



Voluntary Carbon Standard
Project Description Template

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[Table of Contents]

S . No	CONTENTS
1	Description of project
2	VCS Methodology
3	Monitoring
4	GHG Emission reductions
5	Environmental Impact
6	Stakeholders comments
7	Schedule
8	Ownership

List of Annexures

Annex 1: Calculation of fugitive emissions Fugitive
Methane Emissions and Leakage Emissions Factor

1 Description of Project:

1.1 Project title

Natural Gas Based Combined Cycle Power Generation, at Kothapeta, East Godavari, Andhra Pradesh, India

1.2 Type/Category of the project

According to the approved methodologies by the VCS board the project falls under the following category:

Sectoral Scope – 1: Energy industries (renewable /
non-renewable)

The project is not a grouped project

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

The project activity claims emission reductions by the usage of cleaner fuel i.e natural gas for electricity generation. The annual estimated emissions reductions are 1358857 tonnes of CO₂e.

Years	Annual estimation of emission reductions in tonnes of CO ₂ e
2009 - 2010	1358857
2010 - 2011	1358857
2011 - 2012	1358857
2012 - 2013	1358857
2013 - 2014	1358857
2014 - 2015	1358857
2015 - 2016	1358857
2016 - 2017	1358857
2017 - 2018	1358857
2018 - 2019	1358857
Total estimated reductions (tonnes of CO₂e)	13588570
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO₂e)	1358857

The project activity falls under the Mega Project category as it exceeds the limit of 1,000,000 tonnes CO₂ equivalent emissions reductions per year.

1.4 A brief description of the project:

The project activity is Phase-I grid connected 445 MW natural gas based Combined Cycle Power Plant (CCPP). The power plant comprises of 2 x 140 MW natural gas-run turbines, two heat recovery steam generators and a 165 MW steam turbine. It is a green field project developed by Konaseema Gas Power Ltd, hereinafter called KGPL, located at East Godavari district, Andhra Pradesh, India.

The generated power will be exported to the Andhra Pradesh power grid (part of the southern grid of India) and this is ensured by the Power Purchase Agreement (PPA) signed with State government owned Andhra Pradesh Transmission Corporation of India Ltd. (APTRANSCO). The project activity will meet the base load requirement of the southern grid.

In the absence of the project activity the same quantity of power would have been produced from Green House Gases (GHGs) intensive fossil fuel i.e coal. Since natural gas is energy intensive fuel it emits less GHGs comparatively for the same quantity of power generated using coal. Thus the project activity would help in reducing GHGs emissions into the atmosphere by the combustion of relatively cleaner fuel.

The project activity involves highly sophisticated and technologically superior equipment, for example the gas turbine is equipped with hybrid burners that emit low NO_x and it has got extended maintenance intervals which means increased availability of the equipment.

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

The project site is at Devarapalli village (Latitude: 17° 01' 60' N; Longitude: 81° 32' 60' E) which is located in Kothapeta Mandal at a distance of 4 km from Ravulapalem. The site is located adjacent to the highway connecting Rajahmundry and Amalapuram. The nearest town is Rajahmundry, which is at a distance of 35 km and is well connected with major cities like Hyderabad, Chennai, Calcutta, and Visakhapatnam by rail and road. Nearest Airport to the plant is Vijayawada, Andhra Pradesh.

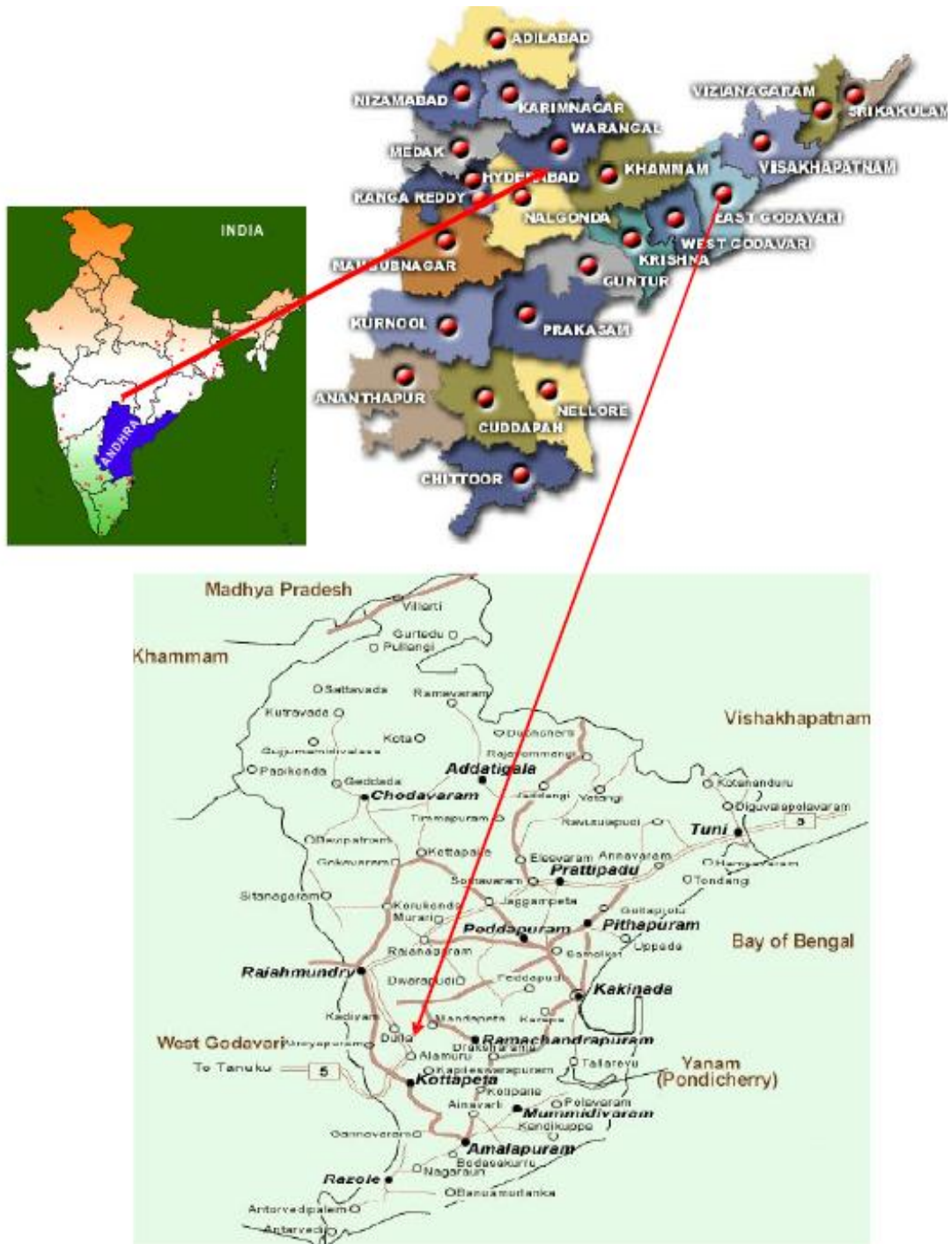


Figure 1 – Location Maps

1.6 Duration of the project activity/crediting period:

- *Project start date: 04 June 2009*
- *Crediting period start date: 04 June 2009*

Crediting period: The technical lifetimes of the project equipment are 20 years, hence the crediting period will be renewed by one more time after the first ten year period.

1.7 Conditions prior to project initiation:

Power generation using natural gas is a Greenfield activity, the project activity supplies power to electricity deficit southern grid of India. The project activity will help to bridge the demand supply gap.

Southern Grid	Availability (GWh)			Peak Load (MW)		
	Demand	Supply	Deficit	Demand	Supply	Deficit
05-06	157,179	155,790	-1,389	24,889	23,372	-1,517
07-08	187,743	181,820	-5,923	26,777	24,368	-2409

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

The project activity utilises natural gas for power generation, it's a cleaner and energy intensive fuel that emits less GHGs for the same quantity of power produced. In absence of the project activity the same quantity of power would have been produced from carbon GHG intensive fossil fuel i.e coal. Thus the project activity would help in reducing GHGs emissions into the atmosphere by the combustion of relatively cleaner fuel.

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

The proposed project is a green field 445MW natural gas based combined cycle power generation project with 2 x 140 MW natural gas-run turbines, two heat recovery steam generators and a 165 MW steam turbine. The prime objective of the project activity is not only to provide electricity to the grid but also to meet the full year demands in order to bridge the gap between demand and supply. As the gas based power plants are easy to start and bring them in-line for power generation compared to that of other conventional power plants. The generated power will be exported to the Southern India Grid, through the State Government owned Andhra Pradesh Transmission Corporation of India Ltd. (APTRANSCO).

The baseline scenario is arrived at after considering different technologies prevalent or planned in the region for power generation such as nuclear, wind, natural gas, hydro and coal. Nuclear energy is reserved for development by the government. Hydro and wind projects depend upon the availability of water and wind and cannot generate electricity on a fixed and regular basis.

Considering these aspects, the possible alternatives for comparable power generation capacity are coal, diesel and natural gas based power plants. These are analysed elaborately in the later section of the PD. As per the methodology adopted, the economically most attractive option must be identified using an investment analysis and chosen as the baseline scenario. Based on the levelised

cost of power generation, coal based power generation is the cheapest of all the options; followed by the project activity and diesel based generation. So, the baseline scenario would invariably be coal based sub-critical power plant.

The GT module is a 4 stage turbine with Nickel material based blades, 16 stage compressors provided with adjustable inlet guide vanes (IGVs), and sophisticated large external silo type combustors equipped with hybrid burners for premix and diffusion mode operation. And this premix mode of hybrid burner ensures low NO_x and CO emissions. This turbine is characterised with extended maintenance interval of 41,000 equivalent operating hours (EOH) which literally means increased equipment availability and reduced life cycle cost.

1. Gas Turbines

Parameters	Description
Equipment	Heavy duty Natural gas-run turbine, 94.2 model, single shaft, axial flow
Nos	2
Make	Siemens
Capacity	140MW * 2

2. WHRBs

Parameters	Description
Equipment	Waste heat recovery boilers
Nos	2
Capacity	556 TPH

3. Steam Turbine

Parameters	Description
Equipment	Steam turbine
Nos	1
Make	LMZ Energy Limited
Capacity	165 MW

4. Combined cycle power plant parameters

Parameters	Description
Total capacity of the plant	445 MW
Auxiliary consumption	3%
Plant Load Factor	85 %
Heat rate	1850 kCal/kWh
Gross Calorific value of natural gas	8800 kCal/SCM

The two gas turbines are designed to produce combined power output of 280 MW with a higher station heat rate; the hot waste gases coming out of the

turbine at higher temperature are utilized by the two waste heat recovery boilers to generate super-heated steam at a higher pressure and temperature. The high pressure super-heated steam is then expanded in a steam turbine to produce additional power of 165MW. The project equipment viz gas turbines, waste heat recovery boilers and steam turbine are procured from Siemen’s and LMZ Energy respectively, who are the renowned power plant equipment suppliers worldwide. Thus the technologies adopted by the project equipment are environmentally safe and sound.

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

The project activity 445 MW natural gas based power project is an environmental friendly project that emits less GHG compared to the other alternatives for the same capacity. The project proponent has got the requisite clearances for setting up the project and the same are detailed below:

Agency(ies)	Approvals	Significance
Government of Andhra Pradesh (GoAP)	Environment Clearance	GoAP mandates Environment Clearance for the project activity of this magnitude and type to commence
Andhra Pradesh Pollution Control Board (APPCB)	Consent to Establish	APPCB gives statutory approvals for the power plant viz “consent to establish” for setting up of the plant and “consent to operate” for subsequent operation of the plant.
Andhra Pradesh Transmission Company(APTRANSCO)	Power Purchase Agreement(PPA)	PPA between the project proponent and APTRANSCO facilitates the export of electricity to the grid at the agreed price for the time period

It is clearly evident from the above obtained clearances that the project activity complies all the local laws and regulations.

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

In India the pricing of all the petroleum products are traditionally operated under an Administered Pricing Mechanism. And this is to ensure that products like kerosene, or products used as feedstock for production of fertilizer, like naphtha, natural gas for power production may be sold at subsidized prices.

It is contemplated that in a phased manner, all administered price products will be taken out of the administered pricing regime and the system will be replaced

by a market determined progressive tariff regime in order to provide a level playing field for new investments in a free and competitive market¹.

Once the APM is dismantled², which is likely to happen in near future, the price of natural gas would go up. This situation would eventually lead to increase in cost of power generation thereby posing as a key risk factor affecting the project GHG emission reductions.

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

The primary objective of the project activity is to generate power from the sourced cleaner fuel i.e natural gas and supply the same to the power deficit grid. Hence it is evident that creation of GHG emissions for its subsequent removal was not the primary objective of the project activity.

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

The project activity does not involve itself in any other forms of environmental credit.

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

The project activity is currently in CDM cycle with UNFCCC. The PDD has been webhosted for global stake holder's comments at the UNFCCC website as part of the CDM requirement.

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

Project Proponent: Konaseema Gas Power Limited

The project proponent has formed a monitoring team that adheres to a specific monitoring plan. All the parameters that lead to computation of emission reductions will be monitored by the personnel. And the monitored data will be reviewed periodically by the plant head.

Organization:	Konaseema Gas Power Limited
Street/P.O.Box:	6-2-913/914, Khairatabad
Building:	2nd Floor, Progressive Towers
City:	Hyderabad
State/Region:	Andhra Pradesh
Postcode/ZIP:	500 004
Country:	INDIA
Telephone:	+91-40-23301166/99

¹ <http://petroleum.nic.in/apppric.htm>

² <http://profit.ndtv.com/news/show/govt-won-t-dictate-price-of-natural-gas-oil-secy-109432>

FAX:	+91-40-23301160/61
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Title:	Mr
Salutation:	
Last name:	SEN
Middle name:	
First name:	N.C
Department:	
Mobile:	
Direct FAX:	
Direct tel:	
Personal e-mail:	nimai_sen@rediffmail.com

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.):

The project activity fulfils the sustainable development indicators prescribed by the host country. The indicators are as follows:-

1. Social well being
2. Environmental well being
3. Economic well being
4. Technological well being

1. Social well being:

The project activity generates employment opportunities to the local people both directly and indirectly during various stages of its implementation viz construction phase, erection and commissioning and during commercial operation. The project activity also brings about infrastructural developments to that region like better road facilities, communication networks, access to health centres and educational institutions etc.

2. Environmental well being:

Natural gas is a cleaner fuel that emits less GHG's comparatively than other fossil fuels for the same quantity of power generated. Moreover the high end technology adopted in the natural gas burner will emit less NOx. The project activity is free from problems related to disposal of ash as would be in the case of coal based power plants, thereby minimising the burden on the environment. Thus the project activity helps in reduction of GHGs, solid wastes and other pollutants viz SOx, NOx etc. The people living around the project site will have cleaner environment to survive.

The project activity also helps in conservation of fast depleting natural resources viz coal which is exploited to a greater extent for power generation.

3. Economic well being:

Employment opportunities due to the project activity improve the living standards of the people in the region. Successful implementation of the project activity would result in new schools/colleges, hospitals, commercial establishments and other related engineering firms in the region. Further, access to green funding for the clean project will attract other investors to initiate green projects of this scale at large.

4. Technological well being:

The project activity involves high end sophisticated modern combined cycle technology. It enables the work force to get exposed to the new technology viz (gas turbine, waste heat recovery boiler, steam turbine and Demineralisation plant) and enhance their technical skills. Further the local engineering firms, schools and colleges can be mutually benefitted by way of MoU / tie-ups.

1.17 List of commercially sensitive information (if applicable):

No commercially sensitive information is envisaged in this project activity.

2 VCS Methodology:

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

The project activity uses the CDM approved methodology and it falls under the *Energy Industries* category.

Title : **“Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas”**

Reference : Approved baseline methodology AM0029

Version : 03

Sectoral Scope : 01

EB : 39

Methodology refers to the tool for calculating baseline CO₂ emission factor.

Title : **“Tool to calculate emission factor for an electricity system”**

Version : 02

EB : 50

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

The project activity fulfils the applicability conditions of the methodology **AM0029 “Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas”**

- Project activity is a greenfield, grid connected natural gas based electricity generation plant.
- The geographic and system boundaries for the project activity is the southern electricity grid of India and it is clearly identified and information on the characteristics of the grid is publicly available³.
- Natural gas reserves in the KG basin: recent discoveries by the government and the private players have boosted the country's gas reserves.

Table 1: Natural Gas reserves in the Krishna Godavari Basin⁴

Year	Gas reserves in (trillion cubic feet)	Discovered by
2002	14	Reliance Industries Ltd (World's largest gas discovery in 2002)
June 2005	20	Gujarat State Petroleum Corporation
May 2009	20	Reliance Industries Ltd
June 2009	10	ONGC

- Project participant has received a long-term allotment of natural gas from Krishna- Godavari (KG) river basin in Andhra Pradesh through Gas Authority of India Ltd (GAIL). KG basin as on 2002 is credited as the largest gas reserves in the world, with a capacity of 550,000 barrels of oil equivalent per day which is equivalent to 40% of India's current combined oil and gas production⁵. The fact that the PP has sourced fuel from the new source (KG basin) reveals there is no diversion of fuel meant for other purposes.
- The gas allotment was issued by the Ministry of Petroleum & Natural Gas, Government of India. The allotment issued on 19 February 2001⁶ is for 2.0 MMSCMD⁷ which is sufficiently equivalent for the requirement of the power plant.

The availability of natural gas from the Krishna Godavari basin is shown in Table 1.

The Shankar Committee on utilization of Natural Gas in Andhra Pradesh, constituted by the Government of Andhra Pradesh (GoAP) in May 2003 observed that the established reserves in KG basin as on April 1, 2002 was

³ <http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>

⁴ http://en.wikipedia.org/wiki/Krishna_Godavari_Basin

⁵ http://www.ril.com/html/business/exploration_production.html

⁶ Allocation of gas is made on respective date for future, when plant will start operation

⁷ MMSCMD - Million metric standard cubic meters, per day

about 45.59 billion cubic meters (BCM) with the production rate of about 7.50 MCMD⁸.

These existing reserves are expected to be augmented further by the recent gas discoveries in the KG basin. Under the new Exploration Licensing policy of Government of India, Reliance and Cairn Energy announced discoveries of gas in the KG basin with large estimated reserves. The Reliance group and its alliance company, Niko Resources found a large deepwater gas discovery offshore in the KG basin on block KG_DWN_98/3. The total volume of gas reserves discovered by Reliance is estimated to be about 219.70 BCM. Recently, a new gas reserve was explored by Reliance Industries surrounding D1 and D3 blocks of K-G Basin with estimated reserve of 1-2 trillion cubic feet of gas⁹.

Table 2: Natural Gas Production in the Krishna Godavari Basin by Reliance Industries Ltd, 2007-2013

Year	Gas production in MMSCMD
2007-08	Nil
2008-09	60
2009-10	80
2010-11	80
2011-12	80
2012-13	80

Table 3: Natural Gas Production in Andhra Pradesh, 2004-2019¹⁰

Year	Natural gas-production in (million cubic metre)
2004-05	1707
2005-06	1663
2006-07	1525
2007-08	1567
2008-09	1524

- It is evident from the above data that the natural gas is sufficiently available in the region and the future natural gas based power projects comparable in size are not constrained by the implementation of the project activity.
- Further the plant is fully functional at its rated PLF presently and similar

⁸<http://www.infraline.com/ong/default.asp?URL1=/ong/naturalgas/utilisation/SankarCommRepUtilisNatGasMay03.asp&idCategory=4798#infra>

⁹ <http://www.tribuneindia.com/2010/20100410/biz.htm#2>

¹⁰ <http://www.petroleum.nic.in/petstat.pdf>

new projects of comparable capacity are in various stages of execution with few already in operational stage viz Vemagiri Power Generation Ltd (388.5 MW), Gautami Power Ltd (469 MW). Considering the recent gas discovery in the region few plants namely Vemagiri have also planned capacity expansion in addition to the existing ones. This substantiates the claim that new NG power plants are not constrained by the operation of KGPL plant.

Through the generation of 445 MW power, this project activity actively meets the electricity demand of the Indian State of Andhra Pradesh, in turn reducing the power deficit and contributes positively towards industrialization in the State.

Therefore, the proposed project activity meets the applicability criteria.

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

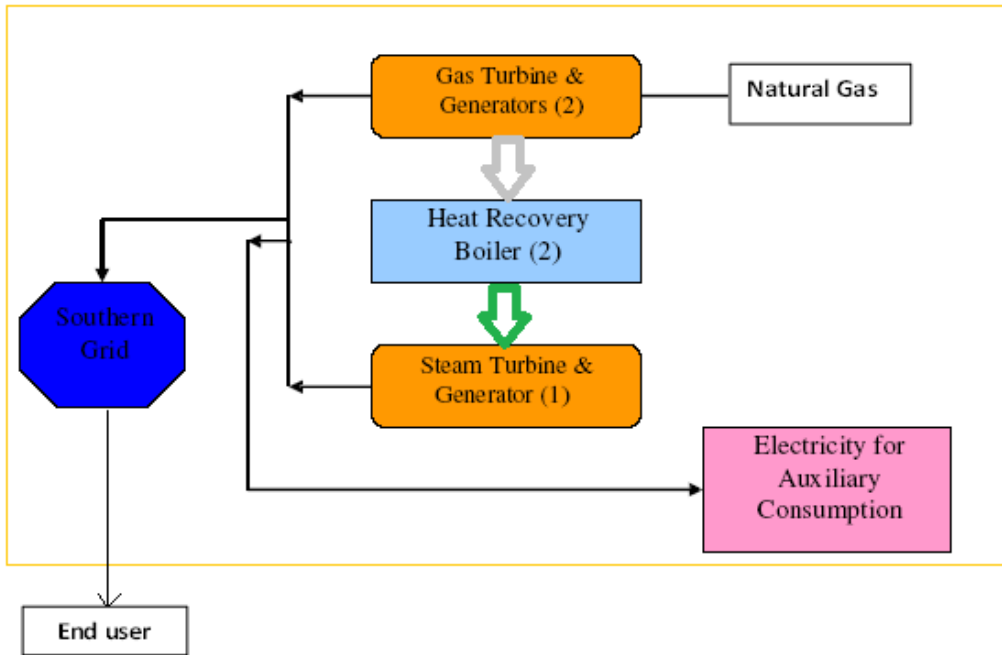
Table 4: Overview of Emissions Sources Included in or Excluded from the Project Boundary

	Source	Gas	Included	Justification /Explanation
Baseline	Power generation in baseline	CO2	Yes	Main emission source
		CH4	No	Excluded for simplification. This is conservative.
		N2O	No	Excluded for simplification. This is conservative.
Project Activity	Onsite fuel combustion due to project activity	CO2	Yes	Main emission source
		CH4	No	Excluded for simplification. This is conservative.
		N2O	No	Excluded for simplification. This is conservative.

For the proposed project activity, the project boundary is from the point of fuel supply to the point of power export to the southern grid where the project participant has full control. Thus, the project boundary covers the two gas

turbines, two waste heat recovery boilers, a steam turbine, three electricity generators, all other auxiliary equipment and southern grid.

Fig 2: Project Boundary



But according to relevant methodology AM0029 version 03, the spatial extent of project boundary includes the project site and all power plants connected physically to baseline grid as defined in “Tool to calculate emission factor for an electricity system”, version 2.

The baseline grid for the proposed project activity is Southern grid, shown in figure 3.



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

The baseline methodology for grid connected electricity generation plants using natural gas AM0029 suggests using the following two steps to define the baseline scenario:

Step 1: Identify plausible baseline scenarios

In this step, all the possible realistic and credible alternatives that provide outputs or services comparable with the proposed project activity will be identified.

The existing and planned generation technologies within southern grid are as follows:

Table 5: Generation Technologies for Southern Grid

Fuel	Technology	Output and Service
<i>Natural gas</i>	<i>Combined cycle gas turbine</i>	<i>Full year generation at peak capacity</i>
<i>Natural gas</i>	<i>Gas turbine (open cycle)</i>	<i>Full year generation at peak capacity</i>
<i>Natural gas</i>	<i>Gas turbine - cogeneration</i>	<i>Full year generation at peak capacity</i>
<i>Natural gas</i>	<i>Gas engine</i>	<i>Full year generation at peak capacity</i>
<i>Coal</i>	<i>Sub critical</i>	<i>Full year generation at peak capacity</i>
<i>Coal</i>	<i>Super critical</i>	<i>Full year generation at peak capacity</i>
<i>Lignite</i>	<i>Sub critical</i>	<i>Full year generation at peak capacity</i>
<i>Wind</i>	--	<i>Seasonal generation at low plant load factor</i>
<i>Nuclear</i>	--	<i>Full year Generation at peak capacity</i>
<i>Hydro</i>	<i>Run of river</i>	<i>Seasonal generation</i>
<i>Hydro</i>	<i>Dam based</i>	<i>Seasonal generation</i>

a) Project activity not undertaken as VCS activity

The natural gas project (445 MW) with a lifetime of 15-20 years¹¹ is intended to supply power to the southern grid of India and it complies with all the legal and regulatory requirement. But the activity would have faced barriers as discussed in section 2.5 of the PD.

b) Natural gas based power generation in open cycle mode (445 MW)

Power generation in open cycle mode can meet the base load requirement, but the system has got very low system efficiency¹² as compared to the combined cycle because of the high exhaust loss. Further it does not deliver comparable output to that of the project activity, hence it is not considered as the credible alternative for the PP.

c) Natural gas based – Cogeneration

¹¹ http://cercind.gov.in/160502/comp_bidding.pdf

¹²

http://books.google.com/books?id=s0spIzYtrCAC&pg=PA181&dq=efficiency+value+of+open+cycle+natural+gas+plant&hl=en&ei=V5p0TZ2OL43jrAe1ovnRCg&sa=X&oi=book_result&ct=result&resnum=1&ved=0CDwQ6AEwAA#v=onepage&q=efficiency%20value%20of%20open%20cycle%20natural%20gas%20plant&f=false pg 181

The project activity involves supplying electricity to the grid and does not involve thermal energy supply. Hence this alternative is not considered as an alternative. Moreover this alternative does not deliver similar output/services compared to the project activity.

d) Power generation from diesel based power plant (with a lifetime of >20 years and efficiency of 50%¹³)

In India diesel based power generation are limited to smaller capacities in the order of 50 MW. Below table shows the list of such plants connected to southern grid. Cluster of smaller capacity diesel based power plants can be a realistic alternative and hence considered further in the analysis.

Diesel based power plants in southern grid¹⁴

Power Plant	Entity	Location	Capacity (MW)	Year
<i>Basin bridge</i>	<i>GMR Energy</i>	<i>Chennai</i>	<i>4 × 50</i>	1998-99
<i>Yelahanka</i>	<i>Karnataka SEB</i>	<i>Bangalore</i>	<i>21.32*6</i>	1993-94
<i>Kozhikode</i>	<i>Kerala SEB</i>	<i>Kozhikode</i>	<i>128</i>	1999
<i>Samayanallur</i>	<i>Private entity</i>	<i>Samayanallur</i>	<i>106</i>	2001
<i>Samalpatti</i>	<i>Samalpatti Power Corp.</i>	<i>Samalpatti</i>	<i>105.7</i>	2001
<i>Bellary DG</i>	<i>Private entity</i>	<i>Bellary</i>	<i>25.2</i>	2000
<i>Belgaum</i>	<i>TATA PCL</i>	<i>Belgaum</i>	<i>3 × 27.1</i>	2001
<i>Kasargode</i>	<i>RPG</i>		<i>21.84</i>	1999

e) Coal based power generation (500 MW Sub-critical plant with a lifetime of 25-30 years¹⁵)

This alternative, in the efficiency range of 32-38%¹⁶, will meet the base load requirement of the grid and is in compliance with all the legal requirement. Hence this option is a realistic and credible alternative therefore considered further in the analysis.

f) Coal based power generation (Super-critical plant)

Super critical plant operates above the critical pressure of steam (221 bar) with a higher plant efficiency in the range of 36-40%¹⁷. This technology is credited

¹³ <http://www.bwsc.com/4-stroke.aspx?ID=70>

¹⁴ CEA database version 5

¹⁵ http://cecind.gov.in/160502/comp_bidding.pdf

¹⁶ <http://www.energyjustice.net/files/coal/igcc/factsheet.pdf>

¹⁷

http://cea.nic.in/thermal/Special_reports/Report%20of%20the%20committee%20to%20recommend%20next%20higher%20size%20of%20coal%20fired%20thermal%20power%20stations.pdf

as least polluting with low ash related problems. But the super critical technology was novice when the project activity was envisaged and the country's first super critical plant was being built as late as 2006¹⁸. Hence this is not considered as the plausible alternative.

g) Lignite based power generation

Neyveli Lignite Corporation Ltd has implemented the only lignite based power plant that is connected to the southern grid. Further this plant is set up only near the lignite mines (Pit head) owing to the specific characteristics of the lignite. Since there is no such mines in the project activity region, this alternative is not considered further.

h) Wind based power generation with low PLF¹⁹

Project activity caters to the base load requirement of the grid but wind mills are not meant for meeting the base load power, moreover wind mill based power generation are volatile and are subjected to seasonal variations. Hence this alternative is not compared with the project activity in terms of services that it delivers.

i) Hydro based power generation

'Run-of-river' and 'reservoir based' are the two types of hydro power generation. But both the category is suited for meeting only the peak load²⁰ requirement of the grid whereas the project activity *is for catering the base load. Hence this alternative is not considered in the analysis.*

j) Power generation using Nuclear fuel

Nuclear energy based power generation is developed exclusively by Government of India (GoI), and thus totally out of consideration for private companies. Therefore this alternative is excluded from the analysis.

k) Electricity import from other grid

Planned power capacity addition is being done by the Ministry of Power through the five year plans. But inspite of that India continue to face power shortage with demand exceeding the supply.²¹

The energy shortage during the year 2004-05 was 7.3% as compared to 2003-04 (7.1%), the peak shortage in 2004-05 was 11.7% as against 11.2% in 2003-04.

Power deficit in regional grids²²

<i>Year</i>	<i>Northern region</i>	<i>Southern Region</i>	<i>Eastern region</i>	<i>Western Region</i>	<i>North Eastern</i>

¹⁸ www.ese.iitb.ac.in/~aer2006/papers/MVJJ_031.doc

¹⁹ <http://energymanagertraining.com/kaupp/Article28.pdf>

²⁰ Hydro Sector Development in India (Growth & Investment Opportunities) – By R.V.Shahi, Secretary, Ministry of Power, Government of India July, 2003

²¹ http://cea.nic.in/about_us/Annual%20Report/2004-05/chapter04.pdf

²² http://www.cea.nic.in/about_us/Annual%20Report/2004-05/Contents.htm

					region
2004-05	9.1%	2.5%	2.5%	20.3%	13.6%

From the above table it is quite clear that power crisis exists in the entire regional grids and importing of grid power is not a feasible option. Hence this option is ruled out of consideration.

After considering all the above mentioned alternatives, the comparable realistic alternatives that will provide comparable output and service as that of VCS project activity are as follows:

Table 6: Comparable Alternatives to the Proposed Project Activity

Fuel	Technology	Output and Service
<i>Natural gas</i>	<i>Combined cycle gas turbine</i>	<i>Full year generation at peak capacity</i>
<i>Coal</i>	<i>Sub critical</i>	<i>Full year generation at peak capacity</i>
<i>Diesel</i>	<i>DG sets</i>	<i>Full year generation at peak capacity</i>

A. Step 2: Identify the economically most attractive baseline scenario alternative

According to the methodology, the economically most attractive baseline scenario has to be identified by using investment analysis. The project proponent wishes to use levelised cost of electricity generation as the financial indicator for all alternatives remaining after step 1.

Levelized cost of electricity generation is a realistic approach when comparisons are done among different technologies (alternatives) with varying lifetime since it allows to quantify, the unitary cost of the electricity (kWh) generated. The levelized cost of electricity being a mean value, allows the comparison with the cost of other alternatives. It is also important to note that for all power generation projects in India which are evaluated by Ministry of Power, Government of India, levelized cost of generation²³ is the evaluation criteria.

The relevant assumptions and parameters are listed as follows:

Table 7: Different Parameters for All Plants

²³ http://powermin.nic.in/whats_new/competitive_guidelines.htm

<i>Item</i>	<i>Unit</i>	<i>Escalation</i>	<i>Cost</i>	<i>Source</i>
CCGT (445 MW)				
<i>Fuel cost</i>	<i>INR</i>	<i>7%</i>	<i>Rs. 6.510 /SCM</i>	<i>Technical appraisal report</i>
<i>O & M Cost</i>	<i>INR</i>	<i>6%</i>	<i>2.5 % of the project cost</i>	<i>Technical Appraisal report</i>
<i>Plant Load Factor</i>	<i>--</i>	<i>--</i>	<i>85%</i>	<i>Technical Appraisal report</i>
Coal based Sub-critical (500 MW)				
<i>Fuel Expenditure</i>	<i>INR</i>	<i>4%</i>	<i>Rs. 1357/Tonne</i>	<i>Data available from Singareni colliery; Price notification 4/10/2001 and applicable taxes</i>
<i>O & M Cost</i>	<i>INR</i>	<i>6 %</i>	<i>2.50% of project cost</i>	<i>CERC (Terms and Conditions of Tariff) Regulations, 2001 P.No 11 and 12</i>
<i>Plant Load Factor</i>	<i>--</i>	<i>--</i>	<i>80%</i>	<i>Technical Appraisal report</i>
Diesel based (450 MW)				
<i>Fuel Expenditure</i>	<i>INR</i>	<i>4 %</i>	<i>19.73 Rs/lit</i>	<i>India's Petrol, Diesel, Kerosene & LPG prices published periodically by Reuters</i>
<i>O & M Cost</i>	<i>INR</i>	<i>7.10 %</i>	<i>2.5% of project cost</i>	<i>Equipment supplier and Operational norms for Diesel plant; http://www.powermin.nic.in/ acts_notification/operationalnor ms_diesel_lignite.htm</i>
<i>Plant Load Factor</i>			<i>75%</i>	<i>Equipment supplier</i>

Table 8: Capital Expenditure of Different Technologies

<i>Technology</i>	<i>Capacity</i>	<i>Capital Expenditure (million)</i>	<i>Capital Expenditure / MW</i>	<i>Source</i>
<i>Combined Cycle Gas Turbine</i>	<i>445 MW</i>	<i>Rs. 13647</i>	<i>Rs. 30.66 Million</i>	<i>Technical appraisal report of the project</i>
<i>Sub-Critical Coal power plant</i>	<i>500 MW</i>	<i>Rs. 20000 Million</i>	<i>Rs. 40 Million</i>	<i>Expert estimation and Central Electricity Authority (CEA) of India Study reports</i>

<i>(Diesel based Power plant)</i>	<i>450 MW</i>	<i>Rs. 16635 Million</i>	<i>Rs.36.968 Million</i>	
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Table 9: Technical Lifetime

<i>Technology</i>	<i>Lifetime</i>	<i>Source</i>
<i>Combined Cycle Gas Turbine</i>	<i>15-20 Years</i>	<i>CERC</i>
<i>Sub Critical Coal Power plant</i>	<i>25 -30 Years</i>	<i>CERC</i>
<i>Diesel based Power plant</i>	<i>20-30 Years</i>	http://www.bwsc.com/4-stroke.aspx?ID=70

Based on the above parameters, the levelised cost of corresponding options for electricity generation are calculated and listed in Table 12 below in section 2.5. Sensitivity analysis is shown in the same table.

According to AM0029 Version 03, the baseline alternative with lowest levelised cost can be accepted as the most plausible scenario. In the case of the proposed project, 500 MW Coal based power plant has the lowest levelised cost of power generation, so it is considered as the most plausible baseline scenario. The sensitivity analysis done also confirms that it is the most financially attractive alternative, within the range or realistic variation of the parameters considered.

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

The project activity reduces the GHG emissions by adopting the cleaner natural gas as the fuel source. And the project is additional to any that would occur in the absence of the project activity and this is evaluated by one of the three additionality tests given by the VCS methodology.

Test 1 – The Project Test

Step 1: Regulatory Surplus

As per Voluntary Carbon Standard (VCS-2007.1), the PP needs to prove that the project is not mandated by any enforced law, statute or other regulatory framework.

There is no National Legislation that stipulates the power generation through natural gas resources. The implementation of the natural gas based power

project activity is purely a voluntary step undertaken by the project proponents with no direct or indirect mandate by law / any regulatory framework.

Step 2: Implementation barriers

Additionality of the project activity is strengthened by demonstrating the investment barrier that the project faces.

Step I: Investment analysis

According to AM0029, financial unattractiveness is demonstrated 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 additionality tool.

“Tool for the demonstration and assessment of additionality” Version 5.2 is used.

Whether the proposed project activity is not:

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

is determined using the tool

Sub-step II.b (Option III) – Apply Benchmark Analysis

Levelised cost of generation (INR/kWh) is used as the financial indicator for the project activity. The basis of choosing it as financial indicator is indicated in the baseline scenario analysis.

Sub – step II c. Calculation and Comparison of Financial Indicators

The main parameters for financial analysis of this project are shown in the table below:

Table 10: Main Parameters for Financial Analysis

Items	Unit	Value	Source
Capacity	MW	445	Technical Appraisal report of the project activity
Total Investment	Rs. Million	13647	Technical Appraisal report of the project activity
Annual Generation Of Units	Million kWh	3313	Technical Appraisal report of the project activity

The following table compares the levelised cost of generation for the project with the most likely alternative technology for electricity generation.

Table 11: Levelised cost for Different Comparable Alternatives

Plant Type	Capacity	Levelised Cost of
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		Generation
CCGT Plant (without VCS benefits)	445 MW	3.29 INR/kWh
Coal-fired power plant*	500 MW	2.00 INR/kWh
Diesel based PP	450 MW	7.32 INR/kWh

The above table shows the proposed project activity is not the financially attractive option for the PP. coal based power plant is the financially attractive option amongst the alternatives as it is economically viable and technologically proven, hence considered as the benchmark. The project activity has a less levelised cost of generation than the benchmark therefore it is not financially attractive.

Sub – step II d. Sensitivity Analysis

AM0029, version 3 states:

“The range of the sensitivity analysis should cover, in a realistic way, the possible variations of all key parameters that are related to the analysis and that could change over the crediting period.”

The sensitivity parameters that are likely to have impact on the return of the project are: Cost of the project, Plant Load factor (PLF) and Station Heat Rate (SHR) and fuel price as shown in Table 12.

Cost of the project can fluctuate due to escalation in costs of plant and equipment and unforeseen delays in commissioning. Plant Load Factor can fluctuate due to many reasons such as unplanned shut down, machinery failure duration of plant etc. Station Heat Rate (SHR) will be affected by the gas consumption and efficiency of the project machinery. All these risks have been very much inherent in the project. PP has considered both positive and negative variations of the above mentioned parameters. There is less probability for significant positive variations. The extent of negative variation is not far from reasonable possibility.

Table 12: Sensitivity Analysis

A. Fuel price variation

Parameters	-10%	0%	10%
Coal	1.90	2.00	2.11
Natural Gas	3.03	3.29	3.54
Diesel	6.69	7.32	7.95

B. Heat rate

Parameters	-10%	0%	10%
Coal	1.90	2.00	2.11
Natural Gas	3.03	3.29	3.54
Diesel	6.69	7.32	7.95

C. PLF

Parameters	-10%	0%	10%
Coal	2.12	2.00	1.91
Natural Gas	3.37	3.29	3.22
Diesel	7.43	7.32	7.23

D. Project cost

Parameters	-10%	0%	10%
Coal	1.90	2.00	2.1
Natural Gas	3.21	3.29	3.36
Diesel	7.22	7.32	7.42

E. GCV

Parameters	-10%	0%	10%
Coal	2.12	2.00	1.91
Natural Gas	3.57	3.29	3.05
Diesel	8.03	7.32	6.75

The sensitivity of the project shows the financial unattractiveness of the project activity.

Further the project activity faces price risks due to:

- High volatility in the price of petroleum products
- Government of India's policy to eventually align the domestic gas prices to global prices.

Step 3 – Common Practice

Power generation using natural gas in India is a recent development in the power sector. As on Mar 2004 the share of natural gas for power generation is only 10.51% whereas the contribution due to steam comprising of fuels viz coal, lignite etc is on the higher side i.e 57.64%.

Table 13: All India installed electricity generation capacity source wise (as on 31 March 2004)²⁴

Source	Installed capacities in MW	% share
Hydro	29506.83	26.19
Steam	64955.88	57.64

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

Diesel & Wind	3660.94	3.25
Gas	11839.82	10.51
Nuclear	2720.00	2.41
Total	112683.47	100

The contribution of natural gas-based power plants in generation mix of Southern grid is as low as 8.53 % in 2004-05. The table below shows the percentage of natural gas-based power plants in the preceding previous years.

Table 14: Share of Gas-Based Power Plants in southern grid of India 2001-2005

Year	Total Installed Capacity in MW		% of Gas to Total
	Total	Gas Based	
2001-02	25302	1910	7.55
2002-03	28751	2550	8.87
2003-04	29907	2650	8.86
2004-05	31876	2720	8.53

(Source: Central Electricity Authority)

It is evident from the table 14 that the power generation due to natural gas is only around 8% in southern grid and as such natural gas based power generation is not a common practice in the region.

Table 15: NG based power plants connected to southern grid of India²⁵

S.No	Unit name	Installed Capacity (MW)	Year of Commissioning	Fuel	(Central /State/ Private)	ICB/ two part tariff
1	VIJESWARAN GT	272.3	1990- 97	Gas/ Napt	State	No
2	JEGURUPADU GT	235.4	1996-98	do	Pvt. (GVK Ind)	No
3	GODAVARI GT	208	1997-98	do	Pvt. (SPECT Ind)	No
4	KONDAPALLI GT	350	2000	do	Pvt.	-
5	PEDDAPURAM CCGT	220	2002	do	Pvt. (REL)	-
6	TANIR BAVI	220	2001	do	Pvt. (GMR)	No
7	KAYAM KULAM GT	350	1998-99	do	Center	No
8	VALUTHUR GT	246	2002-08	Gas	State	No

²⁵ <http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>

9	KUTTALAM GT	101	2003-04	Gas	State	No
10	KOVILKALAPPAL	107	2001	Gas	State	No
11	P.NALLUR CCGT	330.5	2001	Gas/ Napt	Pvt.	No
12	KARUPPUR GT	119.8	2005	Gas	Pvt. (ABAN)	-
13	KARAIKAL	32.5	2000	Gas	State	No
14	VALANTHARVI GT	67.6	2005-06	Gas	State	No
15	VEMAGIRI CCCP	388.5	2006	Gas	Pvt.	Yes
16	GVK Jegurupadu II	220	2009	Gas	Pvt.	Yes
17	Gautami Power Ltd.	464	2009	Gas	Pvt.	Yes

The Table above shows that only three power plants are from private sectors that have the same investment climate as the project activity. The Power Purchase Agreement for the project activity was signed with APTRANSCO at a tariff that was fixed for the short gestation projects (Natural Gas Based Power Generation Projects) selected under the International Competitive Bid Process (ICB).

The Natural Gas based power plants that have participated in the ICB process and won the bid for the similar tariff²⁶ include:

1. 220 MW GVK Industries Ltd. Jegurupadu power plant²⁷
2. 388.5 MW Grid connected electricity generation using natural gas by the Vemagiri Power Generation Ltd²⁸.
3. 469 MW Gautami Power Project being promoted by Gautami Power Limited²⁹.

And all these projects are in various stages of claiming carbon credits

No other Natural Gas based Power Projects with similar tariff structure has been commissioned in Andhra Pradesh. Hence, it is concluded that no similar activities have diffused in the region without the consideration of Carbon revenue.

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:

²⁶ <http://www.aperc.gov.in/> (Refer to links at “Existing PPA for [M/s Gouthami Power Ltd](#), [M/s GVK](#), [M/s Konaseema EPS Oak well Power Ltd](#), [M/s Vemagiri Power Generation Limited](#)”

²⁷

<http://cdm.unfccc.int/Projects/Validation/DB/82ORS4DFFAE3F7JI64VMOSYQEYXGCB/view.html>

²⁸

<http://cdm.unfccc.int/Projects/Validation/DB/R6JCKXWNYC9LJFX2PQ13OLGTQT8FNE/view.html>

²⁹

<http://cdm.unfccc.int/Projects/Validation/DB/T75O751QXNTM82IQ0KN5FUQNSRZ155/view.html>

Monitoring Methodology:

Title : “**Grid connected Electricity Generation Plants using Non-Renewable and Less GHG Intensive Fuel**”
 Reference : AM0029
 Version : 03
 Sectoral Scope : 01
 EB : 39

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

The purpose of monitoring is to calculate the GHG emission reductions (Voluntary Carbon Units) as claimed by the project activity in-line with the VCS 2007.1 guidelines. The PP has developed a monitoring plan that describes about the parameters required to be monitored to compute emission reductions, organisation structure, and procedures for data collection, storage, QA/QC and reporting of data.

Data type and Information for reporting:

- Quantity of Natural Gas combusted in the project activity for power generation in (scm).
- Net calorific value of the Natural gas used in the project activity (kCal/scm or GJ/scm)
- Gross electricity generation (GWh) by the project activity.
- Emission factor for Natural gas (tCO₂/GJ).
- Emission factor for upstream fugitive methane emissions of natural gas from production, transportation and distribution (tCH₄/GJ)

Monitoring Equipment:

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

Monitoring roles and responsibilities are defined in the Monitoring Plan in section 3.4

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

Data / Parameter:	EFBM , y
Data unit:	tCO ₂ /GWh

Description:	The Build Margin emission factor of Southern grid
Source of data used:	CEA CO ₂ Baseline Database, version 05; November 2009, (http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver5.pdf)
Value applied:	820
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is taken from the database developed by Central Electricity Authority (CO ₂ Baseline database for the Indian power sector, Version 5.0). The database is Government of India's official publication based on the 'Tool to calculate the emission factor for an electricity system'.
Any comment:	-

Data / Parameter:	EF _{OM,y}
Data unit:	tCO ₂ /GWh
Description:	The Operating Margin emission factor of Southern grid
Source of data used:	CEA CO ₂ Baseline Database, version 05; November 2009, (http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver5.pdf)
Value applied:	986.7
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is taken from the database developed by Central Electricity Authority (CO ₂ Baseline database for the Indian power sector, Version 5.0). The database is Government of India's official publication based on the 'Tool to calculate the emission factor for an electricity system'.
Any comment:	The yearly Operating Margin emission factor of southern grid is as follows (2006-07: 1.00), (2007-08: 0.99), (2008-09: 0.97) Average = 0.9867

Data / Parameter:	NCV _{Coal}
Data unit:	kCal/ kg
Description:	Net Calorific Value of Coal
Source of data used:	GCV and conversion factor (GCV to NCV) sourced from "CO ₂ Baseline Database for the Indian Power Sector, Version 5.0 issued by Central Electricity Authority, Ministry of Power, Government of India (GoI)" (http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver5.pdf)
Value applied:	3625
Justification of the choice of data or description of measurement methods and	The data used is sourced from national database prepared by GoI

procedures actually applied :	
Any comment:	--

Data / Parameter:	EF _{Coal}
Data unit:	t CO2e/TJ
Description:	Emission Factor of Coal
Source of data used:	CEA CO2 Baseline Database, version 05
Value applied:	95.8
Justification of the choice of data or description of measurement methods and procedures actually applied :	The value is taken from the database developed by Central Electricity Authority (CO2 Baseline database for the Indian power sector, Version 5.0). The database is Government of India's official publication based on the 'Tool to calculate the emission factor for an electricity system'. (http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver5.pdf)
Any comment:	-

Data / Parameter:	EF _{CM}
Data unit:	tCO2/GWh
Description:	The Combined Margin Emission factor of the Southern grid
Source of data used:	Calculated as the weighted average of the build margin emission factor and operating margin emission factor (with 50/50 weights to OM and BM)
Value applied:	903.30
Justification of the choice of data or description of measurement methods and procedures actually applied :	The values are taken from the database developed by Central Electricity Authority (CO2 Baseline database for the Indian power sector, Version 5.0). The database is Government of India's official publication based on the 'Tool to calculate the emission factor for an electricity system'. (http://www.cea.nic.in/reports/planning/cdm_co2/user_guide_ver5.pdf)
Any comment:	-

Data / Parameter:	EF _{CO2,NG}
Data unit:	tCO2/GJ
Description:	CO2 Emission Factor of Natural Gas
Source of data used:	Table 1.4, Chapter 1, Volume 2, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	0.0561
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC values are treated as national level data by the national authority
Any comment:	-

Data / Parameter:	$EF_{CO_2,diesel}$
Data unit:	tCO ₂ /TJ
Description:	CO ₂ emission factor of diesel
Source of data used:	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied:	74.1
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC Tier 1 default value used. IPCC values are treated as national level data by the national authority.
Any comment:	

Data / Parameter:	$OXID_{NG}$
Data unit:	Unit less factor
Description:	Oxidation factor of natural gas
Source of data used:	IPCC Default Value
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC values are treated as national level data by the national authority
Any comment:	-

Data / Parameter:	$OXID_{,Diesel}$
Data unit:	Unit less factor
Description:	Oxidation factor of diesel
Source of data used:	IPCC Default Value
Value applied:	1.00
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC values are treated as national level data by the national authority
Any comment:	

Data / Parameter:	$OXID_{Coal}$
Data unit:	Unit less factor
Description:	Oxidation Factor of Coal
Source of data used:	IPCC Default Value

Value applied:	0.98
Justification of the choice of data or description of measurement methods and procedures actually applied :	IPCC values are treated as national level data by the national authority
Any comment:	--

Data / Parameter:	EFBL _{upstream,CH4}
Data unit:	tCH4/ MWh
Description:	Emission factor for upstream fugitive methane emissions for baseline fuel i.e coal
Source of data used:	It's a calculated data using the formula specified in the AM0029 methodology
Value applied:	0.000769 t CH4 /MWh.
Justification of the choice of data or description of measurement methods and procedures actually applied :	Estimated from CEA data and IPCC default emissions factors for upstream methane leakage as cited in AM0029. See also Annex 4 of PDD.
Any comment:	

Ex-Post parameters

Data / Parameter:	FC _{NG,y}
Data unit:	SCM or m3
Description:	Net quantity of natural gas consumption by the project plant during the year, y
Source of data to be used:	Fuel flow meter reading at project boundary.
Value of data applied for the purpose of calculating expected emission reductions	696581761.36
Description of measurement methods and procedures to be applied:	A gas flow meter will continuously monitor the natural gas input to the power plant and the project participant will record the data on a daily basis. The data will be archived both in electronic form and in paper format. Calibration of the instrument will be as per manufacturer's standards.
QA/QC procedures to be applied:	Quantity of natural gas consumed by the project activity will be cross-checked with the invoices raised by from the fuel supplier.
Any comment:	The data will be stored for two years after the end of the crediting period or the last issuance of VCU's, whichever

	occurs later.
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Data / Parameter:	$FC_{LNG,y}$
Data unit:	SCM or m3
Description:	Net quantity of LNG consumption by the project plant during the year, y
Source of data to be used:	Fuel flow meter reading at project boundary.
Value of data applied for the purpose of calculating expected emission reductions	0
Description of measurement methods and procedures to be applied:	The flow meter will continuously monitor the LNG input to the power plant and the project participant will record the data on usage. The data will be archived both in electronic form and in paper format. Calibration of the instrument will be as per manufacturer's standards.
QA/QC procedures to be applied:	Quantity of LNG consumed by the project activity will be cross-checked with the invoices raised by from the fuel supplier.
Any comment:	The data will be stored for two years after the end of the crediting period or the last issuance of VCU's, whichever occurs later.

Data / Parameter:	$NCV_{Natural\ Gas,y}$
Data unit:	kCal/SCM or m3
Description:	Net calorific value of natural gas
Source of data to be used:	Data from fuel supplier will be used.
Value of data applied for the purpose of calculating expected emission reductions	8000.00
Description of measurement methods and procedures to be applied:	The NCV is measured by using a Gas calorimeter that is installed by the fuel supplier at their terminal. The value will be indicated in the invoices raised by the fuel supplier on the project proponent.
QA/QC procedures to be applied:	No additional QA/QC procedures are to be applied.
Any comment:	The data will be stored for two years after the end of the crediting period or the last issuance of VCU's, whichever occurs later.

Data / Parameter:	EGy
Data unit:	GWh
Description:	Electricity generation in the project plant
Source of data to be	Common Tri-vector energy meter at the plant site present

used:	in the switch yard.
Value of data applied for the purpose of calculating expected emission reductions	3313
Description of measurement methods and procedures to be applied:	Electricity supply to the grid will be monitored using Tri-vector energy meter placed at the project boundary. The digital readings will be monitored each hour and data will be recorded monthly. Accuracy of the measured data will be maintained as per PPA. Calibration of the meters will be done on an annual basis to the manufacturer’s standards.
QA/QC procedures to be applied:	The electricity output will be monitored and recorded by a computer system, at each turbine. Project participant will be responsible for this data.
Any comment:	Electricity supplied by project activity can be cross checked by electricity received by grid, metered for billing purposes. The data will be stored for two years after the end of the crediting period or the last issuance of VCU’s, whichever occurs later.

3.4 Description of the monitoring plan

A. The monitoring plan

This document serves as the Monitoring Plan (MP) for the project activity. The document presents a plan to meet the monitoring requirement for the collection, processing and reporting of data required to fulfill the requirements in decision 7/CMP.17. It describes management systems and procedures to be implemented by KGPL upon project implementation in order to ensure consistent project operation as well as monitoring, processing and reporting of data required for the calculation of emission reductions (ERs; taking into account AM0029 and the guidance presented in the Validation and Verification Manual. If necessary, the MP can be updated and adjusted to meet operational requirements, provided such modifications are approved by DOE during the process of validation and/or verification.

B. Obligations of KGPL’s VCS Manager

It is the responsibility of KGPL’s VCS Manager to develop and implement a management and operational system that meets the requirements of this MP.

C. Description of Data Required to be Monitored

The MP foresees recording of the following parameters during project operation in order to enable calculation of emission reductions from the project activity. In

tables 14.1 and 14.2 they are described in detail. The tables also show the recording frequency of each parameter as given in AM0029.

Table 14.1: Parameters to be Monitored for Calculation of Project Emissions

ID	Data variable	Source of data	Data unit	Recording frequency
FC Natural gas,v	Fuel consumption	Flow meter	m3	Daily
NCV Natural gas,y	Net calorific value	Fuel supplier(s) / transporter(s)	GJ/m3	Fortnightly

Table 14.2: Parameters to be Monitored for Calculation of Baseline Emissions

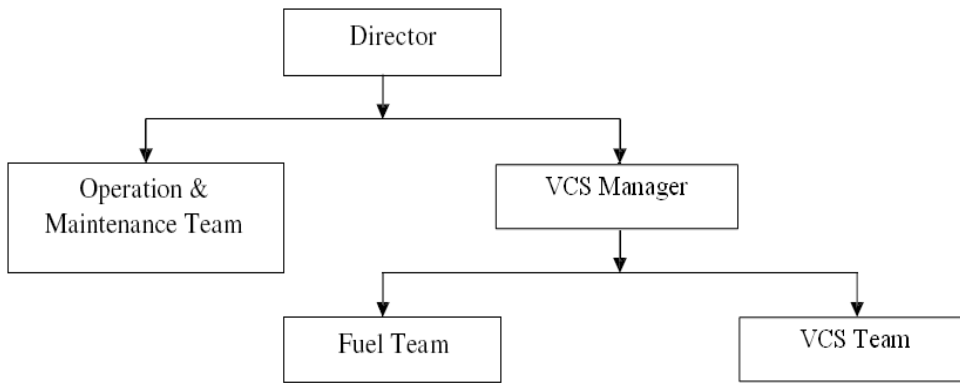
ID	Data variable	Source of data	Data Unit	Recording Frequency
EGy	Electricity generation by project activity for supply	Electricity meter	MWh	Hourly measurement, monthly recording

D. Approach used in this monitoring plan

This MP has been designed to clearly separate data collection activities and ER calculation activities. Each activity follows its own organizational structures and procedures. ER calculation will be undertaken with a standalone Excel spreadsheet and Data collection activities have been designed to derive verifiable monthly and/or yearly values from the periodic measurements undertaken for each parameter that can be easily processed in a Workbook for ER calculation.

Description of organizational structures & procedures for collection, processing, review, storage and reporting of data

E. The organization structure and responsibility matrix for this VCS project activity is as below: VCS Organization Structure:



The Director of KGPL has authorised the VCS Manager to develop the PD and the Monitoring Plan, delegating all powers in relation thereto, to the VCS Manager:

- a) Provide all information/data required for this monitoring plan
- b) Comply with all the requirements as per the Project Document and Monitoring Plan.
- c) Adherence to the laid down protocols, procedures and processes, in relation to VCS project activity, by the aforesaid O & M team, fuel team and the VCS team
- d) Refer all conflicts, discrepancies, mistakes, etc in relation to the Monitoring Plan of the VCS project activity, to the VCS manager for resolution, which resolution in this regard shall be final and binding on the aforesaid teams. The VCS team consists of VCS auditor and VCS compiler. The O&M team is headed by the Head, O & M and the Fuel team is headed by the Fuel Manager.

F. VCS Responsibility Matrix:

S.No	Designation	Responsibilities
1.	Director	Implement the organization structure. Issue office orders, authorizing the VCS Manager to implement the PD and the Monitoring plan and delegating to him all powers in relation thereto

VCS Project Description Template

2.	VCS Manager	Direct the O& M team, fuel team, VCS team in relation to conformance with PD and monitoring plan Storage of aggregated data. Coordinate with DOE during verification process. Monitor raw data in relation to Build Margin, Oxidation factor and where national institutions / AM 0029 default data are involved. Randomly check data wherever necessary to independently check the authenticity of data and take corrective actions wherever required. Resolve all conflicts in relation to VCS project activity. Calculate ER and submit them to DOE. Implement the PD and the Monitoring Plan
3.	O & M Team	Calibrate the monitoring instrument to industry standards and maintain data.
4.	VCS Auditor	Data review, Process review, Monitoring plan Report, non-conformances with PD, and VCS manager's directions
5.	VCS Compiler	Data processing and data aggregation
6.	FuelTeam	Monitor raw data as per enclosed task

Parameters		Project Emissions		Baseline Emissions
		FCN G,y	NCV NG,y	EGy
Monitoring of raw data	Responsible person at KGPL	Head O&M	Fuel Manager	Head O&M
	Data source	Flow meter	Fuel supplier(s)/transporter(s)	Electricity meters
	Frequency of data collection	Daily	Fortnightly	Hourly measurement, monthly recording
	Data format	Electronic	Electronic	Electronic
Data processing	Procedures Of maintenance and calibration of monitoring equipment	As per calibration and maintenance protocol	N/A	As per calibration and maintenance protocol
	Responsible person at KGPL	VCS Compiler	VCS	VCS Compiler
	Description of procedure	Consistency check, validation and recording	Consistency check, validation and recording	Consistency check, validation and recording
	Frequency of processing	Daily	Monthly	Daily
	Format processing	Excel	Excel	Excel
	Data storage source	Note-1	Note-2	Note-4
Data review	Responsible person at KGPL	VCS Auditor	VCS Auditor	VCS Auditor
	Description of procedure	As per data review protocol	As per data review protocol	As per data review protocol
Monthly/early aggregation of data	Responsible person at KGPL	VCS Compiler	VCS Compiler	VCS Compiler

	Description of procedure	Aggregates the daily measurement to monthly value	Aggregates the daily measurement to monthly value and saves it in electronic format	Aggr
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Note-1: Records will be kept for two years after the end of the crediting period or the last issuance of VCUs for this project activity, whichever occurs later

The electricity generation and fuel consumption by the project activity are measured by energy meter and gas flow meter respectively. Following guidelines will be followed for the i) Data Monitoring ii) Calibration and maintenance and iii) Verification of monitoring results.

i) Data Monitoring

The data that will be monitored include:

- a) Monitoring of electricity generated by the project: The electricity generated by the project will be through energy meter at the plant. The data can also be monitored and recorded at the on-site control center using a computer system.
There will be main metering system and backup metering system. The meter reading will be readily accessible for DOE. Calibration test records will be maintained for verification.
- b) Monitoring of quantity of gas combusted: Quantity of gas combusted will be monitored through gas flow meters. Detailed monitoring procedure of quantity of gas combusted by the project will be established in accordance with the agreements with the gas suppliers and gas transporter. The meter reading will be readily accessible for DOE. Calibration test records will be maintained for verification.
- c) Monitoring of NCV: The NCV of gas will be obtained from the fuel supplier.

ii) Calibration and Maintenance

The detailed calibration, testing and maintenance procedure shall be prepared by the VCS Manager as per equipment manufacturer's recommendations and the industry / national standards as applicable.

iii) Verification of Monitoring Results

The responsibilities for verification of the project are as follows:

- The VCS Manager will arrange for the verification and will prepare for the audit and verification process.
- The VCS Manager will facilitate the whole verification process by providing the DOE with all required necessary information, before, during and, in the event of queries, after verification.

Description of organizational structures & procedures for calculation of emission reductions as well as review, storage and reporting of the ER calculation results Calculation of ERs is carried out by the VCS Manager annually by utilization of an excel-based workbook whose functions are explained in detail below. The VCS Manager decides whether there is sufficient national data available to depart from the default values specified in AM0029 for the two parameters to be monitored for leakage.

The VCS Manager must retain a copy of every month's workbook. Each month's workbook must be saved on the plant server under a unique name reflecting the month for which monitoring has been carried out and hard copies of the workbook shall be printed out, signed by the VCS Manager in accordance with company procedures, and stored in the archive room. In addition, after each data entry and/or modification of the workbook, electronic copies of the workbook shall be saved under a new name, and hard copies shall be signed and stored safely. Yearly summaries are calculated based on the monthly results. The workbooks serve as a data base for the periodic reporting of ERs to the verifying DOE by the VCS Manager. After completion of the workbook, the ER results are reviewed according to the procedures laid out in the data review protocol.

Description of the workbook for emission reduction calculation

This section explains and illustrates the steps required to be performed by the VCS Manager to enable the GHG emission reductions to be calculated on an annual basis using the workbook. It presents the worksheets contained in the workbook and explains their use. The section is intended as a user manual for the workbook. The relevant formulas are displayed in the relevant worksheets for easier orientation. The electronic workbook is an Annex to the MP and an integral part thereof.

The VCS Manager is responsible for ensuring the entry of the required data shown in tables below into the electronic workbook and completion of the workbook starting with November 2008, as required by the monitoring methodology and the data input templates in the electronic workbook.

The workbook is designed with 1; Data entry and aggregation screen, and 2; Data calculation screen. The data to be entered is keyed in the data entry screen and also aggregated in the same screen where necessary. The data calculation screen has all the formulas required for the calculation as per the approved methodology and is linked to the appropriate cell of data entry screen.

The screen shots of these screen along with formula used are given below:

Organizational structures & procedures during project implementation

Before the start of the crediting period the VCS Manager will develop the following protocols whose functions are described below, based upon the organizational structures & procedures described in this MP.

Data handling protocol

The establishment of a transparent system for the collection, computation and storage of data, including adequate record keeping and data monitoring systems is required. It is the VCS Manager's responsibility with the assistance of VCS Auditor to ensure implementation of a protocol that provides for these critical functions and processes. For electronic -based and paper-based data entry and recording systems, there will be clarity in terms of the procedures and protocols

for collection and entry of data, usage of the spreadsheets and any assumptions made, so that compliance with requirements can be assessed by the DOE. Stand-by processes and systems, e.g. paper-based systems, must be outlined and used in the event of, and to provide for, the possibility of systems failures.

Training protocol

It is the VCS Manager's responsibility to ensure that the required capacity and internal training is made available to assigned staff, to enable them to undertake the tasks required by this MP. All staff involved in any of the procedures will be trained before the start of the crediting period in order to perform the tasks specified in this MP. For this purpose a training protocol will be prepared.

Calibration and maintenance protocol

It is the VCS Manager's responsibility to ensure that the calibration and maintenance procedures for all measuring instruments relevant for monitoring the parameters included in this MP are followed. A calibration and maintenance protocol will be established for this purpose which will be prepared by the VCS manager based as described above.

Data review protocol

It is the VCS Manager's responsibility to prepare a data review protocol that in case of failure of an instrument, or inconsistency of the data, enables staff to adjust the data according to the procedures outlined in this protocol. The data review protocol shall also include procedures for emergency preparedness for cases where emergencies can cause unintended emissions.

4 GHG Emission Reductions:

4.1 Explanation of methodological choice:

The approved methodology AM0029, Version 03 “Methodology for Grid Connected Electricity Generation Plants using Natural Gas” has been applied to the proposed project activity.

Project Emissions (PE_y):

The project activity consists of on-site combustion of natural gas to generate electricity. Then, CO₂ emissions from electricity generation (PE_y) are calculated as follows using Eq. (1) of AM0029

$$PE_y = FC_{f,y} \times COEF_{f,y} \tag{1}$$

Where,

FC_{f,y} = is the total volume of fuel ‘f’ natural gas and diesel (back up DG set) combusted in the Project plant (m³) in year y

COEF_{f,y} = is the CO₂ emission coefficient (tCO₂/m³) in year y for fuel f (natural gas and diesel)

The emission coefficients of natural gas and diesel are calculated as follows:

$$\text{COEF}_{f,y} = \text{NCV}_{f,y} \times \text{EFCO2}_{f,y} \times \text{OXID}_f \quad (1a)$$

Where,

$\text{NCV}_{f,y}$ = is the net calorific value of fuel ‘f’ natural gas and diesel (GJ/ m³), in year y, which is determined from the fuel supplier.

$\text{EF}_{\text{CO2},f,y}$ = is the CO₂ emission factor per unit of energy of fuel f (natural gas and diesel) in year y (tCO₂/GJ), which is taken from the IPCC data.

OXID_f = is the oxidation factor of fuel f (natural gas and diesel)

Baseline Emissions

As shown in the methodology AM0029, version 3, baseline emissions (tCO₂e/year) are given by:

$$\text{BE}_y = \text{EG}_{\text{PJ},y} \times \text{EF}_{\text{BL},\text{CO2},y} \quad (2)$$

Where,

$\text{EG}_{\text{PJ},y}$ = is the electricity generated by the power plant

$\text{EF}_{\text{BL},\text{CO2},y}$ = is the baseline carbon dioxide emission factor

According to methodology AM0029 / Version 03, there are uncertainties in the determination of an appropriate value of the baseline emission factor $\text{EF}_{\text{BL},\text{CO2}}$. The methodology states in order to address this uncertainty in a conservative manner, project participants shall use for $\text{EF}_{\text{BL},\text{CO2},y}$ 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” and calculated as follows:

$$\text{EF}_{\text{BL},\text{CO2}} \text{ (tCO2/MWh)} = \text{COEF}_{\text{BL}} / \eta_{\text{BL}} \times 3.6 \text{ GJ/MWh} \quad (3)$$

Where,

COEF_{BL} = the fuel emission coefficient (tCO₂e/GJ), based on national average fuel data, if available, otherwise IPCC defaults can be used

η_{BL} = the energy efficiency of the technology,

as estimated in the baseline scenario analysis in the above section

Values of ‘build margin’ and ‘combined margin’ considered in Options 1 and 2 are taken from ‘**CO2 Baseline Database for the Indian Power Sector**’. The values are calculated as per procedures prescribed in the “Tool to calculate emission factor for an electricity system” by Central Electricity Authority (CEA). The database is an official publication of the Government of India for the purpose of CDM Baselines and is based on the most recent data available with CEA.

As described in earlier section, the coal-based sub critical power plant has been identified as the economically most attractive baseline. Eq. (3) then becomes

$$EF_{\text{coal,CO}_2}(\text{tCO}_2/\text{MWh}) = \text{COEF}/\eta_{\text{BL}} \times 3.6\text{GJ}/\text{MWh} \quad (3a)$$

The emission coefficient $\text{COEF}_{\text{coal}}$ can be calculated using an equation analogous to Eq (1a) above, but applied to coal:

$$\text{COEF}_{\text{coal,y}} = \text{NCV}_{\text{coal,y}} \times \text{EFCO}_2_{\text{coal,y}} \times \text{OXID}_{\text{coal}} \quad (3b)$$

Where,

$\text{NCV}_{\text{coal,y}}$ = is the net calorific value (energy content) per mass of coal

$\text{EFCO}_2_{\text{coal,y}}$ = is the CO2 emission factor per unit of energy of coal

$\text{OXID}_{\text{coal}}$ = is the oxidation factor of coal

Central Electricity Authority (CEA) values of NCV_i and $\text{EFCO}_2_{,i}$ are used.

Leakage

Leakage may result from fuel extraction, processing, liquefaction, transportation, regasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH₄ emissions and CO₂ emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered:

- Fugitive CH₄ emissions associated with fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity.
- In the case LNG is used in the project plant: CO₂ emissions from fuel combustion/electricity consumption associated with the liquefaction, transportation, re-gasification and compression into a natural gas transmission or distribution system.

Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{\text{CH}_4,y} + LE_{\text{LNG,CO}_2,y} \quad (4)$$

Where,

- LE_y = Leakage emissions during the year y in tCO_{2e}
- $LE_{CH_4,y}$ = Leakage emissions due to fugitive upstream CH₄ emissions in the year y in tCO_{2e}
- $LE_{LNG,CO_2,y}$ = Leakage emissions due to fossil fuel Combustion / electricity consumption associated with liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_{2e}.

Fugitive Methane Emissions ($LE_{CH_4,y}$)

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

$$LE_{CH_4,y} = [FC_y \times NCV_y \times EF_{NG,upstream,CH_4} - EG_{PJ,y} \times EF_{BL,upstream,CH_4}] \times GWP_{CH_4} \quad (5)$$

Where,

- $LE_{CH_4,y}$ = Leakage emissions due to fugitive upstream CH₄ emissions in the year y in tCO_{2e}
- FC_y = Quantity of natural gas combusted in the project plant during the year y in m³
- NCV_y = Average net calorific value of the natural gas combusted during the year y in GJ/m³
- $EF_{NG,upstream,CH_4}$ = Emission factor for upstream fugitive methane 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 tCH₄ per GJ of fuel supplied to final consumers
- $EG_{PJ,y}$ = Electricity generation in the project plant during the year y in GWh.
- $EF_{BL,upstream,CH_4}$ = Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH₄ per GWh electricity generation in the project plant, as defined below
- GWP_{CH_4} = Global warming potential of methane valid for the relevant commitment period

As per the applicable methodology, the emission factor for upstream fugitive CH₄ emissions occurring in the absence of the project activity $EF_{BL,upstream,CH_4}$ should be calculated consistent with the baseline emission factor (EF_{BL, CO_2}) used in equation (2) above. Since the option 1 ‘build

margin' approach is used to calculate the emission factor (EF BL, CO2), the EF_{BL,upstream,CH4} is found using the following equation and it will be determined ex-post.

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

EF_{BL,upstream,CH4} = Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in t CH4 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 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 type) in t CH4 per MJ fuel produced

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

CO2 emissions from LNG

Project activity does not involve LNG, so LELNG,CO2,y is considered as 'zero' but, in case if LNG is used in future then leakage due to that will be accounted for using the equation 6

$$LE_{LNG,CO2,y} = FC_y * EF_{CO2,upstream,LNG} \quad (6)$$

Where:

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 t CO2e

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

EF_{CO2,upstream,LNG} = Emission factor for upstream CO2 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

In the absence of the reliable and accurate EFCO_{2,upstream,LNG} data, the default value of 6t CO₂/TJ provided by the methodology will be used.

Presently leakage due to CH₄ fugitive upstream emissions is only accounted for. Then Eq. (4) becomes:

$$LE_y = LE_{CH_4} \quad (4a)$$

Emission Reductions

To calculate the emission reductions the project participant shall apply the following equation:

$$ER_y = BE_y - PE_y - LE_y \quad (7)$$

Where,

- ER_y = emissions reductions in year y (tCO₂e)
- BE_y = emissions in the baseline scenario in year y (tCO₂e)
- PE_y = emissions in the project scenario in year y (tCO₂e)
- LE_y = leakage in year y (tCO₂e)

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

Emission factors are calculated for all the three options:-

Option 1) Build margin

The value is taken from the ‘CO₂ Baseline Database for the Indian Power Sector’ version 5 for the year 2008-09.

$$= 820 \text{ tCO}_2\text{e/GWh}$$

Option 2) Combined margin

The combined margin is a calculated value with a 50/50 OM/BM weights. The Operating Margin (OM) and the Build Margin (BM) values are taken from the ‘CO₂ Baseline Database for the Indian Power Sector’ version 5 for the year 2008-09. The Operating margin is fixed ex-ante and is taken as the average of the recent three years data given by the CEA at the time of PD submission.

Year	Operating margin
2006-2007	1000 tCO ₂ e/GWh
2007-2008	990 tCO ₂ e/GWh

2008-2009	970 tCO ₂ e/GWh
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Therefore the operating margin is calculated to be

$$= (1000+990+970)/3$$

$$= 986.7 \text{ tCO}_2/\text{GWh}$$

And the combined margin is estimated as

$$= (0.5*986.7) + (0.5*820)$$

$$= \mathbf{903.3 \text{ tCO}_2/\text{GWh}}$$

Option 3) Emission factor of the identified baseline power plant

As described in section B.4, the coal-based sub critical power plant has been identified as the economically most attractive baseline. Eq. (3) then becomes

$$EF_{\text{coal},\text{CO}_2}(\text{tCO}_2/\text{MWh}) = \text{COEF}/\eta_{\text{BL}} \times 3.6\text{GJ}/\text{MWh} \quad (3a)$$

The emission coefficient COEF_{coal} is calculated using an equation analogous to Eq (1a) above, but applied to coal:

$$\text{COEF}_{\text{coal},y} = \text{NCV}_{\text{coal},y} \times \text{EF}_{\text{CO}_2,\text{coal},y} \times \text{OXID}_{\text{coal}} \quad (3b)$$

Where,

$$\begin{aligned} \text{NCV}_{\text{coal},y} &= \text{is the net calorific value (energy content) per mass of coal} \\ &= 3624.52 \text{ kCal/kg} \\ \text{EF}_{\text{CO}_2,\text{coal},y} &= \text{is the CO}_2 \text{ emission factor per unit of energy of coal} \\ &= 95.80 \text{ t CO}_2/\text{TJ} \\ \text{OXID}_{\text{coal}} &= \text{is the oxidation factor of coal} \\ &= 0.98 \\ \text{COEF}_{\text{coal},y} &= \mathbf{0.093883 \text{ tCO}_2\text{e}/\text{GJ}} \end{aligned}$$

$$\begin{aligned} \text{EF}_{\text{coal},\text{CO}_2}(\text{tCO}_2/\text{MWh}) &= (0.093883/32.8\%) * 3.6 * 1000 \\ &= \mathbf{1030.43 \text{ tCO}_2/\text{GWh}} \end{aligned}$$

The minimum value among the three options is the build margin emission factor, i.e. EF_{grid, BM,y} = 820 tCO₂/GWh, which is considered as the baseline emission factor.

Baseline Emissions

As shown in the methodology AM0029, version 3, baseline emissions (tCO₂e/year) are given by:

$$\text{BE}_y = \text{EGPJ},y \times \text{EFBL},\text{CO}_2,y$$

Where,

$$\begin{aligned} \text{EGPJ},y &= \text{is the electricity generated by the power plant} \\ \text{EFBL},\text{CO}_2,y &= \text{is the baseline carbon dioxide emission factor} \\ &= 3313 * 820 \end{aligned}$$

$$= \mathbf{2717045 \text{ t CO}_2\text{e}}$$

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

Project Emissions (PE_y):

$$PE_y = FC_{f,y} \times COEF_{f,y}$$

Where,

$$FC_{f,y} = \begin{array}{l} \text{is the total volume of natural gas} \\ \text{combusted in the Project plant (m}^3\text{) in year y} \\ = 696581761.36 \text{ m}^3 \end{array}$$

$$COEF_{f,y} = \begin{array}{l} \text{is the CO}_2\text{ emission coefficient} \\ \text{(tCO}_2\text{/m}^3\text{) in year y for natural gas} \end{array}$$

The emission coefficient of natural gas is calculated as follows:

$$COEF_{f,y} = NCV_{f,y} \times EFCO_{2,f,y} \times OXID_f$$

Where,

$$NCV_{f,y} = \begin{array}{l} \text{is the net calorific value of} \\ \text{natural gas (GJ/ m}^3\text{), in year y, which is determined} \\ \text{from the fuel supplier.} \\ = 0.033488 \text{ GJ/ m}^3 \end{array}$$

$$EFCO_{2,f,y} = \begin{array}{l} \text{is the CO}_2\text{ emission factor per unit of energy natural} \\ \text{gas in year y (tCO}_2\text{/GJ), which is taken from the IPCC} \\ \text{data.} \\ = 0.0543 \text{ tCO}_2\text{/GJ} \end{array}$$

$$OXID_f = \begin{array}{l} \text{is the oxidation factor of natural} \\ \text{gas} \\ = 1 \end{array}$$

$$COEF_{f,y} = 0.033488 * 0.0543 * 1$$

$$= 0.00181840 \text{ tCO}_2\text{/m}^3$$

$$PE_y = 0.00181840 * 696581761.36$$

$$= \mathbf{1266663 \text{ t CO}_2}$$

Leakage

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

Where,

$$LE_y = \begin{array}{l} \text{Leakage emissions during the year y} \\ \text{in tCO}_2\text{e.} \end{array}$$

$$LE_{CH_4,y} = \begin{array}{l} \text{Leakage emissions due to} \\ \text{fugitive upstream CH}_4\text{ emissions in the year y in tCO}_2\text{e} \\ = 91525.27 \end{array}$$

$$LE_{LNG,CO_2,y} = \begin{array}{l} \text{Leakage emissions due to fossil fuel} \\ \text{combustion/electricity consumption associated with} \\ \text{liquefaction, transportation, re-gasification and} \end{array}$$

compression of LNG into a natural gas transmission or distribution system during the year y in t CO₂e.

$$= 0$$

$$= 91525.27 + 0$$

$$= 91525.27 \text{ t CO}_2 \text{ e}$$

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

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation of overall emission reductions (tonnes of CO ₂ e)
2009	1266663	2717045	91525	1358857
2010	1266663	2717045	91525	1358857
2011	1266663	2717045	91525	1358857
2012	1266663	2717045	91525	1358857
2013	1266663	2717045	91525	1358857
2014	1266663	2717045	91525	1358857
2015	1266663	2717045	91525	1358857
2016	1266663	2717045	91525	1358857
2017	1266663	2717045	91525	1358857
2018	1266663	2717045	91525	1358857
Total (tonnes of CO₂e)	12666630	27170450	915250	13588570

5 Environmental Impact:

In order to obtain the required clearance from the Ministry of Environment & Forest (MoEF), Government of India (GoI), Rapid Environmental Impact Assessment (REIA) Report is a statutory prerequisite. Thus, the REIA study is aimed at predicting the possible environmental impacts due to construction and operation of the project, suggesting environmental remedies/safeguards and formulating an effective Environmental Mitigation Plan to ensure an environmentally sustainable development.

The major environmental disciplines studied include geology, soils, surface & ground water hydrology, meteorology, land use, surface & ground water quality, air quality, terrestrial & aquatic ecology, demography & socio economics and noise.

REIA was conducted for the project by M/s Pioneer Enviro-Laboratories & Consultants Private Ltd.

A network of 7 ambient air quality monitoring stations was selected to analyse the ambient air quality. The results obtained are:

Table 17: Ambient Air Study Results

Parameter	Minimum Level (µg/m³)	Maximum Level (µg/m³)
RPM	11	82
SPM	59	260
NO _x	5.0	20.0
SO ₂	4.0	13.0
CO	225	975

According to the 7 no. of noise sampling stations, the day-night noise level was measured to be ranging from 40.65 dBA to 56.04 dBA.

Similarly, water samples from 7 points from dug well/bore well were collected and analyzed for various parameters. Three surface water samples were also analyzed.

Air Environment:

The height of each HRSG stack proposed is 60 m and that of bypass stack is 30 m for effective dispersion of pollutants. As per the designed parameters, the net concentration of the gases will be below the national ambient air quality standard (NAAQS). Hence, no significant impacts on air quality due to the project activity implementation are envisaged.

Water Environment:

The effluent generated from the power plant will be treated in the ETP and re-used within the plant premises and the remaining will be discharged into the drain situated on the southern boundary of the project site. The steam turbine is a condensing turbine; hence, there is very little water effluent. Hence, there will not be any impact on surface/ground water within the study area of the power plant.

Noise:

Adequate measures will be taken for 'noise control' apart from the extensive greenbelt existing in the power plant.

Solid Waste:

The solid waste generation from the effluent treatment plant will be sent to the landfill for further treatment.

Emergency Preparedness:

- Adequate safety measures will be taken up to tackle emergency.

- No significant impacts have been identified in the REIA study.
- REIA report is available for reference during validation by the Designated Operational Entity (DOE)

REIA study did not indicate any significant environmental impacts. However, mitigative measures have been taken up for lesser impacts, as per details provided in the above section. Regular monitoring of all significant environmental parameters is essential to check the compliance status vis-à-vis the environmental laws and regulations. The objectives of the monitoring will be as follows:

- To verify the results of the impact assessment study with respect to the proposed project.
- To study the trend of ‘concentration values’ of the parameters, which have been identified as critical and for which mitigative measures are planned.
- To check and assess the efficiency of pollution control equipment.
- To ensure that any additional parameters, other than those identified in the impact, do not become critical after the commissioning of the project activity.

All necessary steps will be taken to monitor the efficiency of pollution control equipment on regular basis. Regular monitoring and vigilance of the surrounding environmental quality will be done. All necessary stipulations and legal requirements of Andhra Pradesh Pollution Control Board (APCB), MoEF; will be fully complied.

KGPL has prepared a Environment Management Plan (EMP) to ensure mitigating measures for all kind of environmental issues. The EMP is a part of Rapid Environment Impact Assessment (REIA). The EMP aims at controlling pollution at the source level to the possible extent with the available and affordable technology followed by treatment measures before they are discharged.

EMP aims at the preservation of the ecosystem by considering the pollution abatement facilities at the plant inception. In the project power plant, pollution abatement has become an integral part of planning and design along with techno economic factor.

Table 18: Various Monitoring parameters

S.No	Particulars	Monitoring Frequency	Monitoring Parameters
1.0	Water and water quality		
1.1	Sanitary Effluent/Industrial Effluents	Monthly	pH, TDS, BOD
1.2	Ground water Quality		pH, TDS
2.0	Air Quality		
2.1	Stack monitoring		NO _x
2.2	Ambient Air Quality Monitoring at project site & other sampling location given		NO _x

3.0	Noise level at GT, ST, HRSG and Compressor	Bi- Monthly	Noise Level in dBA
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6 Stakeholders comments:

Project participant identified local communities as the most important stakeholders of interest in the proposed project activity. Project participant has sent invitation letters in the regional language (Telugu) to representatives of various stakeholders' groups with a brief on 'agenda of the meeting' well in advance. Subsequently the Stake Holder's Meeting (SHM) was carried out on 10th October 2006 at the plant premises, Devarapalli (V) Ravulapalem (M), East Godavari District.

Villagers from the vicinity also showed their interest in the project and related social & environmental development activities. The agenda of the meeting were as follow:

- Welcome the gathering
- Kyoto protocol
- Description of the project details and how it mitigates the climate change
- Question and Answer session
- Vote of thanks

The 'Minutes of Meeting' and attendance sheet of the SHM are available for validation.

Table 19: Name and details of stakeholder attended the meeting

Name	Details
Mrs. APPARI SURYA KUMARI	Sarpanch, Devarapalli (Village)
Mr. APPARI SURYA KUMAR	Member Ex-ZPTC, Devarapalli (Village)
Mrs. MOORKONDA VIMALA JYOTHI	Vice-President, Devarapalli (Village)
Mr. MOORKONDA NAGA BABU	Devarapalli (Village)
Mr. GUDALA VEERA VENKATA SATYANARAYANA	Member RIPTC, Devarapalli (Village)
Mr. MADHURAPANTULA SATYANARAVANA MURTHY	Kothapeta
Mr. M.V.V.S. PRASAD	Advocate, Kothapeta.
Mr. KOTHA V.V.N. KRISHNA MURTHY	Vedireswararn (Village)
Mr. P. RAMESH RAJU	Vedireswarm (Village)
Mr. VANAPALLI SRINIVASARAO	Timber Merchant, Ravulapalem

After the detailed description about the project activity, its impacts on the climate change and how it would help the local region, the chairperson presided the

Question and Answer (Q&A) session. The stakeholders were appreciative of the project coming up in their region and welcomed the green development initiatives by the PP viz increasing the greeneries and other community development programs.

Few stakeholders' requested the PP to continue the policy of engaging local people, wherever possible for the project activity's works as this would enhance the employment opportunity in the region

7 Schedule:

The project schedule as per VCS guidelines is tabulated in table below:

<i>Parameter</i>	<i>Date/period</i>
Initiation of project	12/07/2004
Commissioning date	04/06/2009
Project lifetime	20 years
VCS PD completion	November 2010
Begin VCS Validation	November 2010
Monitoring frequency	Once every month
Project termination	2029

8 Ownership:

8.1 Proof of Title:

For the ownership details of the project any of the following may be referred to:

1. Power Purchase Agreement (PPA) between State Electricity Board (APSEB) and PP
2. C.O.D Letter

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

The project does not participate in any other emission trading program for the proposed verification term.

Annex 1

Calculation of Fugitive Methane Emissions and Leakage Emissions Factor

According to AM0029, version 3, “Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary.”

Leakage emissions are calculated using the following equation:-

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

Where,

LE_y = Leakage emissions during the year y in tCO_2e

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

$LE_{LNG,CO_2,y}$ = Leakage emissions due to fossil fuel combustion/electricity consumption associated with 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 ($LE_{CH_4,y}$)

$$LE_{CH_4,y} = [FC_y \times NCV_y \times EF_{NG,upstream,CH_4} - EG_{PJ,y} \times EF_{BL,upstream,CH_4}] \times GWP_{CH_4}$$

As per the applicable methodology, the emission factor for upstream fugitive CH_4 emissions occurring in the absence of the project activity $EF_{BL,upstream,CH_4}$ should be calculated consistent with the baseline emission factor (EF_{BL,CO_2}) used in equation (2). Since the option 1 ‘build margin’ approach is used to calculate the emission factor (EF_{BL,CO_2}), the $EF_{BL,upstream,CH_4}$ is found using the following equation and it will be determined ex-post.

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

$EF_{BL,upstream,CH_4}$ = Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH_4 per MWh electricity generation in the project plant

j = Plants included in the build margin

$FF_{j,k1}$ = Quantity of fuel type $k1$ (coal + lignite) combusted in power plant j included in the

build margin
= 14486885 tonnes/year

EF_{k1,upstream,CH4} = Emission factor for upstream fugitive methane emissions from production of the fuel type k (a coal type) in t CH₄ per kilo tonne of fuel produced
= 0.8 t CH₄ per kt

FF_{j,k2} = Quantity of fuel type k2 (natural gas) combusted in power plant j included in the build margin
= 959974979 m³/year

EF_{k2,upstream,CH4} = Emission factor for upstream fugitive methane emissions from production of the fuel type k2 (natural gas) in t CH₄ per PJ of fuel produced
= 296 t CH₄ per PJ

EG_j = Electricity generation in all the plants' j' included in the build margin in MWh/a
= 28700153 MWh

EF_{BL,upstream,CH4} = $(14486885 \cdot 0.8) + (959974979 \cdot 8800 \cdot 296) / 28700153$
= 0.000769 t CH₄ / MWh

Justification of the values taken in the calculations above:

National level data on fugitive emission factor for the fuels considered are not available; hence the default values given by the Meth are taken.

Coal

Coal production in India is done by Coal India Ltd (CIL) through its subsidiaries and by Singareni Collieries Company Limited (SCCL). Open-case or surface mining forms nearly 90% of coal production methods in both CIL and SCCL and this is evident from the link <http://www.coal.nic.in/cpdanx.htm#Annexure-IV>. Therefore coal surface mining value of 0.8 tCH₄/ktonne of coal from Table 2 of the methodology is taken as the fugitive CH₄emissions factor value.

Lignite

Neither IPCC nor AM0029 specifies an emission factor for lignite, therefore the conservative value corresponding to open coal mining i.e 0.8 tCH₄/ktonne of lignite is taken for calculation. Moreover lignite is also produced by surface mining method and this can be verified from Neyveli Lignite Corporation's (NLC) website, the leading producer of lignite in India: http://www.nlcindia.com/about/about_01b.htm.

Natural gas

We use the same fugitive emissions factor as in the project case, i.e 296 tCH₄/PJ (rest of the world data)

Note that net calorific value is used in each case, and for some fuels a conversion is needed from gross calorific value and “Delta GCV-NCV” both provided by the official Central Electricity Authority database used for determination of the CO₂ emissions factor of the grid.

$$LECH_4, y = [FC_y \times NCV_y \times EF_{NG, upstream, CH_4} - EG_{PJ, y} \times EF_{BL, upstream, CH_4}] \times GW_{PCH_4}$$

- FC_y = Quantity of natural gas combusted in the project plant during the year y in m³
= 696581761.36 m³
- NCV_y = Average net calorific value of the natural gas combusted during the year y in GJ/m³
= 0.033488000 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 tCH₄ per GJ of fuel supplied to final consumers
= 0.00030 tCH₄ per GJ
- EG_{PJ, y} = Electricity generation in the project plant during the year y in MWh
= 3313470 MWh
- EF_{BL, upstream, CH₄} = Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in tCH₄ per GWh electricity generation in the project plant
= 0.000769 t CH₄ / MWh
- GW_{PCH₄} = Global warming potential of methane valid for the relevant commitment period
= 21

$$LECH_4, y = ((696581761.36 * 0.033488000 * 0.00030) - (3313470 * 0.000769)) * 21$$

$$LECH_4, y = 91525.27 \text{ tCO}_2\text{e}$$

CO₂ emissions from LNG

In case if LNG is used in future then leakage due to that will be accounted for using the equation 6

$$LE_{LNG, CO_2, y} = FC_y * EF_{CO_2, upstream, LNG} \tag{6}$$

Where:

$LE_{LNG,CO_2,y}$ = 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 t CO₂e

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

$EF_{CO_2,upstream,LNG}$ = Emission factor for upstream CO₂ 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

In the absence of the reliable and accurate $EF_{CO_2,upstream,LNG}$ data, the default value of 6t CO₂/TJ provided by the methodology will be used.

$LE_{LNG,CO_2,y}$ is considered as ZERO since LNG is not utilised in the project activity.

There fore,

$$\begin{aligned} LE_y &= LE_{CH_4,y} + LE_{LNG,CO_2,y} \\ &= 91525.27 + 0 \\ &= 91525.27 \mathbf{tCO_2e} \end{aligned}$$