows that future capacity additions are also not constrained.

Hence, the required NG is adequately available at source and applicability condition is satisfied.