CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
VERSION 03 - IN EFFECT AS OF: 28 JULY 2006

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Annexes

Appendices

SECTION A. General description of project activity

A.1. Title of the project activity:

>> "Grid Connected Gas based Combined Cycle Power Project in Andhra Pradesh."
Version 0~~5~~4
Dated: ~~02/11/2012~~21/01/2013

A.2. Description of the project activity:

>>

Purpose of the project activity

The scope of the project activity involves implementation and operation of a new natural gas fired grid-connected Combined Cycle Power Plant (CCPP) of 2*371 MW capacity at Kondapalli near Vijayawada, Andhra Pradesh by Lanco Kondapalli Power Limited (LKPL).

The proposed CCPP will operate on Brayton Cycle (Compressor & Gas Turbine) at top and Rankine Cycle (Heat Recovery Steam Generator & Steam Turbine) at bottom. The project employs state of the art technology with estimated project life of 20 years.

The project will comprise of the following major equipments:

- Two advanced class, heavy duty, Gas turbine generators with a nominal output of about 241 MW capacity each at site condition and with each having a Gas turbine Inlet air-cooling system..
- Two Heat Recovery, natural circulation, three pressure vertical type Steam Generator.
- Two Steam Turbine Generators of around 130 MW capacity each (@ 30 deg C, 60% RH), which is multistage, intermediate injection, condensing type.

The project activity is designed to use natural gas as fuel for power generation. LKPL has not yet finalized the Gas Supply Agreement (GSA) and Gas Transportation Agreement (GTA) for this project. However, LKPL is likely to source the natural gas from Reliance Industries Limited (RIL) and gas is likely to be transported through Reliance Gas Transportation Infrastructure Limited (RGTIL). This natural gas will be sourced from the Krishna Godavari basin of Reliance Industries Limited (RIL).

The power generated from the proposed power plant will be delivered to the existing substation of Power Grid Corporation of India Limited (PGCIL) at Nunna through existing 400kV double circuit transmission lines. The power generated would be stepped up to 400 kV level by using 15/420 kV generator transformers. A 400 kV Gas Insulated Switchgear (GIS) type substation, which is available at the site, will be used for this process. The power generated from the project activity will be sold on merchant basis to the state utilities in Southern, Western & Northern India.

The pre project scenario

The project activity is a new grid connected power plant. Hence the pre-project scenario will include generation of power from existing or proposed new power plants connected to the Southern regional grid. Alternatives to the project activity include power generation based on domestic coal, imported coal; lignite; natural gas, naphtha, nuclear energy; renewable sources of energy (like wind, hydro). The other alternatives included capacity additions to existing power plants in the region or establishing new inter-connections with the other regional grid. All these alternatives have been discussed in detail in section B.4 of the PDD.

Baseline Scenario

In accordance with the approved baseline methodology AM0029, version – 03 (based on approach 48b of the CDM modalities and procedures) baseline has been established considering "emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment". In line with this approach a detailed investment comparison analysis has been carried out in section B.4 of this document considering the levelised cost of generation as the most suitable financial indicator.

In the present context it has been established that a new coal based power station using subcritical technology would be the economically most attractive alternative to the project activity and hence the most plausible baseline scenario. The details on technology, efficiency, operating lifetime for various fuel/ technology options have been discussed in detail in Section B.4.

Reduction of greenhouse gas emissions

The project activity involves power generation from the grid connected (Southern Regional Grid) gas based Combined Cycle Power Plant (CCPP). The technology employed in the project activity has been discussed in section A.4.3 of this document.

The carbon intensity of the present project activity would be lower than the southern regional grid (as per Build Margin & Combined Margin) and the coal based power station using sub-critical technology, which has been identified as the most plausible baseline option. Hence the project activity reduces CO_2 emission by way of avoiding power generation from relatively higher carbon intensive sources.

The approved baseline methodology AM0029, version – 03 recommends the lowest emission factor amongst three options to be considered for ascertaining the emission reductions due to the project activity (details are available in section B.6.1); the Build Margin was determined as the baseline emission factor.

In the context of the present project activity the build margin emission factor has been found to be the most conservative. Hence the build margin emission factor has been considered towards determining the emission reduction due to the present project activity. It has been discussed in detail in section B.6.1 of this document.

The description of the sources of greenhouse gases included in or excluded from the project boundary has been discussed in section B.3 of this document.

Views of the project participant on contribution of the project activity to sustainable development

The contribution of this project activity towards sustainable development as per the four indicators prescribed by The National CDM Authority ("**NCDMA"**) in India i.e., Ministry of Environment and Forests ("**MoEF**") is presented below.

Social well being:

- The project activity has generated employment for the local population during the construction as well as operational phases of the project activity, both direct and indirect.
- It has also provided an opportunity for secondary small scale entrepreneurs' development near the project site, such as small shops, etc. Overall, there has been employment creation as a result of the project activity.

Economic well being:

- By creating employment in the area, as described above, the project activity has brought in economic improvement for the local population.
- If the project activity is registered as a CDM project, then by way of generating Certified Emission Reductions ("**CERs**") and through transaction of such CERs with Annex I Parties, the project activity would bring in additional revenue to India.

Environmental well being:

- The project activity avoids use of any other fossil fuels., and thus reduces emissions of GHGs, oxides of sulphur and nitrogen, particulate matters and unburned carbon, fly ash (in case of coal and lignite), etc.

Technological well being:

- The project activity is a natural gas based combined cycle power plant and would result in improved power generation efficiency as compared to an open cycle or coal or lignite based thermal power plant of similar capacity.

The project proponent will contribute 2% of the revenue realized from sale of certified emission reduction arising from the candidate CDM project towards sustainable development including initiatives towards society / community development.

LKPL is aware about the DNA guideline and a formal undertaking is being submitted separately.

A.3. Project participants:

>>

Name of Party involved ((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
India (host)	Private Entity: Lanco Kondapalli Power Limited.	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

>> Village – Kondapalli, District – Krishna, Andhra Pradesh, India

A.4.1.1. Host Party(ies):

>> India

A.4.1.2. Region/State/Province etc.:

>> Andhra Pradesh

A.4.1.3. City/Town/Community etc.:

>> Village – Kondapalli, District – Krishna

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

>> The proposed power project will be located in the existing location of phase II which is at Kondapalli, Krishna District, Andhra Pradesh. The existing plant is adjacent to State highway connecting Kondapalli and Mylavaram. Kondapalli railway station is approximately 1km from the site and the nearest Airport is at Gannavaram at about 35 kilometres from the plant. The proposed project site is at a latitude of 16.641694°N and at a longitude of 80.551481°E.
The location details are presented in **Appendix 1** of this document.

A.4.2. Category(ies) of project activity:

>> As per the scope of the project activity listed in the "List of Sectoral scopes" (Document CDM-ACCR-06 version 04)', the project activity will principally fall in Scope Number 1, Sectoral scope – energy industries (renewable/ non-renewable sources) being a Grid-connected electricity generating project using non-renewable fuel in energy industries.

A.4.3. Technology to be employed by the project activity:

>> The project activity construction and operation of a new natural gas fired grid-connected electricity generation plant.

Pre-project scenario:
Since the project activity is a new grid connected (Southern Region) power plant, the pre-project scenario includes generation of power from existing or proposed new power plants connected to the Southern regional grid or import of electricity from connected grids, including the possibility of new interconnections.

Project activity:
The scope of the project activity involves implementation and operation of a new natural gas fired grid-connected Combined Cycle Power Plant (CCPP). The project proposes to employ state of the art technology with estimated project life of 20 years. There is no technology transfer in this project activity. The table below provides the details of main equipment of the power plant:

S.No	Equipment	Specifications	Special Features
1.	GTG (2 nos)	Make : GE, USA GTG is of advanced class industrial heavy-duty type (Model 9FA) with dry low NO_x technology capable of operating in combined cycle mode, Nominal output capacity: 241 MW (per unit) at site conditions	Low NO_x technology along with state of the art cooling. Thermal efficiency close to 53 – 58% (LHV)
2.	STG (2 nos.)	Make: Harbin, China One steam turbine generator of output capacity 130 MW (per unit) at site condition (	• Multistage, intermediate injection, condensing type steam turbine. • State of the art DCS control system
3.	HRSG (2 Nos)	Make: : Thermax , India Capacity: : HP/IP/LP Flow 282.79/ 42/34.26 TPH; temperature 567.3/567/286.6 DegC ; pressure 98.47/22.4/3.1 Bar	Horizontal flue gas flow and natural circulation. HRSGs are designed with three pressure stages to improve thermal efficiency, against conventional two pressure

			stages for similar application. State of the art DCS control system.

In addition to the main plant equipment, auxiliary cooling water system, condenser cooling water system, electrical systems, evacuation of power, etc., are also parts of the power project. Also included are features for addressing environmental aspects and safety in operation and maintenance of the power project.

The power generated from the proposed power plant will be delivered to the existing Nunna substation of Power Grid Corporation of India Limited (PGCIL) at Kondapalli through existing 400kV double circuit transmission lines. The power generated would be stepped up to 400 kV level by using 15/420 kV generator transformers. A 400 kV Gas Insulated Switchgear (GIS) type substation, which is available at the site, will be used for this process.

The necessary transmission lines for this purpose have already been installed by LKPL. The GTG is connected to the bus in the switchyard through a generator transformer that steps up voltage from 15 kV to 400 kV, provided with off load tap changers on the high voltage side. The STG is connected to the switchyard through a generator transformer that steps up voltage of 13.8 kV to 420 kV.

The project activity is designed to use natural gas as fuel for power generation. NG used as fuel for the project in future may be a combination of NG and Re-gassified- Liquid Natural Gas ("R-LNG"). Further, the gas allocation has not yet completed for the project activity. LKPL is likely to source the gas from RIL.

The green house gases emitted from project activity would include CO2 emissions due to on-site fuel combustion; CO2 and CH4 emissions due to Transportation of fuel to project site (inside the project boundary). The CO2 emissions due to Processing and transportation of fuel outside the project boundary are being accounted for as leakage emissions.

Baseline scenario:

Since the project activity is a new grid connected (Southern Region) power plant, the baseline scenario will include generation of power from existing or proposed new power plants connected to the southern regional grid or import of electricity from connected grids, including the possibility of new interconnections.

The applied baseline methodology AM0029 version 03 is based on the approach 48 (b) of CDM modalities and procedures "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment" for determining the baseline scenario. Based on this, all the plausible baseline scenarios were evaluated based on investment comparison analysis using levelized cost of generation as a parameter for identifying the "economically most attractive baseline scenario alternative". In case of the subject project activity, newpower plant (s) based on coal using sub-critical technology has been established as the economically the most attractive option

The details on technology, efficiency, operating lifetime for various fuel/ technology options have been discussed in detail in Section B.4.

The green house gases in the baseline scenario (coal based power plant using sub-critical technology) would emit higher CO2.

A.4.4. Estimated amount of emission reductions over the chosen crediting period:

>> The estimated emission reductions over the 10 year fixed crediting period (2012 – 2022) would be**13,875,550 tCO_2e** as per details on annual emission reductions provided below.

Years	**Annual estimation of emission reduction (tCO_{2e})**
2013	1,387,555
2014	1,387,555
2015	1,387,555
2016	1,391,357
2017	1,387,555
2018	1,387,555
2019	1,387,555
2020	1,391,357
2021	1,387,555
2022	1,387,555
Total estimated reductions (tCO_{2e})	13,883,154
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tCO_{2e})	1,388,315

A.4.5. Public funding of the project activity:

>> There is no ODA involved in development of the proposed CDM project activity.

SECTION B. Application of a baseline and monitoring methodology

B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:

>> Approved baseline methodology AM0029 (version 03EB39) has been used to determine the baseline emissions and emission reduction due to the project activity. The title of this baseline methodology is **"Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas"**.

The reference for this methodology is available on http://cdm.unfccc.int.

The project activity also refers to the "Tools to calculate the emission factor for an electricity system" (Version 2.2.1, EB 63; Annex-19).

The project activity also refers to the "Tool for the demonstration and assessment of additionality" (Version 06.0.0, EB 65).

B.2. Justification of the choice of the methodology and why it is applicable to the project activity:

>> The selected methodology AM0029 version 03is applicable to the proposed CDM project activity.

The project activity is the construction and operation of a new natural gas fired grid-connected (Southern grid) electricity generation plant. The justification for the various applicability conditions of AM0029 has been presented below.

The project activity is the construction and operation of a new natural gas fired grid-connected electricity generation plant. Natural gas should be the primary fuel. Small amounts of other startup or auxiliary fuels can be used, but can comprise no more than 1% of total fuel use, on energy basis.

The project activity involves construction and operation of a new natural gas fired grid-connected electricity generation plant, of 742 MW capacity. The only fuel used is natural gas and no auxiliary fuels are used.

The geographical/ physical boundaries of the baseline grid can be clearly identified and information pertaining to the grid and estimating baseline emissions is publicly available.

The baseline grid is southern[1] regional electricity grid, whose geographical/ physical boundaries can be clearly identified and information pertaining to the grid and estimating baseline emissions is available in public domain on the website of the Central Electric Authority of India http://cea.nic.in.

Natural gas is sufficiently available in the region or country, e.g. future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in the project activity. In some situations, there could be price-inelastic supply constraints (e.g. limited resources without possibility of expansion during the crediting period) that could mean that a project activity displaces natural gas that would otherwise be used elsewhere in an economy, thus leading to possible leakage. Hence, it is important for the project proponent to document that supply limitations will not result in significant leakage as indicated here.

Production of natural gas in India is around 87 million standard cubic meters per day[2] ("**MMSCMD**"). The main producers of natural gas are Oil & Natural Gas Corporation Ltd. ("**ONGC**"), Oil India Limited ("**OIL**") and JVs of Tapti, Panna-Mukta and Ravva[3]. Out of the total production of around 87 MMSCMD, after internal consumption, extraction of Liquefied Petroleum Gas ("**LPG**") and unavoidable flaring, around 74 MMSCMD[4] is available for sale to various consumers.

Under the Production Sharing Contracts, private parties from some of the fields are also producing gas. Government have also offered blocks under New Exploration Licensing Policy ("**NELP**") to private and public sector companies with the right to market gas at market determined prices[5].

Most of the production of gas comes from the Western offshore area. The on-shore fields in Assam, Andhra Pradesh and Gujarat States are other major producers of gas. Smaller quantities of gas are also produced in Tripura, Tamil Nadu and Rajasthan States. OIL is operating in Assam and Rajasthan States, whereas ONGC is operating in the Western offshore fields and in other states. The gas produced by ONGC and a part of gas produced by the JV consortiums is marketed by the Gas Authority of India Ltd ("**GAIL**"). The gas produced by OIL is marketed by OIL itself except in Rajasthan where GAIL is marketing its gas. Gas produced by Cairn Energy from Lakshmi fields and Gujarat State Petroleum Corporation Ltd. ("**GSPCL**") from Hazira fields is being sold directly by them at market determined prices.

[1] Southern regional grid is used as the default grid in pursuance with the CDM EB recommendations on grid selection.
[2] http://petroleum.nic.in/ng.htm
[3] http://petroleum.nic.in/ng.htm
[4]http://petroleum.nic.in/ng.htm
[5] http://petroleum.nic.in/ng.htm

There have been discoveries in Krishna-Godavari (KG) basin[6] by – Reliance Industries Limited ("**RIL**") way back in 2002. RIL expected to produce @ 80 MMSCMD[7] (i.e.29.2 Billion Cubic Meter per year) RGTIL has constructed a cross country natural gas pipeline connecting eastern coast of India in Andhra Pradesh and Bharuch in Gujarat on western coast of India. State-owned Gujarat State Petroleum Corporation Limited ("**GSPCL**") has also struck gas in the Krishna Godavari basin, off Andhra Pradesh coast in the Bay of Bengal.

LNG Re-gasification terminals:

The installed terminals include– Dahej (5 Million Metric Tonnes Per Annum ("**MMTPA**") equivalent to 7142.85 Million Standard Cubic Meter (MSCM) / Year), Hazira (2.5 MMTPA equivalent to 3571.4 MSCM/Year) on west coast.

Under implementation: Dabhol (RGPPL) (2.5 MMTPA equivalent to 3571.4 MSCM/Year), Dahej Expansion (5 Million Metric Tonnes Per Annum ("**MMTPA**") equivalent to 7142.85 Million Standard Cubic Meter (MSCM) / Year), Kochi (2.5 MMTPA equivalent to 3571.4 MSCM/Year).

Proposed LNG Regas – Dahej Expansion (5 MMTPA), Mangalore (5 MMTPA equivalent to 3571.4 MSCM/Year), Ennore (2.5 MMTPA equivalent to 3571.4 MSCM/Year).

Amongst all the NG/RLNG supply sources discussed above the likely future supply sources in the Southern region are as follows:

Supply Source (Southern Region)	Units (MSCM/Year)
Reliance Industries Limited (RIL) – domestic natural gas. (East – West gas distribution network)	29200
Dahej Expansion – imported re-gasified LNG[8]. (East – West gas distribution network) 5MMTPA	7142.85
Dhabol – imported re-gasified LNG[9] (East – West gas distribution network) 2.5 MMTPA	3571.429
Total	**39914.29**

For understanding the natural gas requirement of the future gas based power station in the Southern region, the table below gives a list of gas based power stations included in the 11th five year plan (2007 - 2012)[10] in the Southern Region and associated natural gas requirement therein. This estimation is based on a conservative normative station heat rate of 1950 kCal /kWh[11] and at PLF of 85%[12].

Sl.No	Station	Capacity (MW)	Power generation (Million units/Year)	Gas requirement (Million SCM/Year[13])
1.	Gautami - CCPP ; Andhra Pradesh[14]	Gas Turbine – 290MW	3251.71	708.87

[6] http://www.financialexpress.com/news/reliance-ipps-under-bses-may-use-krishnagodavari-gas/68427/
[7] http://www.business-standard.com/india/news/more-d-6-gas-may-dryspot-lng-in-months/361130/
[8] http://www.petronetlng.com/ ; http://www.petronetlng.com/news1/detailedratingrationalefinal.pdf (company profile page 3 of 11 – "The expansion of the Dahej plant from 5 MMTPA to 10 MMTPA....")
[9] 1. http://www.rgppl.com/project.html; 2. http://bsl.co.in/india/news/dabhol-lng-terminal-to-be-operational-by-november/371714/
[10] http://www.cea.nic.in/archives/plg/monitor_11plan/jul09.pdf
[11] CERC tariff order dated 26th March, 2004
[12] Detailed Project Report of the project activity
[13] http://www.cea.nic.in/archives/plg/monitor_11plan/jul09.pdf
[14] http://www.cea.nic.in/archives/exec_summary/feb09.pdf (page 17)

Sl.No	Station	Capacity (MW)	Power generation (Million units/Year)	Gas requirement (Million SCM/Year[13])
		Steam Turbine – 174 MW		
2.	Koenseema CCPP ; Andhra Pradesh[15]	Gas Turbine 1 – 140 MW Gas Turbine 2 – 140 MW Steam Turbine – 165MW	3119	680
3.	Lanco Kondapalli - CCPP - Stage - II ; (Project Activity) Andhra Pradesh	Gas Turbine – 233MW Steam Turbine – 133MW	2565	588.78 (assumed SHR 1850 kCal / kWh)
4.	Lanco Kondapalli - CCPP - Stage - III ; (Project Activity) Andhra Pradesh	Gas Turbine – 241 MW *2 Steam Turbine – 130 MW*2	5359	1193.8 (assumed SHR 1850 kCal / kWh)
5.	Valuthur - GTPP; Phase II; Tamil Nadu[16]	Gas Turbine – 59.8 MW Steam Turbine – 32.4 MW	646	141
Total			**9581**	**3311.8**

Natural gas requirement by gas based power station in the Southern region is 3311.8 million SCM per year against an availability of 39914.29 million SCM per year. It is apparent from the statistics presented above that the future gas supply in the Southern region would be adequate for meeting the fuel requirement of the gas based power stations as included in the 11th five year plan of Government of India. This data further substantiates that natural gas is sufficiently available in the region and future natural gas based power capacity additions, comparable in size to the project activity, are not constrained by the use of natural gas in the project activity.

From the above discussion, it is apparent that the project activity satisfies all the applicability conditions of AM0029, version - 03.

B.3. Description of the sources and gases included in the project boundary:

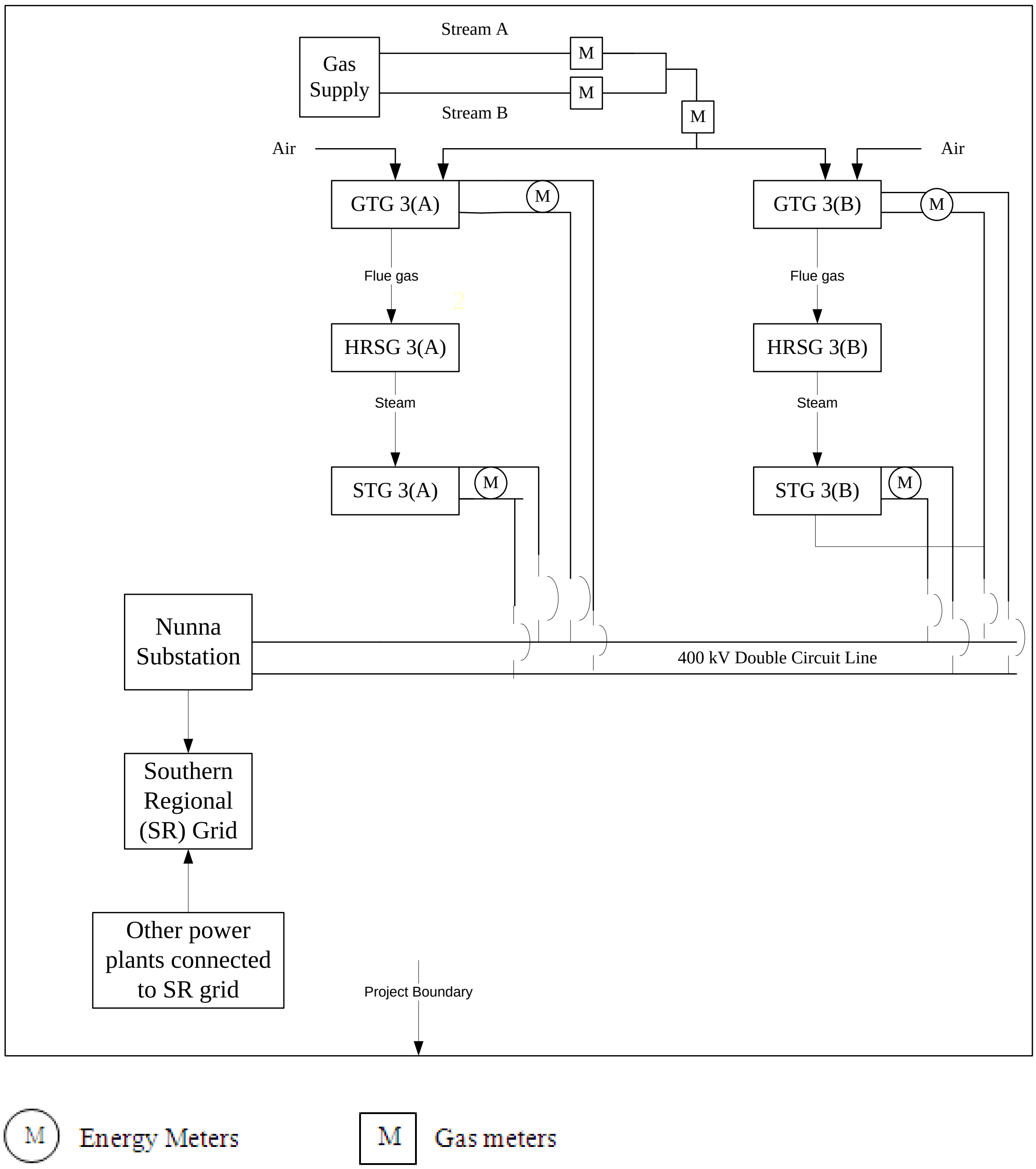
>> The spatial extent of the project boundary includes the equipment that constitute the 742 MW CCPP at Kondapalli site of LKPL as listed below and all power plants connected physically to the baseline grid as defined in “Tool to calculate the emission factor for an electricity system”.

The equipments that form part of the project boundary are:

1. Two Gas Turbine Generators – 241 MW capacity (per unit of 371 MW capacity).
2. Two Steam Turbine Generators – 130 MW capacity (per unit of 371 MW capacity).
3. Two HRSGs

[15] http://www.cea.nic.in/archives/exec_summary/feb09.pdf (page 17)
[16] http://www.cea.nic.in/archives/exec_summary/feb09.pdf (Page 17)

4. GT/ST Generator & Unit aux. transformers – Transformer capacity is 315 MVA (GTG – 1 and GTG – 2) and 160 MVA (STG – 1 and STG – 2)
5. Auxiliary equipments of Gas Turbine & Generator – Lube oil system, Air intake system, Evaporative cooling system, Exhaust system, Heat Recovery Steam Generator - Circulation Pumps, valves, HP/LP Bypass system, Piping etc.
6. Auxiliary equipments of Steam Turbine & Generator – Hydraulic and lube oil system, condenser, Feed Pumps, Condensate extraction pumps



In the calculation of project emissions, only CO_2 emissions from fossil fuel combustion at the project plant are considered. In the calculation of baseline emissions, only CO_2 emissions from fossil fuel combustion in power plant(s) in the baseline are considered.

The greenhouse gases included in or excluded from the project boundary are shown in the table below:

Table 1: Overview of emissions sources included in or excluded from the project boundary

	Source	**Gas**	**Included?**	**Justification / Explanationf**
Baseline	Power generation using coal/lignite/ naphtha as fuel	CO_2	Yes	Main emission source.
		CH_4	No	Excluded (conservative approach).
		N_2O	No	Excluded (conservative approach).
	Grid electricity generation in baseline	CO_2	Yes	Main emission source.
		CH_4	No	Excluded (conservative approach).
		N_2O	No	Excluded (conservative approach).
Project Activity	On-site fuel combustion due to the project activity	CO_2	Yes	Main emission source.
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

>>

As required under AM0029, version - 03 the approach 48 (b) of CDM modalities and procedures "*Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"*

is being used to determine the baseline scenario.

The plausible baseline scenarios, as required using Step 1 of "Identification of baseline scenarios" of the applied baseline methodology AM0029, are described below. In the absence of the project activity, one or more of the following could happen:

1. Establishing similar new generation capacity following the recent fuel and technology choice trend in power generation in India, including addition of plants running on coal – sub critical technology; coal – super critical technology (domestic & imported fuel); lignite; naphtha;
2. Establishing similar new generation capacity power plant based on natural gas but with alternative technologies;
3. Establishing similar new generation capacity power plant based on nuclear energy;
4. Establishing similar new generation capacity with renewable energy sources e.g., wind, hydro based power generation in India;
5. Capacity additions to a number of existing power plants aggregating to the capacity of the project activity; and
6. Import of electricity from connected grids, including the possibility of new interconnections.

An important fact to note here is that the project activity power plant will be built as a Merchant Power Plant (MPP). It is connected to the Southern regional electricity grid. On analysing the installed

capacities connected to the southern grid as on 30th September, 2009, the pattern for fuel distribution[17] emerges as follows:

Power Generating Source	Hydro	Coal	Gas	Diesel	Total thermal	Nuclear	RES	Total
Total Installed Capacity in SR (MW)	11107.03	17322.5	4159.78	939.32	22421.6	1100	6983.7	41612.33
Contribution of specific fuel to the total SR installed capacity (%)	27	42	10	2	54	3	17	100.00

It is apparent from the table above that the thermal generating sources are quite predominant in the Southern regional grid as against the other sources of power generation. The thermal generating sources are mainly based on coal followed by gas and diesel.

In line with the statistics discussed above the potential baseline alternatives available to the present project activity is summarised in the table below

Scenario	Potential alternative conditions	Permitted by regulations
1.	Project activity implemented as a project without the CDM revenue	Yes
2.	Power generation using Natural Gas as fuel and open cycle technology.	Yes
3.	New power plant (s) based on coal – sub-critical technology	Yes
4.	New power plant (s) based on coal (Imported fuel)– super-critical technology	Yes
5.	New power plant (s) based on coal (Domestic fuel)– super-critical technology	Yes
6.	New power plant (s) based on lignite	Yes
7.	New power plant (s) based on naphtha	Yes
8.	New power plant (s) based on hydro power (run-of-river[18])	Yes
9.	New power plant (s) based on wind energy	Yes
10.	Import of electricity from connected grids, including the possibility of new interconnections	Yes

All the above options are permitted by regulations. Analysis of all these options for their suitability as a most probable baseline scenario is presented in the sections below. For all the plausible options, levelized cost of electricity generation has been calculated in INR/kWh. The detailed levelized tariff calculations of all fuel/ technology options will be made available to the DOE during validation.

The nuclear energy based power generation in India does not fall in the purview of CERC/ SERCs and the tariff is unilaterally decided by Nuclear Power Corp. Ltd. There is no verifiable source of information available in public domain on the unit cost of power generation using nuclear energy. The levelized tariff of generation from nuclear energy is, however, higher than that from coal by about

[17] http://www.cea.nic.in/archives/exec_summary/sep09.pdf, Highlights of Power Sector in India, Installed Generation Capacity as on 30 – 09 – 2009, page 9 of 42

[18] Storage, reservoir type hydro has been excluded since it deliver peak in power rather than base load power

15%[19] and also this option is not available to a private investor and hence has been excluded as a baseline option.

The candidate project is a utility scale 742 MW gas based power plant. As can be observed in the CEA database version – 7, there are no solar power plants (PV or Solar thermal) of comparable capacity. Hence, electricity generation based on solar technology has not been considered as a baseline alternative.

Alternative 1: Power generation using natural gas as fuel and combined cycle technology without CDM revenues

Technology: Gas turbine plants operate on the Brayton cycle. They use a compressor to compress the inlet air upstream of a combustion chamber. Then the fuel normally Natural Gas / Liquefied Natural Gas is introduced and ignited to produce a high temperature, high-pressure gas that enters and expands through the turbine section. The turbine section powers both the generator and compressor. Gas turbines are also able to burn a wide range of liquid and gaseous fuels. The turbine's energy conversion efficiency typically remains low (@ 25-35 %) when utilised as an Open (simple) cycle. The simple cycle efficiency can be increased by installing a waste heat recovery boiler onto the turbine's exhaust. A waste heat boiler generates steam by capturing heat form the turbine exhaust. These boilers are known as heat recovery steam generators (HRSG). They can provide steam at high pressure and temperature which can be used to generate power with steam turbines (Rankine Cycle), which is called a combined cycle (Gas and steam turbine operation). Thus HRSG and STG increase the overall energy cycle efficiency to around 50 %[20]).

Establishment of a new power plant based on Natural gas using CCGT technology (without CDM revenue) is a plausible alternative.

Alternative 2: Power generation using Natural Gas as fuel and open cycle technology.

Technology: Gas turbine plants operate on the Brayton cycle. They use a compressor to compress the inlet air upstream of a combustion chamber. Then the fuel normally Natural Gas / Liquefied Natural Gas is introduced and ignited to produce a high temperature, high-pressure gas that enters and expands through the turbine section. The turbine section powers both the generator and compressor. Gas turbines are also able to burn a wide range of liquid and gaseous fuels. The turbine's energy conversion efficiency typically remains low (@ 25-35[21] %) when utilized as an Open (simple) cycle. This very low efficiency makes open cycle gas turbine based power generation as a non-plausible baseline option and thus this option has not been discussed any further in the PDD.

Alternative 3: Power generation using coal as fuel – sub critical technology

Technology: Fossil fuel-fired (coal) power plants use steam to provide the mechanical power to electrical generators. Pressurized high temperature steam or gas expands through various stages of a turbine, transferring energy to the rotating turbine blades. The turbine is mechanically coupled to a generator, which produces electricity. Steam turbine power plants operate on a Rankine cycle. The steam is generated by a boiler, where pure water passes through a series of tubes to capture heat from

[19] Projected Costs Of Generating Electricity, Update 1998 published by Nuclear Energy Agency of International Energy Agency & Organisation For Economic Co-Operation And Development

[20] http://books.google.co.in/books?id=KJOoQm3fbEoC&pg=PT433&lpg=PT433&dq=efficiency+of+open+cycle+power+plant&source=web&ots=HRYT81RY0h&sig=yRBE5betwGqHsZ6RQVpjrYZoQWQ&hl=en&sa=X&oi=book_result&resnum=6&ct=result

[21] http://books.google.co.in/books?id=KJOoQm3fbEoC&pg=PT433&lpg=PT433&dq=efficiency+of+open+cycle+power+plant&source=web&ots=HRYT81RY0h&sig=yRBE5betwGqHsZ6RQVpjrYZoQWQ&hl=en&sa=X&oi=book_result&resnum=6&ct=result

the furnace and then boils under high pressure to become superheated steam. The heat in the furnace is normally provided by burning fossil fuel (e.g. coal, fuel oil etc). The coal is fed to boiler after pulverization in the coal mills. The pulverized coal is transported to burners through primary air which is heated in Air Pre-heaters. The secondary air (preheated) is fed to boilers for complete combustion. The fuel firing normally takes place in the range of 1200-1300°C. The combustion chamber is enclosed by tubes termed as water wall tubes and these tubes form the gas tight chamber and water cooled furnace. The bottom ash is collected in the furnace bottom and fly ash carried along with the flue gases is collected in ESP hoppers and discharged to Ash areas. The superheated steam leaving the boiler then enters the steam turbine throttle, where it powers the turbine and connected generator to make electricity. After the steam expands through the turbine, it exits at the back end of the turbine, where it is cooled and condensed back to water in the surface condenser. This condensate is then returned to the boiler through high-pressure feed pumps for reuse. Heat from the condensing steam is normally rejected from the condenser to a body of water or cooling tower. The power plant efficiency is typically remains around 33 to 38%.

Establishing a new power plant using coal as fuel with sub-critical technology is a plausible alternative.

<u>Alternative 4: Power generation using coal (imported & domestic) as fuel with super-critical technology</u>

<u>Technology</u>: Super critical technology is almost similar to the sub critical technology explained in the Scenario 2 except that the super critical steam generators operate at "supercritical pressure". In contrast to a "sub-critical boiler", a supercritical steam generator operates at such a high pressure (over 3200 PSI, 22 MPa, 220 bar) that actual boiling ceases to occur, and the boiler has no water - steam separation. There is no generation of steam bubbles within the water, because the pressure is above the "critical pressure" at which steam bubbles can form. It passes below the critical point as it does work in the high pressure turbine and enters the generator's condenser. This is more efficient, resulting in slightly less fuel use and therefore less greenhouse gas production. The term "boiler" should not be used for a supercritical pressure steam generator, as no "boiling" actually occurs in this device. Differences between sub critical and super critical power plants are limited to a relatively small number of components; primarily the feed water pumps and the high-pressure feed water train equipment. All the remaining components are common to sub critical and super critical coal-fired power plants. Super critical technology also follows the same Rankine cycle. Steam generated from the generator will be allowed to expand in the Steam turbine and thus producing the work. The power plant cycle efficiency is in the range of 36 % to 43%. Since the efficiency of the super critical technology is better, the coal consumption and ash / pollution generated are also less compared with the sub critical technology. However the capital cost for the super critical technology is higher. Establishing new thermal power plants based on super-critical technology – using both domestic or imported coal are plausible alternatives.

<u>Alternative 5: Power generation using lignite as fuel</u>

<u>Technology</u>: Fuel combustion in Circulating Fluid Bed system takes place in a vertical chamber referred to as the Combustor, in which the fluidisation of the fuel and the fuel combustion takes place. The fuel is preheated before entry and burnt at 850°C. The particle size of fuel used at bed is typically in the range of 50-300 microns. The bed material is fluidized by preheated primary air introduced through a grate at the bottom of the bed and by the combustion gases generated which flow upwards at a relatively high fluidizing velocity. The entire combustor contains a high concentration of suspended solids, which decrease continuously towards the top of combustor. The combustion gas entrains a considerable portion of the solids inventory from combustor. The bulk of these entrained solids is separated from the gas in the cyclone and is continuously returned to be bed by recycle loop. The very

high internal and external circulating rates of solids, characteristics of the Circulating Fluid Bed, result in consistently uniform temperatures throughout the combustor and the solids recycle system. The long residence and contact times, coupled with the small particle sizes and efficient heat and mass transfer rates, produce high combustion efficiency. The relatively high ratio of solids circulation to fuel feed means that the Combustor is largely full of recycled solids and actual carbon content is surprising low. Further the large thermal inertia of the recycled solids allows the CFB system to handle high ash or high moisture fuels better than conventional combustion systems. Combustion of low volatile fuels like coke breeze in a CFB system is therefore more stable and of high efficiency. Combustion air is introduced into the combustor at multiple levels. About forty percent of the combustion air is passed as primary fluidizing air through the grate at the bottom and the balance is admitted as preheated secondary air through multiple ports in the side walls of the combustor. Combustion therefore occurs in two zones: a primary reducing zone in the lower section of the combustor, and complete combustion using excess air via the secondary air ports in the upper section. This staged combustion at controlled low temperatures of around 850°C, effectively suppresses NO_x formation. The entire combustor as well as the grate is enclosed by water walls and the lower water wall section is refractory lined to prevent corrosion and attack of the metal surfaces. The upper water wall section is not refractory lined and provides the majority of the evaporative duty of the boiler. The bottom ash discharged from the combustor is at 850°C and so it needs to be cooled in an ash cooler to approx. 200-250°C. The fly ash separated in the back pass and air pre heater and the fly ash from the ESPs are collected in the hoppers. The steam from the steam generator is fed to turbine for power generation and turbine and other systems are similar to that of conventional Thermal Power plant. Establishing new thermal power generating stations based on lignite is a plausible alternative.

Alternative 6: Power generation using naphtha as fuel

Technology: The power generation technology using Naphtha as fuel is same as that of the project activity. Thus for comparison with project activity a naphtha based power plant of 742 MW has been considered. Naphtha fired gas turbine power plants operate on the Brayton cycle. They use a compressor to compress the inlet air upstream of a combustion chamber. Then the fuel, naphtha is introduced and ignited to produce a high temperature, high-pressure gas that enters and expands through the turbine section. The turbine section powers both the generator and compressor. The turbine's energy conversion efficiency typically remains low (@25-35 %[22] when utilised as an Open (simple) cycle. The simple cycle efficiency can be increased by installing a waste heat recovery boiler onto the turbine's exhaust. A waste heat boiler generates steam by capturing heat form the turbine exhaust. These boilers are known as heat recovery steam generators ("**HRSG**"). They can provide steam at high pressure and temperature which can be used to generate power with steam turbines, which is called a combined cycle (steam and Gas turbine operation). Thus HRSG and STG increase the overall energy cycle efficiency to around 50%[23]. Establishing new naphtha based power plant is a plausible alternative

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22 http://books.google.co.in/books?id=KJOoQm3fbEoC&pg=PT433&lpg=PT433&dq=efficiency+of+open+cycle+power+plant&source=web&ots=HRYT81RY0h&sig=yRBE5betwGqHsZ6RQVpjrYZoQWQ&hl=en&sa=X&oi=book_result&resnum=6&ct=result

23 http://books.google.co.in/books?id=KJOoQm3fbEoC&pg=PT433&lpg=PT433&dq=efficiency+of+open+cycle+power+pla
nt&source=web&ots=HRYT81RY0h&sig=yRBE5betwGqHsZ6RQVpjrYZoQWQ&hl=en&sa=X&oi=book_res
ult&resnum
=6&ct=result

Alternative 7: Power generation using hydro power

Technology: In the last five years the following hydel energy based power plants have been added to the southern grid[24]:

S.No.	Power Plant Name	Unit	State	Date of Addition	Capacity (MW)
1.	Priyadarshni Jurala	1	Andhra Pradesh	28-Mar-08	39
2.	Priyadarshni Jurala	2	Andhra Pradesh	31-Aug-08	39
3.	Priyadarshni Jurala	3	Andhra Pradesh	27-Jun-09	39
Total – Andhra Pradesh					**117**
1.	Almatti Dam	1	Karnataka	26-Mar-04	15
2.	Almatti Dam	2	Karnataka	4-Nov-04	55
3.	Almatti Dam	3	Karnataka	13-Jan-05	55
4.	Almatti Dam	4	Karnataka	26-Mar-05	55
5.	Almatti Dam	5	Karnataka	6-Jul-05	55
6.	Almatti Dam	6	Karnataka	10-Aug-05	55
Total – Karnataka					**290**
1.	Chembukadavu-II	1	Kerala	25-Jan-04	1.25
2.	Chembukadavu-II	2	Kerala	25-Jan-04	1.25
3.	Chembukadavu-II	3	Kerala	25-Jan-04	1.25
4.	Urumi	1	Kerala	25-Jan-04	1.25
5.	Urumi	2	Kerala	25-Jan-04	1.25
6.	Urumi	3	Kerala	25-Jan-04	1.25
Total – Kerala					**7.5**
1.	Pykara Alimate	1	Tamil Nadu	11-Aug-05	50
2.	Pykara Alimate	2	Tamil Nadu	11-Aug-05	50
3.	Pykara Alimate	3	Tamil Nadu	5-Sep-05	50
4.	Bhawani Kattalai Barrage	1	Tamil Nadu	1-Aug-06	15
5.	Bhawani Kattalai Barrage	2	Tamil Nadu	22-Sep-06	15
Total Tamil Nadu					**180**
Total Southern Region					**594.5**

This data indicates that out of the entire capacity of 594.5 MW of hydro power plant, 71.48%% (425 MW) has been with 50 MW plus size with storage hydro thereby catering to the peak-in load rather than base load of the grid.

On the contrary the project activity is a gas based MPP. Depending upon the requirement, the project activity power plant would provide steady supplies to the grid and also could be used to meet the grid demand during peak loads. This makes run-of-the-river hydro energy based power generation as a non-plausible baseline option.

Scenario 8: Power generation using wind energy

The proposed project activity is a gas based MPP without any PPA being executed for power off-take. In absence of PPA as with traditional independent power projects, the project activity would compete for customers and absorb full market risks. Depending upon the requirement, the project activity power plant would provide steady supplies to the grid and also could be used to meet the grid demand during peak loads.

[24] http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm

Wind power generation will not qualify as a source of "base-load firm power" because wind power projects are not subject to the dispatch rules as the coal or gas or hydro. This is also due to the fact that there is no scheduling and dispatching of wind power - the grid accepts wind power generation as and when the wind generators generate electricity. Moreover unlike present project activity wind power projects are always governed by long term PPA.

Thus, wind energy based power generation cannot be strictly compared with the proposed project activity in terms of the services that it delivers and hence has been excluded as a baseline option. This is not a plausible project alternative.

Alternative 9: Import of electricity from connected grids, including the possibility of new interconnections

The actual power supply position during the period April – September, 2009[25] is as follows

Regional Grid	Northern Region	Western Region	Southern Region	Eastern Region	North – Eastern Region
Power Requirement (Million Units)	134,349	124,916	107,855	44,750	4,746
Power Availability (Million Units)	117,672	109,504	101,210	42,652	4,113
Surplus / Deficit (-)	-16,677	-15,412	-6,645	-2,098	-633

It remains implied from the statistics furnished above that all the regional grids in the country are power deficit.

Import of electricity from the inter-regional grid is not a plausible option due to intermittent power availability and power deficit nature of the regional grid. Further, the import of power from grid is subjected to other transmission issues like availability of transmission corridor for long term etc. Hence this scenario is excluded from further consideration to determine the baseline alternative of the project activity

Given the grid data of last 3 years, all the regional grids are power deficit. It makes import of electricity from the interconnected grids not a plausible baseline option.

The above analysis of the 9 alternatives available to a company investing in power generation for supply of base load power to Southern regional grid in India leads to following alternatives:

Scenario 1: Power plant based on natural gas using CCPP technology

Scenario 2: Power plant based on coal using sub-critical technology

Scenario 3: Power plant based on coal (Imported fuel) with super-critical technology

Scenario 4: Power plant based on coal (Domestic fuel) with super-critical technology

Scenario 5: Power plant (s) based on lignite

Scenario 6: Power plant (s) based on naphtha

For these six alternatives, the economically most attractive option has been evaluated in Step-2 in the following section.

[25] http://www.cea.nic.in/archives/exec_summary/sep09.pdf, Power Supply Position (Provisional)

Step 2 "**Identify the economically most attractive baseline scenario alternative"** of AM0029, version - 03 requires:

> ***"****The economically most attractive baseline scenario alternative is identified using investment analysis. Calculate a suitable financial indicator for all alternatives remaining after Step 1. Include all relevant costs (including, for example, the investment cost, fuel costs and operation and maintenance costs), and revenues (including subsidies/fiscal incentives, ODA, etc. where applicable), and, as appropriate, non-market costs and benefits in the case of public investors."*

LKPL has chosen levelized tariff i.e., levelized cost of generation as the financial indictor for identifying the economically most attractive baseline scenarios of the 5 plausible scenarios identified under step 1 above. Levelized tariff accounts for all relevant costs, revenues and benefits that are available to investors in power sector in the country.

Further, for all power generation projects in India, levelized cost of electricity generation is one way to perform comparisons among different technologies (alternatives) since it allows to quantify, the unitary cost of the electricity (the kWh) generated during the lifetime of all the alternatives being compared. The levelized cost of electricity being a mean value, allows the immediate comparison with the cost of other alternatives. It considers the total electrical energy that the power plant will produce in its lifetime and it is divided between the total cost generated by construction investment along with the interest rate and the cash flow during construction plus the operation and maintenance cost, etc (considering everything in present money worth). The consideration of all the affecting components in present money worth in calculation of levelized cost of generation provides a level ground for comparison and justifies its use as a suitable indicator. 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 generation[26] is the evaluation criteria.

<u>Levelized Tariff Analysis</u>

For the scenarios 1,3,4,5 and 6 discussed earlier in this section, the levelized tariff has been calculated based on two major components namely fixed cost and variable cost. The fixed cost includes the following factors[27] as per the guidelines prescribed by Central Electricity Regulatory Commission (CERC)[28]. For the levelized Tariff analysis for CCGT, following are the parameters used

1. Return on Equity (ROE) at 16% as per CERC regulation
2. Debt: Equity ratio of 70:30.
3. Operation & Maintenance expenses: INR 1.75 million/ MW (This is inclusive of employee cost, repairs and maintenance charges and administrative and general charges).
4. O&M escalation at 5.72% p.a.
5. Average depreciation for first 12 years: 5.28% p.a
6. Average depreciation for the next 8 years: 3.33% p.a.
7. Interest on loan at 11.50 % as per Average of prevaling interest rate at the time of investment decision making.
8. Interest on working capital (WC): 11.50% as per the DPR

[26] http://powermin.nic.in/whats_new/competitive_guidelines.htm
[27] Reference: http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
[28] Central Electricity Regulatory Commission (Terms & Conditions of Tariff) Regulations, 2001 available on http://cercind.gov.in

9. Normative Plant Load Factor (PLF) at 85%
10. Discount factor of 10.19% % as per CERC order
11. Corporate Income Tax with surcharge & cess on income at 33.99% as per Income Tax Act of India
12. MAT rate with surcharge & cess at 17% as per Income Tax Act of India

The variable cost has been calculated based on the cost of the fuel.

Levelized tariff for gas: The levelized tariff comes out as **INR ~~6.1398~~4.2522/ kWh**. This has been calculated based on the following factors:

Capacity in MW	742	Aux. Consumption	3%
Rate of Depreciation	As above	GSHR (kcal/kWh)	1850
Per MW Cost (INR million)	35.18	Price of Fuel (INR/SCM)	9.13
Total Debt (INR million)	18270.0	NCV (kCal / SCM)	8,562
Total Equity (INR million)	7830.0	O&M Expenses (INR Million/MW)	1.75

Levelized tariff for coal with sub-critical technology:

The levelized tariff for power generation with coal using sub-critical technology comes out as **INR ~~2.8478~~2.8556/ kWh**. This has been calculated based on the following factors:

Capacity in MW	500	Aux. Consumption	9%
Rate of Depreciation	5.28% for first 12 years; 2.05 % for the remaining 13 years	GSHR (kcal/kWh)	2450
Per MW Cost (INR million)	40	Price of Fuel (Rs / kg)	1.2849
Total Debt (INR million)	14000	NCV (kcal/kg) –	3946
Total Equity (INR million)	6000	O&M Expenses (lacs per MW/yr)	15.36

Levelized tariff for with super-critical technology using domestic coal:

The levelized tariff for power generation with domestic coal on Super critical technology comes out as **INR ~~2.9270~~2.9340/ kWh**. This has been calculated based on the following factors:

Capacity in MW	660	Aux. Consumption	9.00%
Rate of Depreciation	5.28% for first 12 years; 2.05 % for the remaining 13 years	GSHR (kcal/kWh)	2380
Per MW Cost (INR million)	49.36	Price of Fuel (Rs / kg)	1.2849
Total Debt (INR million)	22805	NCV (kcal/kg)	3946
Total Equity (INR million)	9774	O&M Expenses (lacs per MW/yr)	13.82

Levelized tariff for super-critical technology using imported coal:

The levelized tariff for power generation with imported coal on Super critical technology comes out as INR ~~4.8342~~4.8385 / kWh. This has been calculated based on the following factors:

Capacity in MW	660	Aux. Consumption	9.00%
Rate of Depreciation	5.28% for first 12 years; 2.05 % for the remaining 13 years	GSHR (kcal/kWh)	2274
Per MW Cost (INR million)	47.47	Price of Fuel (Rs / kg)	1.925

Total Debt (INR million)	21932	NCV (Kcal/kg)	5784
Total Equity (INR million)	9399	O&M Expenses (lacs per MW/yr)	13.32

Levelized tariff for lignite:

The levelized tariff for power generation with lignite comes out as **INR ~~2.8984~~2.9063/kWh**. This has been calculated based on the following factors:

Capacity in MW	500	Aux. Consumption	9.%
Rate of Depreciation (up to 90%)	5.28% for first 12 years; 2.05 % for the remaining 13 years	SHR (kcal/kWh)	2668
Per MW Cost (INR million)	40.60	Price of Fuel (Rs/ kg))	0.80
Total Debt (INR million)	14210	NCV (Kcal/kg)	2699
Total Equity (INR million)	6090	O&M Expenses (Rs. Lakhs/MW)	15.36

Levelized tariff for naphtha:

The levelized tariff for power generation with naphtha comes out as INR ~~13.9044~~13.9103 / kWh. This has been calculated based on the following factors:

Capacity in MW	742	Aux. Consumption	3.50%
Rate of Depreciation (up to 90%)	5.28% for first 12 years; 2.05 % for the remaining 13 years	GSHR (kcal/kWh)	2117
Per MW Cost (INR million)	35.2	Price of Fuel (Rs/kg)	27.00
Total Debt (INR million)	18272	NCV (Kcal/kg)	10500
Total Equity (INR million)	7831	O&M Expenses (% of capital cost)	2.50

Summary of levelized tariff for all plausible baseline options is as follows:

S.No.	Baseline Scenario	Levelized Tariff (INR/kWh)
1.	New power plant (s) based on natural gas	~~6.1398~~4.2522
2.	New power plant (s) based on coal with sub-critical technology	~~2.8478~~2.8556
3.	New power plant (s) based on coal with super-critical technology using imported coal	~~4.8342~~4.8385
4.	New power plant (s) based on coal with super-critical technology using domestic coal	~~2.9270~~2.9340
5.	New power plant (s) based on lignite	~~2.8984~~2.9063
6.	New power plant (s) based on naphtha	~~13.9044~~13.9103

Option 5, i.e. establishing a new power plant based on coal with sub-critical technology is clearly the most attractive option. Levelized tariff under option 1 i.e. the project activity implemented without considering the CDM revenue is amongst the more costly generation sources.

A sensitivity analysis was performed on the data above for the following factors to corroborate the conclusions drawn from the analysis above.

1.Total project cost: Increase and decrease by 5% and 10%.

2. Station Heat Rate (SHR): Increase and decrease by 5% and 10%.
3. Fuel price: Increase and decrease by 5% and 10%.
4. Plant Load Factor (PLF): increase and decrease by 5% and 10%.

The results of sensitivity analysis on levelized tariff of generation for various fuels are presented in the table below:

Project Cost	Project Cost -10%	Project Cost -5%	Project Cost +5%	Project Cost +10%
Gas	4.2030~~6.0906~~	4.2276~~6.1152~~	4.2768~~6.1644~~	4.3013~~6.1890~~
Coal – Sub-critical	2.7703~~2.7625~~	2.8130~~2.8051~~	2.8983~~2.8904~~	2.9409~~2.9331~~
Lignite	2.8197~~2.8118~~	2.8630~~2.8551~~	2.9496~~2.9418~~	2.9929~~2.9851~~
Super Critical Coal (Domestic fuel)	2.8328~~2.8257~~	2.8834~~2.8763~~	2.9847~~2.9776~~	3.0353~~3.0282~~
Super Critical Coal (Imported fuel)	4.7375~~4.7331~~	4.7880~~4.7836~~	4.8890~~4.8847~~	4.9395~~4.9352~~
Naphtha	13.8173~~13.8120~~	13.8638~~13.8582~~	13.9568~~13.9506~~	14.0033~~13.9968~~

Station Heat Rate (SHR)	SHR - 10%	SHR -5%	SHR +5%	SHR +10%
Gas	3.9380~~5.6357~~	4.0951~~5.8877~~	4.4093~~6.3919~~	4.5664~~6.6439~~
Coal– Sub-critical	2.7032~~2.6953~~	2.7794~~2.7715~~	2.9318~~2.9240~~	3.0081~~3.0002~~
Lignite	2.7552~~2.7474~~	2.8308~~2.8229~~	2.9819~~2.9740~~	3.0574~~3.0495~~
Super Critical Coal (Domestic fuel)	2.7859~~2.7788~~	2.8600~~2.8529~~	3.0081~~3.0010~~	3.0822~~3.0751~~
Super Critical Coal (Imported fuel)	4.4995~~4.4951~~	4.6690~~4.6646~~	5.0080~~5.0037~~	5.1776~~5.1732~~
Naphtha	12.6123~~12.6064~~	13.2613~~13.2554~~	14.5594~~14.5535~~	15.2084~~15.2025~~

Fuel Price	Fuel Price ~~------~~ - 10%	Fuel Price~~---~~ - 5%	Fuel Price +5%	Fuel Price +10%
Gas	3.9380~~5.6357~~	4.0951~~5.8877~~	4.4093~~6.3919~~	4.5664~~6.6439~~
Coal– Sub-critical	2.7038~~2.6959~~	2.7797~~2.7718~~	2.9315~~2.9237~~	3.0075~~2.9996~~
Lignite	2.7560~~2.7482~~	2.8312~~2.8233~~	2.9814~~2.9736~~	3.0566~~3.0487~~
Super Critical Coal (Domestic fuel)	2.7865~~2.7794~~	2.8603~~2.8532~~	3.0078~~3.0007~~	3.0816~~3.0745~~
Super Critical Coal (Imported	~~4.49~~4.5009~~65~~	~~4.6653~~4.6697	5.0073~~30~~	5.1761~~718~~

fuel)				
Naphtha	12.6123~~12.6064~~	13.2613~~13.2554~~	14.5594~~14.5535~~	15.2084~~15.2025~~

Plant Load Factor (PLF)	PLF -10%	PLF -5%	PLF +5%	PLF +10%
Gas	4.3755~~6.2619~~	4.3106~~6.1976~~	4.1993~~6.0875~~	4.1512~~6.0399~~
Coal– Sub-critical	2.9924~~2.9836~~	2.9204~~2.9121~~	2.7970~~2.7895~~	2.7437~~2.7366~~
Lignite	3.0445~~3.0358~~	2.9718~~2.9635~~	2.8471~~2.8396~~	2.7932~~2.7861~~
Super Critical Coal (Domestic fuel)	3.0843~~3.0764~~	3.0052~~2.9978~~	2.8696~~2.8629~~	2.8111~~2.8047~~
Super Critical Coal (Imported fuel)	4.9892~~4.9843~~	4.9099~~4.9053~~	4.7740~~4.7698~~	4.7153~~4.7113~~
Naphtha	14.0136~~14.0071~~	13.9593~~13.9530~~	13.8661~~13.8604~~	13.8258~~13.8204~~

From the data presented above, it can be observed that with variations in total project cost, SHR, fuel price and PLF coal based power generation alternative using sub-critical technology continue to remain the economically most attractive options and natural gas as fuel remains amongst the more expensive options. Hence it substantiates that the project activity is not the economically most attractive route for power generation.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):

>> The proposed power plant will use natural gas, a comparatively less GHG intensive fuel compared to other fossil fuels like coal, lignite, etc., resulting in reduction of anthropogenic emission of GHGs. There is no legal requirement in India to choose natural gas in preference to higher GHG intensive fuels like coal.

The national and sectoral policies that may guide the implementation of above options can be understood from discussions provided under the previous section. As per existing national legislation / regulation applicable to similar projects there is no restrictions on utilization of any fuel for Grid Connected Generating stations. Therefore, the alternative to the project activity that could have been installed include either of the following fuels, viz. Coal, Lignite, Naphtha, etc. with conventional technologies.

The project activity leads to additional GHG emission reductions than would have occurred in its absence. In order to demonstrate that the project activity is not a baseline scenario, the following steps are followed for additionality demonstration as recommended in the applied baseline methodology.

Steps for Additionality Check

The start date of the candidate project activity is 1st January, 2010 (the date of Notice to Proceed) which is after 2nd August, 2008. Hence prior consideration of CDM for the candidate project activity has been demonstrated using the Guidelines on the Demonstration and Assessment of Prior Consideration of the CDM, Version -04 (EB 62, Annex 13). The paragraph 2 of the guideline recommends the following

"The Board decided that for project activities with a starting date on or after 2 August 2008, the project participant must inform a Host Party designated national authority (DNA) and the UNFCCC secretariat in writing of the commencement of the project activity and of their intention to seek CDM status. Such notification must be made within six months of the project activity start date and shall contain the precise geographical location and a brief description of the proposed project activity, using the standardized form F-CDM-Prior Consideration. Such notification is not necessary if a project design document (PDD) has been published for global stakeholder consultation or a new methodology proposed to the Executive Board for the specific project before the project activity start date."

The project proponent has informed the UNFCCC secretariat and also the Host Party designated national authority of the commencement of the project activity and their intention to seek CDM status on 25th June 2010 which is prior to the six month period of the project activity start date. All the relevant documents have been made available to the DOE during validation.

In addition, the project proponent has initiated activities in order to secure CDM status parallel with the project implementation. The chronology of events is presented in the table below in order to justify that CDM were a decisive factor in the decision to proceed with the project activity.

Sl. No.	Milestone	Date	Reference[29]
01.	News paper advertisement on Request for Quotation (RFQ) & Request for Proposal (RFP) towards awarding	21st September, 2009	The news paper advertisement
02.	Service order for preparation of feasibility –cum-detailed project report.	11th September, 2009	The feasibility –cum-detailed project report.
03.	Extract of the Board Resolution evidencing CDM revenue has been seriously considered in the decision to go ahead with the project activity.	14th October, 2009	The extract of the Board Resolution.
04.	Execution of the EPC agreement.	23rd December, 2009	The EPC agreement.
05.	Notice to proceed to the EPC contractor with effective commencement date as 1st January,2010. (The project activity start date).	1st January,2010	Notice to Proceed (NTP) to the EPC contractor.
06.	Appointment of CDM consultant	13th December, 2010	The relevant pages of the agreement.
07.	Achieving financial closure	10th January, 2011	The relevant section of the loan sanction letter as received from the FI.
08.	Invitation letter for stakeholders' consultation meeting.	26th August, 2011	The invitation letter.

[29] All the required evidences will be submitted to the DOE during validation

Sl. No.	Milestone	Date	Reference[29]
09.	The stakeholders' consultation meeting.	15th September, 2011	The minutes of the stakeholders' consultation meeting.

The discussion presented above justifies that in parallel with the project implementation activities LKPL has taken many initiatives to secure CDM status of the project activity.

Step 1: Benchmark Investment analysis

Demonstrate that the proposed CDM project activity is unlikely to be financially attractive by applying sub-steps 2b (Option III: Apply benchmark analysis), Sub-step 2c (Calculation and comparison of financial indicators), and 2d (Sensitivity Analysis) of the version 06 of the "Tool for demonstration assessment and of additionality" agreed by the CDM Executive Board.

To determine whether the proposed project activity is economically or financially less attractive than the other alternatives without the CDM revenues, the sub-steps 2b, 2c and 2d have been followed as required under AM0029, version 03.

Sub-step 2(b): Benchmark Analysis (Option III)

Benchmark analysis using equity IRR as the financial indicator:

In addition to the above, project IRR has also been estimated for the project activity. In this regard please refer to paragraph 12 of the guidelines on the assessment of investment analysis, version -05 (EB62; Annex-05.2.1). The guideline recommends the following to determine the benchmark

"In cases where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR. Required/expected returns on equity are appropriate benchmarks for equity IRR."

In the present context in line with the financial indicator (project IRR) Weighted Average Cost of Capital (WACC) of the project activity has been considered as the investment benchmark. In this regard it is worthwhile to note that that project activity can be implemented by any other entity apart from the project participant. Hence following the guideline provided in the sub-step 2b, option III of the additionality tool version 5.2.1 the benchmark has been derived based upon the parameters that are standard in the market and not linked to the subjective profitability expectation or risk profile of the project developer.

WACC has been calculated as per the following illustration:

WACC = [D/(D+E)]*[Cost of Debt] + [E/(D+E)]*[Cost of Equity]

Cost of Equity:

Paragraph 15 of the investment analysis guideline, version -05 provides the following guideline to determine the cost of equity

"If the benchmark is based on parameters that are standard in the market, the cost of equity should be determined either by: (a) selecting the values provided in Appendix A; or by (b) calculating the cost of equity using best financial practices, based on data sources which can be clearly validated by the DOE, while properly justifying all underlying factors."

In case of the present project activity the cost of equity has been determined following the option (b) as mentioned in the guideline above. The Capital Asset Pricing Model (CAPM) has been followed considering Beta values of selected power generating companies in India that were listed at the time of investment decision making process. Detailed calculations of cost of equity and WACC along with an elaboration of the approach are provided in Appendix – 04 of this document. The cost of equity has been estimated at 20.62%.

Cost of Debt:

In order to reflect the standard rate in the market the prime lending rate prevailing at the time of investment decision making has been considered as the cost of debt. The Prime Lending Rate (PLR) at the time of investment was in the range of 11.00% to 12.00% [30]. Hence the average value of 11.50% (pre-tax) has been considered as the applicable cost of debt.

Debt - Equity Ratio:

Paragraph 18 of the guideline on the assessment of investment analysis, version -05 provides the following in order to determine the debt/equity finance structure.

"If the benchmark is based on parameters that are standard in the market, then the typical debt/equity finance structure observed in the sector of the country should be used."

In this regard please refer to the Central Electricity Regulatory Commission (CERC) tariff order dated 26th March, 2004[31] that specifies that debt and equity to be considered at 70:30 for tariff determination. The same has been applied in the present context.

WACC:

Referring to the explanation above the WACC of the project activity has been estimated at 12.86%.

Benchmark analysis using levelised tariff as the financial indicator:

The (2b), option III of the additionality tool version - 6 recommends the following guideline

"Identify the financial/economic indicator, such as IRR, most suitable for the project type and decision context."

Considering the context of decision making levelised cost for power generation (INR / kWh) has been regarded as the most suitable indicator for the project type. The detailed explanation to justify the appropriateness of the financial indicator has been explained in detail in Section B.4 above.

In this regard please refer to the paragraph-19 of the "Guidelines on the Assessment of Investment Analysis" version – 05.

"If the proposed baseline scenario leaves the project participant no other choice than to make an investment to supply the same (or substitute) products or services, a benchmark analysis is not appropriate and an investment comparison analysis shall be used. If the alternative to the project activity is the supply of electricity from a grid this is not to be considered an investment and a benchmark approach is considered appropriate."

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[30] http://www.rbi.org.in/scripts/WSSView.aspx?Id=14114

[31] http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf

The present project activity is a green field natural gas based grid connected Combined Cycle Power Plant (CCPP) of 742 MW capacity. The parent company of LKPL (i.e. Lanco Group) is an Independent Power Producer (IPP) and in the past has ventured into both conventional and non-conventional sources of energy including gas, coal, biomass, hydro and wind. Lanco Group has operational (3892 MW), under construction (5353 MW) and under development (7110 MW) projects amounting to over 16355MW[32]. It is apparent that in absence of the project activity the project proponent would have invested in developing power plant based on any of the alternatives mentioned in section B.4. above.

Hence in line with AM0029, version -03 and also following the Guidelines on the Assessment of Investment Analysis, version -05 the levelised cost of power generation has been considered as the suitable financial indictor.

To further substantiate the choice of the financial indicator as considered in the benchmark analysis please refer to the relevant section of the hand book on "India's Electricity Sector Widening Scope for Private Participation", 6th edition[33]. The particular section of the book elaborates the gradual invention of levelised tariff to evaluate private sector power projects in India.

It is quite explicit from the above discussion that levelised tariff is the key indicator to evaluate the financial proposal of any private sector power producer.

Similar approach (i.e. levelised cost of generation of different alternatives) has been followed by LKPL in order to carry out financial evaluation of the candidate project activity while deciding upon the project investment.

Determination of the investment benchmark:

The lowest value of levelised cost of generation of all the baseline alternatives discussed in section B.4. of this document has been considered to determine the benchmark of the investment analysis. Explanation to justify the suitability of the benchmark is as follows.

For benchmark, the tool under Section 6 of the Sub-step 2 b of additionality tool , version 06.0.0 states "Discount rates and benchmarks shall be derived from:...".

Paragraph d under sub-step (2b), option III of the additionality tool refers to a Government/official approved benchmark where such benchmarks are used for investment decisions. There is no such Government/official[34] approved benchmark available for private sector power generation in the country.

Paragraph e under sub-step (2b), option III of the additionality tool suggests the option of using any other indicators, if the project participants can demonstrate that the above Options are not applicable and their indicator is appropriately justified.

Given the above discussion, in the context of the project activity, the lowest levelised cost of power generation amongst all the plausible baseline options, has been considered as the suitable benchmark.

Sub-step 2c (Calculation and comparison of financial indicators)

Comparison using project IRR as the financial indicator:

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[32] http://www.lancogroup.com/DynTestform.aspx?pageid=11
[33] The relevant document has been submitted to the DOE during validation.
[34] Central Electricity Authority (CEA) /or Central Electricity Regulatory Commission (CERC) do not specify any benchmark return in order to evaluate investment in power project in India

Project IRR has been considered as the financial indicator for the project activity. In this regard please refer to the discussion in section B.4 above on assumption considered to estimate levelised tariff . The same set of assumptions has been considered to determine the IRR of the project activity. In order to compute the IRR of the project activity the annual cost of generation as computed to determine the levelised tariff over 20 year period has been used.

The project IRR has been estimated at ~~11.72%~~11.91% which is lower than the applicable investment benchmark value of 12.86%.

The levelized tariff for all the plausible options to the proposed project activity has been calculated and presented in Section B.4 above. A summary of these levelized tariff[35] calculations is presented in the table below:

S.No.	Baseline Scenario	Levelized Tariff (INR/kWh)
1.	New power plant (s) based on natural gas	~~6.1398~~4.2522
2.	New power plant (s) based on coal with sub-critical technology	~~2.8478~~2.8556
3.	New power plant (s) based on coal with super-critical technology using imported coal	~~4.8342~~4.8385
4.	New power plant (s) based on coal with super-critical technology using domestic coal	~~2.9270~~2.9340
5.	New power plant (s) based on lignite	~~2.8984~~2.9063
6.	New power plant (s) based on naphtha	~~13.9044~~13.9103

On analysing this data it can be clearly seen that the project activity is not the most economical for power production. Using coal as fuel with sub-critical technology is economically the most feasible investment option for power generation. Amongst all the above options, the GHG emissions will be more than the project option.

The Cost of Power Generation using coal as fuel with subcritical technology is considered as the benchmark, as this is the economically most viable option to the project proponent.

Sub-step 2d (Sensitivity Analysis)

The findings of sensitivity analysis on levelized tariff for power generation using natural gas, coal, sub-critical, coal super-critical(Domestic & international fuel), lignite & naphtha were presented in section B.4 above. It further substantiates that even with reasonable variations in the key variable e.g. project cost, fuel price, SHR and PLF, power generation using natural gas as fuel continues to remain amongst the more expensive alternatives and the same using as fuel with sub-critical technology is economically the most attractive option.

On analysing this data it can be clearly seen that the project activity is not the most economical for power production. Using coal as fuel with sub-critical technologyis economically the most feasible investment option for power generation. Amongst all the above options, the GHG emissions will be more than the project option.

The Cost of Power Generation using coal as fuel with subcritical technology is considered as the benchmark, as this is the economically most viable option to the project proponent.

[35] The detailed excel sheets of these calculations are available with the project proponent for verification by DOE.

~~Project IRR has not been subjected to any further sensitivity analysis since variation of any of the sensitivity parameter will have similar impact upon the cost and revenue parameter of the project activity.~~

Sensitivity Analysis of Project IRR:

Sensitivity analysis of the candidate project activity has been conducted following the paragraph 20 and 21 of the 'Guideline on the assessment of Investment Analysis', Version 5 (EB 62, Annex - 5). The following parameters have been considered to have material impact upon the project IRR and have been subjected to sensitivity analysis:

- Plant Load Factor
- Station Heat Rate
- Project capital Cost
- Fuel Cost

S. NO	Parameter	Project IRR (%)	Project IRR (%)	Project IRR (%)	Project IRR (%)	Project IRR (%)	Benchmark (%)
	Percent change	(-10%)	(-5%)~~(-10%)~~	Base Case	(+5%)	(+10%)	
1	Plant Load Factor	11.91%	11.91%	11.91%	11.91%	11.91%	12.86%
2	Station Heat Rate	11.91%	11.91%	11.91%	11.91%	11.91%	12.86%
3	Project capital cost	12.56%	12.22%	11.91%	11.67%	11.41%	12.86%
4	Fuel Cost	11.91%	11.91%	11.91%	11.91%	11.91%	12.86%

It is quite evident from the table above that project IRR remains below the benchmark value (12.86%) in all the sensitivity scenarios. Also, it can be observed that there is marginal variation in the project IRR corresponding to various sensitivity scenarios and base case.

This is mostly attributable to the following reasons:

- Tariff for IRR computation has been derived from the annual levelised cost of generation.
- Cost elements as considered for computing the project IRR have been estimated following the fixed and variable cost as determined to compute levelised cost of generation.

Hence any variation in the input parameters (apart from the project cost) will have similar impact upon applicable tariff and related cost elements resulting into marginal change in the IRR value.

Step 2: Common practice analysis

Demonstrate that the project activity is not common practice in the relevant country and sector by applying Step 4 (common practice Analysis) of the latest version of the "Tool for demonstration and assessment of additionality" agreed by the CDM Executive Board.

Sub-step 4(a). Analyze other activities similar to the proposed project activity

The common practice analysis have been carried out following the UNFCCC's 'Tool to demonstrate Additionality' (version 6, paragraph 47) guidelines on common practice (version 01.0; EB 63 Annex-12).

Step 1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

The capacity of the project activity is 742 MW. Hence in accordance with step 1,the "applicable output range" is determined as 371 MW (project capacity-50%) to 1113 MW (project capacity + 50%).

Also, following the default choice as recommended in the guidelines on common practice (version 01.0; EB 63 Annex-12) the applicable geographical area has been considered as the entire host country i.e. India.

Step 2: In the applicable geographical area, identify all plants that deliver the same output or capacity, within the applicable output range calculated in Step 1, as the proposed project activity and have started commercial operation before the start date of the project. Note their number N_{all}. registered CDM project activities shall not be included in this step

The start date of the project activity is 1st January 2010. The list of projects whose capacities fall within the applicable range have been obtained from the CEA database (version 7) [36] . A total of 104 projects are observed (the excel with this list is has been shared with the DOE); from this list, it is further observed that in the case of 13 projects, the commissioned capacity as on project activity start date is lesser than the lower limit of the applicable range (additional capacity installed in these 13 power plants after project start date takes their capacities beyond 371 MW). Hence the number of projects falling within the applicable range as on project start date is 91. It is also observed that 2 of these projects are present in the CDM cycle and hence are not to be considered further (Vemagiri and Gautami CCCP). Also, part of Kondapalli GT (366 MW out of 716 MW) is currently under CDM validation; upon elimination of the 366 MW capacity, the remaining 350 MW would not qualify within the applicable range. Therefore,

$$\mathbf{N_{all} = 91}$$

Step 3: Within plants identified in Step 2, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

<u>Different Technologies (fuel source)</u>

The following table provides the types of the projects identified in step – 2 above:

S.No	Power Plant Type	Number of Plants
1	Thermal (coal based)	46
2	Thermal (lignite based)	2
3	Thermal (oil based)	1
4	Thermal (gas based)	10

[36] Source: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm ; version -07

S.No	Power Plant Type	Number of Plants
5	Hydro	28
6	Nuclear	4
	Total	**91**

It can be observed from the above table that of the 91 projects identified in step 2, 81 use a different fuel source and hence are different from the candidate project activity.

Investment Climate

Of the 10 gas based power plants, it can be observed that 8 are owned by state/central governments. All these projects would involve public/ or sovereign financing since these have been commissioned by public sector entities. Risk associated with public/ or sovereign financing would be much lower when compared to financing a private enterprise. Hence public sector projects would be more easily accessible to avail finance than the candidate project activity. Hence, these are deemed to be different from the candidate project in terms of investment climate. After the elimination of these projects, it is observed that there are two gas based privately owned power plants – Essar GT (515 MW), Paguthan (655 MW). The Essar 515 MW GT can operate on a variety of fuels (naphtha, high-speed diesel, natural gasoline liquid and/or natural gas)[37] and hence is technologically different.

Hence 90 of the 91 projects identified under N_{all} are different from the candidate project

$$\mathbf{N_{diff} = 90}$$

Step 4: Calculate factor $F=1-N_{diff}/N_{all}$ representing the share of plants using technology similar to the technology used in the proposed project activity in all plants that deliver the same output or capacity as the proposed project activity.

The discussion presented from step 1 to step 3 above have ascertained the value of N_{all} and N_{diff} as 88 and 88 respectively. Hence the calculation of factor F is as follows:

$$\text{Factor F} = 1- 90/91$$

$$= 1 – 0.989$$

$$= 0.011$$

Step 5: The proposed project activity is a common practice within a sector in the applicable geographical area if the factor F is greater than 0.2 and N_{all} - N_{diff} is greater than 3.

Please refer to the step 4 where-in the value of factor F has been calculated as 0

Further, drawing reference from the above steps the value of $N_{all} – N_{diff}$ is:

$$N_{all} – N_{diff} = 91\text{-}90$$

$$= 1;$$

Hence the above discussion demonstrates that the project activity is not a common practice within the given geographical area.

37 http://www.essarenergy.com/media/24371/essar_energy_plc_prospectus_30_april_2010__p_i_e_2042011102203.pdf; page 98

Based on the findings from above steps it is established that project activity itself is not the baseline scenario and hence is additional.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

>> According to the approved baseline methodology AM0029, the emission reductions ER_y by the project activity is calculated using the equation number 6 of version 03 (EB 39)

$ER_y = BE_y – PE_y – LE_y$

Where:

ER_y : emissions reductions in year y (tCO2e)

BE_y : emissions in the baseline scenario in year y (t CO_2e)

PE_y : emissions in the project scenario in year y (tCO_2e)

LE_y : leakage in year y (tCO_2e)

Baseline emissions

Baseline emissions are calculated, using equation number 2 of AM0029 version 03, by multiplying the electricity generated in the project plant ($EG_{PJ,y}$) with a baseline CO_2 emission factor ($EF_{BL,CO2,y}$), as follows:

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

For construction of large new power capacity additions under the CDM, there is a considerable uncertainty relating to which type of other power generation is substituted by the power generation of the project plant. However, for the proposed CDM project activity as mentioned in the Section B.4 above, power generation using coal as fuel applying sub-critical technology is the economically most attractive baseline alternative.

AM0029 advises to address the baseline uncertainties in a conservative manner by choosing the $EF_{BL,CO2,y}$ as the lowest emission factor among the following three options:

Option 1. The build margin, calculated according to “Tool to calculate the emission factor for an electricity system”; and

Option 2 The combined margin, calculated according to “Tool to calculate the emission factor for an electricity system”, using a 50/50 OM/BM weight.

Option 3 The emission factor of the technology (and fuel) identified as the most likely baseline scenario under “Identification of the baseline scenario” above, and calculated as follows:

$$EF_{BL,CO_2}(tCO_2/MWh) = \frac{COEF_{BL}}{\eta_{BL}} * 3.6GJ/MWh$$ *(using equation number 3 of AM0029 ver 03)*

where,

$COEF_{BL}$ = the fuel emission coefficient (tCO_2e/GJ), based on Table 2.2 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories

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

As per AM0029, the baseline emission factor determination is required to be made once at the validation stage based on an *ex ante* assessment and once again at the start of each subsequent crediting period (if applicable). If either option 1 (BM) or option 2 (CM) are selected, then they will be estimated *ex post*, as described in “Tool to calculate the emission factor for an electricity system”.

Option 1: Build Margin, calculated according to “Tool to calculate the emission factor for an electricity system”

The Build Margin emission factor $EF_{grid,BM,y}$ (tCO_2/MWh) is given as the generation-weighted average emission factor of the selected representative set of recent power plants represented by the 5 most recent plants or the most recent 20% of the generating units built:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \times EF_{EL,m,y}}{\sum_m EG_{m,y}}$$

(using equation number 12 of Tool to calcúlate the emission factor for an electricty system)

Where

$EF_{grid,m,y}$ is Build Margin CO2 emission factor in year y (tCO2/MWh)

$EG_{m,y}$ is net quantity of electricity generated and delivered to the grid by power unit *m* in year *y* (MWh)

$EF_{BL,m,y}$ is CO2 emission factor of power unit *m* in year *y* (tCO2/MWh)

m is power units included in the build margin

y is most recent historical year for which power generation data is available

The Central Electricity Authority, Ministry of Power, Government of India has published a database[38] of Carbon Dioxide Emission from the power sector in India based on detailed authenticated information obtained from all operating power stations in the country. This database i.e. The CO_2 Baseline Database provides information about the Operating Margin and Build Margin Emission Factors of all the regional electricity grids in India. The Operating Margin in the CEA database is calculated ex ante using the Simple OM approach and the Build Margin is calculated ex ante based on 20% most recent capacity additions in the grid based on net generation as described in “Tool to calculate the emission factor for an electricity system”. We have, therefore, used the Operating Margin and Build Margin data published in the CEA database, version – 7.0 for calculating the baseline emission factor.

The Build Margin for the southern regional grid for year 2010-11 as per CEA database, version – 7.0 is **0.7339 tCO2e/MWh**.

Option 2 The combined margin, calculated according to “Tool to calculate the emission factor for an electricity system”, using a 50/50 OM/BM weight.

The combined margin emission factor as per “Tool to calculate the emission factor for an electricity system”, is calculated as a combination of the Operating Margin (OM) and the Build Margin (BM). Considering the emission factors for these two margins as $EF_{grid,OM,y}$ and $EF_{grid,BM,y}$, then the $EF_{grid,,CM,y}$ is given by:

[38] Source: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm ; version -07

$$EF_{grid,CM,y} = EF_{grid,OM,y} * w_{OM} + EF_{grid,BM,y} * w_{BM}$$

with respective weight factors w_{OM} and w_{BM} (where $w_{OM} + w_{BM} = 1$).

As instructed in AM0029, we have used a 50/50 weight for OM and BM while calculating the combined margin emission factor.

Operating Margin emission factor

As per "Tool to calculate the emission factor for an electricity system", dispatch data analysis should be the first methodological choice. However, this option is not selected because the information required for calculating OM based on dispatch data is not available in the public domain for the Southern electricity regional grid.

The Simple Operating Margin approach is appropriate to calculate the Operating Margin emission factor applicable in this case. As per "Tool to calculate the emission factor for an electricity system" the Simple OM method can only be used where low cost must run resources constitute less than 50% of grid generation based on average of the five most recent years. CEA Database (version 7) provides the percentage generation by low-cost must run sources for the 5 year period from 2006-07 to 2010-11 as follows[39]:

Year	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**
Must run (as a percentage of net generation in Southern Region)	28.3%	27.1%	22.8%	20.6%	21.0%

From the available information it is clear that low cost/must run sources account for less than 50% of the total generation in the Southern grid in the last five years. Hence the Simple OM method is appropriate to calculate the Operating Margin Emission factor applicable.

As mentioned earlier, Operating Margin in the CEA database has been calculated using the Simple OM method. We have therefore considered the OM numbers provided in the CEA database.

Operating margin data for the Southern region electricity grid for the latest three years available in the CEA database are given below:

Year	**Operating Margin (tCO_2e/MWh)**
2008 – 09	0.973
2009 – 10	0.942
2010 - 11	0.942
Average of 3 years	**0.952**

The Operating Margin applicable for the project activity is taken as average of the latest three years operating margins. Accordingly the Operating Margin is determined as 0.952 tCO2e/MWh. As mentioned earlier, the applicable Build Margin value is 0.7339 tCO2e/MWh.

Applying a 50/50 weightage to the values for operating margin and build margin emission factors provided in the CEA database, the Combined Margin emission factor is calculated as **0.843 tCO_2e/MWh**.

[39] http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm

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

As demonstrated under section B.4 earlier, coal based power generation using sub-critical technology represents economically the most attractive course of action, taking into account barriers to investment. Therefore, coal based power generation using sub-critical technology has been identified as the baseline scenario.

The emission factor of coal based power generation calculated using the equation below:

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

$COEF_{BL}$ = Carbon Emission Factor of coal x Oxidation Factor of coal x 44/12

$COEF_{BL}$ has been estimated at 96.07 tCO_2/TJ (i.e. 0.096 tCO_2/GJ)

η_{BL} = 34.72% (refer Annex 3 for calculations) for coal based power plants using sub-critical technology

$EF_{BL,CO2}(tCO2/MWh)$ = 0.096 (tCO2e/GJ) x 3.6 (GJ/MWh)/ 34.72%

= 0.996 tCO2e/MWh

Baseline Emission Factor

Emission factors determined using the three options are summarised in the table below

Option	Emission Factor (tCO_2e/MWh)
Option 1: Build Margin	0.733
Option 2: Combined Margin	0.843
Option 3: Emission factor of lignite based power plant	0.996

Option 1: Build Margin value is the lowest of all the three options and hence the appropriate Baseline Emission Factor. Accordingly, Baseline Emission Factor value applicable to the project activity is 0.733 tCO2e/MWh.

As per AM0029, in case the Build Margin or the Combined Margin is selected as the baseline emission factor, the baseline emission factor (Build Margin) will be determined *ex-post*, as described in "Tool to calculate the emission factor for an electricity system". As per "Tool to calculate the emission factor for an electricity system", in case of ex-post determination, the Build Margin must be updated annually *ex-post* for the year in which the actual generation and associated emission reduction occur. The latest version of CEA CO2 baseline database that is used to determine the BM factor was published in January 2012 and contains information up to 2010-11. CEA has acknowledged that because of the dynamic nature of data, the database will have to be updated every year. Therefore we expect the CEA database to be updated every year. If the CEA database is not updated, the Build Margin number will be calculated by the project proponent using the available CEA data.

Project emissions

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

$$PE_y = \sum_f FC_{f,y} * COEF_{f,y}$$ (using equation 1 of AM0029 version 03)

Where:

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

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

$$COEF_{f,y} = \sum NCV_y * EF_{CO_2,f,y} * OXID_f$$ (using equation 1a of AM0029 ver 03)

Where:

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

$EF_{CO2,f,y}$: is the CO_2 emission factor per unit of energy of natural gas in year 'y' (tCO_2/GJ) taken from IPCC;

$OXID_f$: is the oxidation factor of natural gas

For start-up fuels, IPCC default calorific values and CO_2 emission factors are acceptable, if local or national estimates are unavailable.

Applicable values for the above parameters are provided below:

NCVy: Calorific value of Natural Gas consumed by the Project activity is: 8562 kCal/SCM or 35847.38 KJ/SCM

$EF_{CO2,f,y}$: CO2 emission factor per unit of energy of Natural gas is determined as follows:

IPCC default value for Carbon Emission Factor of Natural Gas is 56.10 tCO_2e/tJ

$EF_{CO2,f,y}$ = 56.10 tCO_2e/tJ

$OXID_f$: Oxidation factor of Natural Gas as per IPCC Guidelines is 1.0

$COEF_{f,y}$: CO_2 emission coefficient for Natural Gas is determined as:

$COEF_{f,y}$ = 35847.38 /10^9 (tJ/SCM) x 56.10 (tCO_2e/tJ) x 1

$COEF_{f,y}$ = 2011.04 tCO_2e/Mcum

Leakage emissions

Leakage may result from fuel extraction, processing, liquefaction, transportation, re-gasification and distribution of fossil fuels outside of the project boundary. This includes mainly fugitive CH_4 emissions and CO_2 emissions from associated fuel combustion and flaring. In this methodology, the following leakage emission sources shall be considered:[40]

Fugitive CH_4 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.

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

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

Thus, leakage emissions are calculated as follows:

$$LE_y = LE_{CH4,y} + LE_{LNG,CO2,y} \quad (5)$$

where:

LE_y Leakage emissions during the year y in tCO_2e

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

$LE_{LNG,CO2,y}$ Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_2e

Fugitive methane emissions

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

$$LE_{CH4,y} = \left[FC_y . NCV_y . EF_{NG,upstream,CH4} - EG_{PJ,y} . EF_{BL,upstream,CH4}\right] . GWP_{CH4} \quad (6)$$

where:

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

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

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

$EF_{NG,upstream,CH4}$ Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system, in tCH_4 per GJ fuel supplied to final consumers

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

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

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

The emission factor for upstream fugitive CH_4 emissions occurring in the absence of the project activity ($EF_{BL,upstream,CH4}$) should be calculated consistent with the baseline emission factor ($EF_{BL,CO2}$) used in equation (4) above. As presented in Annex 3, the emission factor was found to be the lowest with Build Margin method for the Southern grid, so the same calculation procedure has been adopted to calculate $EF_{BL,upstream,CH4}$, as presented below:

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

where:

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

j Plants included in the build margin

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

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

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

Default values used for calculating leakage emissions due to the project activity are as follows:

Sl. No	Parameter	Default Value	Remarks
1	Emission factor for fugitive CH4 upstream emissions for coal	0.8 tCH4/kt coal	Most of the coal production in India comes from open pit mines contributing over 81% of the total production. A number of large open pit mines of over 10 million tonnes per annum capacity are in operation. Underground mining currently accounts for around 19% of national output. (http://www.coal.nic.in/welcome.html). Further, Singareni Collieries Company Limited (SCCL) is the main source for supply of coal to the southern region (http://www.coal.nic.in/cpddoc.htm) and more than 80% of coal at SCCL is mined from open cast mines (http://www.coal.nic.in/cpdanx.htm#Annexure-II). Hence 0.8 tCH4/kt coal value is used for surface mining
2	Emission factor for fugitive CH4 upstream emissions for Oil	4.1 tCH4/PJ	As per the Table 2 of the methodology. This value includes for oil production, transport, refining and storage.
3	Emission factor for fugitive CH4 upstream emissions for Natural Gas	296 tCH4/PJ	As per the Table 2 of the methodology 296 tCH4/PJ is applicable for rest of the world and 160 tCH4/PJ is for USA and Canada.
4	Oxidation factor of natural gas	1.0	IPCC value as per 2006 IPCC guidelines for National Green House Gas inventories

Leakage calculations are provided in Appendix 2.
Upstream fugitive emissions occurring in the absence of the project activity electricity generation has been calculated using the Build Margin power plants. Therefore in line with the AM0029 requirement of *ex-post* determination of the Build Margin, the Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation (tCH_4 /MWh) will also be determined *ex-post*.

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$EF_{BM,y}$
Data unit:	tCO_2e/MWh
Description:	Build Margin Emission Factor of Southern Regional Electricity Grid

Source of data used:	"CO_2 Baseline Database for Indian Power Sector" Version 7 dated January 2012 published by the Central Electricity Authority, Ministry of Power, Government of India. The "CO_2 Baseline Database for Indian Power Sector" is available at www.cea.nic.in
Value applied:	0.7339
Justification of the choice of data or description of measurement methods and procedures actually applied :	Build Margin Emission Factor has been calculated by the Central Electricity Authority in accordance with "Tool to calculate the emission factor for an electricity system".
Any comment:	-

2. Data / Parameter:	***$EF_{OM,y}$***
Data unit:	tCO_2e/MWh
Description:	Operating Margin Emission Factor of Southern Regional Electricity Grid
Source of data used:	"CO_2 Baseline Database for Indian Power Sector" Version 7 dated January 2012 published by the Central Electricity Authority, Ministry of Power, Government of India. The "CO_2 Baseline Database for Indian Power Sector" is available at www.cea.nic.in
Value applied:	Average value of the three year data = 0.952 2008 – 09: 0.973 2009 – 10: 0.942 2010 - 11: 0.942 **Average: 0.952**
Justification of the choice of data or description of measurement methods and procedures actually applied :	Operating Margin Emission Factor has been calculated by the Central Electricity Authority using the simple OM approach in accordance with "Tool to calculate the emission factor for an electricity system".
Any comment:	-

3. Data / Parameter:	**Carbon Emission Factor of Natural Gas ($EF_{CO2,f,y}$)**
Data unit:	tCO_2/GJ
Description:	The CO_2 emission factor per unit of energy of natural gas in year 'y'
Source of data used:	IPCC default value has been applied (Source: Chapter-2 IPCC 2006 Guidelines for National Greenhouse Gas Inventories)
Value applied:	56.1 tCO_2/TJ (= 0.0561 tCO_2/GJ)
Justification of the choice of data or description of measurement methods and procedures actually applied :	As there are no national data available for the emission factor of the fuel used, default value based on Table 2.2 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories has been applied.
Any comment:	-

4. Data / Parameter:	Oxidation Factor of Natural Gas ($OXID_f$)
Data unit:	-
Description:	Oxidation factor of natural gas
Source of data used:	IPCC default value has been applied (Source: Chapter-2 IPCC 2006 Guidelines for National Greenhouse Gas Inventories)
Value applied:	1.0
Justification of the choice of data or description of measurement methods and procedures actually applied :	As there are no national data available, IPCC default value based on is considered
Any comment:	-

5. Data / Parameter:	Station Heat Rate of the Project activity
Data unit:	kCal/kWh
Description:	Station Heat Rate has been used to calculate the quantity of Natural Gas consumption associated with the expected electricity generations from the project activity. This data is used as an input for calculating Project Emissions.
Source of data used:	Detailed project report (DPR) The CERC tariff order of 2009 has also specified the SHR of 1850 kCal/ kWh for the combined cycle gas based power plant with advanced class machines.
Value applied:	1850
Justification of the choice of data or description of measurement methods and procedures actually applied :	-
Any comment:	-

6. Data / Parameter:	Carbon Emission Factor of Coal, Lignite, Diesel, Oil, Natural Gas
Data unit:	tCO_2/TJ
Description:	Emission factor of Coal, Lignite, Diesel, Oil, Natural Gas. This data will be used as an input for calculating the fugitive CH4 emissions occurring in the absence of the project activity
Source of data used:	Carbon Emission Factor for Coal, Lignite & Oil: Table 2.3 - India specific CO2 emission coefficients, India's first National Communication to the United Nations Carbon Emission Factor for Diesel & Natural Gas: Table 1.4, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, Volume 2, Energy
Value applied:	

Type of FUEL	Net Calorific Value (TJ/ 103 tonnes or TJ/Mcum)	Carbon Emission Factor (t C/ TJ)	Fraction of Carbon Oxidised Oxidation Factor	Emission Coefficient (tCO2/ 103 tonnes or tCO2/Mcum)	Density (kg/ Lt)	Emission factor (tCO2/1000 t or tCO2/Mcum)
(Non coking) Coal	15.16	26.20	1.00	1,452	1.00	1,452
Lignite	10.99	27.30	1.00	1,167	1.00	1,167
Natural Gas	33.16	15.30	1.00	1,860	1.00	1,860
Naphtha	44.95	20.00	1.00	3,296	0.76	2,505

Justification of the choice of data or description of measurement methods and procedures actually applied :	As per AM0029, the fuel emission coefficient is to be determined based on national average fuel data if available. Accordingly we have used the data available in India's first national communication to the United Nations for our calculations where available, otherwise IPCC default values have been used.
Any comment:	-

7. Data / Parameter:	**Oxidation Factor of Coal, Lignite, Diesel, Oil, Natural Gas**
Data unit:	-
Description:	Oxidation factor of coal which has been identified as the baseline scenario fuel This data is used as an input for calculating the fugitive CH4 emissions occurring in the absence of the project activity
Source of data used:	Table 1.4, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 1, Volume 2, Energy
Value applied:	Refer Appendix 2
Justification of the choice of data or description of measurement methods and procedures actually applied :	Only IPCC default values are available.
Any comment:	-

8. Data / Parameter:	**Calorific values of Coal, Lignite, Diesel, Oil and Natural Gas Naphtha**
Data unit:	kCal/Kg or kCal/SCM
Description:	This data is used as an input for calculating the Energy efficiency of coal fired power plants and the fugitive CH_4 emissions occurring in the absence of the

	project activity
Source of data used:	NCV of Coal – Table 6.3, CEA General Review 2006 NCV of Natural Gas, Diesel : CEA Data on Petroleum fuels used by various Gas Turbines and Diesel Engine Power Plants in India in 2003-04
Value applied:	Refer Appendix 2
Justification of the choice of data or description of measurement methods and procedures actually applied :	Central Electricity Authority, Government of India mandated to publish information on performance of power sector in India by the Electricity Act 2003.
Any comment:	-

9. Data / Parameter:	η_{BL} *– Efficiency of coal fired power generating stations using sub-critical technology*
Data unit:	-
Description:	Energy efficiency of coal fired power plant using sub-critical technology which has been identified as the baseline scenario
Source of data used:	Calculated value based on fuel consumption, NCV of coal and electricity generation data of coal fired power stations published in the CEA carbon-di-oxide emission database, version - 07
Value applied:	34.72%
Justification of the choice of data or description of measurement methods and procedures actually applied :	Central Electricity Authority, Government of India mandated to publish information on performance of power sector in India by the Electricity Act 2003.
Any comment:	-

10. Data / Parameter:	**Fuel consumption in coal fired power plants using sub-critical technology in the southern region**
Data unit:	Thousand tons
Description:	This data is used as an input for calculating the Energy efficiency of coal fired power plants
Source of data used:	CEA CO_2 Baseline database, version - 07

<table>
<tr><td>Value applied:</td><td>

Sub Critical Coal fired stations	Coal consumption 1000 tons
RAYAL SEEMA	896.41
RAYAL SEEMA	926.53
RAYAL SEEMA	94.35
R_GUNDEM STPS	2497.82
SIMHADRI	0
RAICHUR	276.79
BELLARY TPS	1986.51
VIJAYWADA TPP-IV	2202.81
TORANGALLU EXT	1420.67
TORANGALLU EXT	1420.67
STERLITE TPP	257.19
STERLITE TPP	469.66
KAKATIYA TPP	1135.37
UPUPI TPP	1120.12

</td></tr>
<tr><td>Justification of the choice of data or description of measurement methods and procedures actually applied :</td><td>CEA CO_2 Baseline database, version - 07</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

11. Data / Parameter:	**Electricity Generation from coal fired power plants using sub-critical technology in the Southern Region**
Data unit:	GWh
Description:	This data is used as an input for calculating the Energy efficiency of coal fired power plants
Source of data used:	CEA CO_2 baseline database, version -06

Value applied:	<table><tr><th>Sub Critical Coal fired stations</th><th>Electricity Generation GWh</th></tr><tr><td>RAYAL SEEMA</td><td>1398.64</td></tr><tr><td>RAYAL SEEMA</td><td>1447.22</td></tr><tr><td>RAYAL SEEMA</td><td>145.49</td></tr><tr><td>R_GUNDEM STPS</td><td>3811.14</td></tr><tr><td>SIMHADRI</td><td>0.00</td></tr><tr><td>RAICHUR</td><td>357.44</td></tr><tr><td>BELLARY TPS</td><td>2486.20</td></tr><tr><td>VIJAYWADA TPP-IV</td><td>3584.89</td></tr><tr><td>TORANGALLU EXT</td><td>2309.78</td></tr><tr><td>TORANGALLU EXT</td><td>2309.78</td></tr><tr><td>STERLITE TPP</td><td>317.14</td></tr><tr><td>STERLITE TPP</td><td>579.13</td></tr><tr><td>KAKATIYA TPP</td><td>1694.06</td></tr><tr><td>UPUPI TPP</td><td>1595.94</td></tr></table>
Justification of the choice of data or description of measurement methods and procedures actually applied :	Central Electricity Authority, Government of India mandated to publish information on performance of power sector in India by the Electricity Act 2003. In order to facilitate baseline emissions relating to electricity generation activities, CEA has published a database of CO_2 emission factors, version -07 for all the regional grids in India. This database also contains information on electricity generation from all major thermal power stations in the country.
Any comment:	-

12. Data / Parameter:	**CO2 emissions from Build Margin Power plants in the southern region**
Data unit:	tCO_2e
Description:	This data is used as an input for calculating the fugitive CH4 emissions occurring in the absence of the project activity
Source of data used:	CEA CO_2 Baseline database, version 7
Value applied:	Refer Appendix 2
Justification of the choice of data or description of measurement methods and procedures actually applied :	Central Electricity Authority, Government of India mandated to publish information on performance of power sector in India by the Electricity Act 2003. In order to facilitate baseline emissions relating to electricity generation activities, CEA has published a database of CO_2 emission factors for all the regional grids in India. This database also contains information on CO_2 emissions of all major thermal power stations in the country.
Any comment:	-

B.6.3. Ex-ante calculation of emission reductions:

>>

The emission reductions ***ERy*** by the project activity during a given year *y* is:

$$\mathbf{ER_y = BE_y - PE_y - LE_y}$$

Where:

ER_y : emissions reductions in year y (t CO_2e)

BE_y : emissions in the baseline scenario in year y (t CO_2e)

PE_y : emissions in the project scenario in year y (t CO_2e)

LE_y : leakage in year y (t CO_2e)

Baseline Emissions:

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

EGy = Annual expected net electricity generation from the project activity

= Gross electricity generation – Auxiliary Power Consumption @ 3% of gross generation

= (742 MW x 85% (PLF) x 8,760 (hours))*0.97

= 5,359,184 MWh

$EF_{BL,CO2,y}$ = 0.7339 tCO_2e / MWh. (refer section B.6.1)

Baseline Emissions = 5,359,184 MWh x 0.7339 tCO2e/MWh = 3,933,105 tCO2e

Project Emissions (PEy):

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

$FC_{f,y}$ = Annual fuel consumption by the project activity

= Gross Annual Electricity Generation x Gross Station Heat Rate / Calorific Value of Natural Gas

= 5,524,932 (MWh) x 1850 (MCal/MWh) / 8562 (MCal/1000SCM)

= 1,193.78 (Million SCM)

$COEF_{f,y}$ = 2,011.04 tCO_2e/Mcum (refer section B.6.1)

Project Emissions = 1,193.78 (Mcum) x 2,011.04 (tCO_2e/Mcum) = **2,400,732 tCO_2e**

Leakage Emissions (LEy)

Leakage: LEy = 144,817 **tCO_2e** (Please refer Appendix 2 for details of Leakage calculations)

Emission Reductions = 3,933,105 tCO_2e – 2,400,732 tCO_2e – 144,817 tCO_2e
= 1,387,555 tCO_2e

Note: The calculation shown above is for a normal year; the values of baseline emission, project emission, leakage and the resultant emission reductions for all the years of the crediting period, which would include two leap-years, has been presented in the ER calculation excel and in the table in section B.6.4 below.

B.6.4 Summary of the ex-ante estimation of emission reductions:

>> A summary of the ex-ante estimation of emission reductions for all years of the crediting period has been presented in the table below:

Year	Estimation of project activity emissions (tCO_2e)	Estimation of baseline emissions (tCO_2e)	Estimation of leakage (tCO_2e)	Estimation of overall emission reductions (tCO_2e)
2013	2,400,732	3,933,105	144,817	1,387,555
2014	2,400,732	3,933,105	144,817	1,387,555
2015	2,400,732	3,933,105	144,817	1,387,555
2016	2,407,310	3,943,881	145,214	1,391,357
2017	2,400,732	3,933,105	144,817	1,387,555
2018	2,400,732	3,933,105	144,817	1,387,555
2019	2,400,732	3,933,105	144,817	1,387,555
2020	2,407,310	3,943,881	145,214	1,391,357
2021	2,400,732	3,933,105	144,817	1,387,555
2022	2,400,732	3,933,105	144,817	1,387,555
Total (tCO_2e)	**24,020,476**	**39,352,602**	**1,448,964**	**13,883,154**

B.7.1 Application of the monitoring methodology and description of the monitoring plan:

>>

Approved monitoring methodology AM0029 "Grid Connected Electricity Generation Plants using Non-Renewable and Less GHG Intensive Fuel".

Reference: Available on http://cdm.unfccc.int, Version 03.0 EB 39.

The applicability of this methodology to the proposed CDM project activity has been discussed in Section B.2 above.
All the data monitored for the estimation of project, baseline and leakage emissions for verification and issuance will be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

1. Data / Parameter:	**$FC_{f,y}$**
Data unit:	m^3 (standard cubic meter)
Description:	Total volume of natural gas combusted in the project plant in year y
Source of data to be used:	Fuel supplier data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	1,193.78 million cu.m
Description of measurement methods and procedures to be applied:	The value will be taken from gas tickets received from the gas transporter. Fuel flow meter (ultrasonic flow meter) shall be installed at plant site by the transporter (main meter) and readings shall be recorded daily. The values will be correlated with joint ticket received from the transporter fortnightly. For cross checking of the values, check meter will also be installed and maintained by LKPL. The mode of archiving data will be electronic and paper.
QA/QC procedures to be applied:	The main meters are maintained by the gas supplier and will be calibrated atleast once in a year. The same calibration frequency would be maintained fotr the check meter maintained by the PP.The meters will be calibrated as per the

	standard procedures and documents for the same will be maintained throughout. Refer Annex 4 more details.
Any comment:	100% of data will be monitored.

2. Data / Parameter:	**$NCV_{f,y}$**
Data unit:	kCal/scum
Description:	The net calorific value (energy content) per volume unit of natural gas in year ‘y’
Source of data to be used:	Fuel supplier data
Value of data applied for the purpose of calculating expected emission reductions in section B.5	8562
Description of measurement methods and procedures to be applied:	The calorific value of natural gas consumed would be provided by gas supplier and recorded by LKPL for verification. A gas chromatograph has been installed at the project site by the gas supplier based on which billing is done. LKPL also maintains a gas chromatograph at the project site for the cross checking of the NCV values provided. The calorific value of the gas is recorded in the instrument once every 4 minutes and daily average values of the NCV are provided by the gas supplier in the daily and consolidated fortnightly gas tickets. The calibration frequency for the gas chromatograph is once every six months (for instruments owned by gas supplier and the PP)
QA/QC procedures to be applied:	
Any comment:	The data will be archived electronically

3. Data / Parameter:	**$EF_{co2,f,y}$**
Data unit:	tCO_2e/GJ
Description:	CO_2 Emission Factor of Natural Gas
Source of data to be used:	IPCC 2006 default values for Carbon Emission Factor
Value of data applied for the purpose of calculating expected emission reductions in section B.6	0.0561
Description of measurement methods and procedures to be applied:	Default values for Carbon Emission Factor of Natural Gas as per Table 1.3 2006 IPCC Guidelines for National Greenhouse Gas Inventories, (Chapter 1, Volume 2, Energy) has been considered. This is also in conformity with the recommendations of the GhG inventory information report submitted by India’s Initial National Communication (Chapter 2) where in it is mentioned that in the case of petroleum products and natural gas, the use of default emissions would be fairly accurate due to relatively low variation in quality of these fuels across the globe, as compared to coal. This data will be recorded annually based on

	latest IPCC information available and will be archived in electronic/paper form. Archived data will be kept up to two years from the end of crediting period or the last issuance, which ever occurs later.
QA/QC procedures to be applied:	No additional QA/QC procedures are planned.
Any comment:	Carbon Emission factor of natural gas will be updated as per the latest guidelines available from IPCC on national greenhouse gas inventory on year to year basis.

4. Data / Parameter:	**$OXID_f$**
Data unit:	
Description:	Oxidation Factor of Natural Gas
Source of data to be used:	IPCC
Value of data applied for the purpose of calculating expected emission reductions in section B.6	1.0
Description of measurement methods and procedures to be applied:	Default values as per Table 1.4 Revised 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual has been considered This is also in conformity with the recommendations of the GhG inventory information report submitted by India's Initial National Communication (Chapter 2) where in it is mentioned that in the case of petroleum products and natural gas, the use of default emissions would be fairly accurate due to relatively low variation in quality of these fuels across the globe, as compared to coal. This data will be recorded annually based on latest IPCC information available and will be archived in electronic/paper form. Archived data will be kept up to two years from the end of crediting period or the last issuance, which ever occurs later.
QA/QC procedures to be applied:	No additional QA/QC procedures are planned.
Any comment:	Oxidation factor of natural gas will be updated as per the latest guidelines available from IPCC on national greenhouse gas inventory on year to year basis.

5. Data / Parameter:	**$EG_{Phase - III}$**
Data unit:	MWh
Description:	Net electricity generation from generating units of LKPL Phase – III project
Source of data to be used:	Electronic meters installed at project site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be	This parameter refers to the electricity generated by the generating units belonging to the LKPL's phase – III project, i.e., the two GTGs (denoted at site as GTG – 2 and GTG – 3) and the two STG's (denoted at site as STG – 2 and

applied:	STG – 3). Generation from each of these generating units are measured at the higher voltage side (i.e a total of 4 meters for the phase III generating units). These readings are recorded on a daily basis in the plant log. The daily reading will be archived electronically for a minimum of crediting period + 2 years.
QA/QC procedures to be applied:	The meters will be calibrated as per the standard procedures and documents for the same will be maintained throughout. The accuracy of energy meters is 0.2; these are calibrated once in 4 years.
Any comment:	None

5. Data / Parameter:	**$EG_{Phase - II}$**
Data unit:	MWh
Description:	Net electricity generation from generating units of LKPL Phase – II project
Source of data to be used:	Electronic meters installed at project site
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	This parameter refers to the electricity generated by the generating units belonging to the LKPL's phase – II project, i.e., one GTG (denoted at site as GTG – 1) and the one STG (denoted at site as STG – 1). Generation from each of these generating units are measured at the higher voltage side (i.e a total of 2 meters for the phase II generating units). These readings are recorded on a daily basis in the plant log. The daily reading will be archived electronically for a minimum of crediting period + 2 years.
QA/QC procedures to be applied:	The meters will be calibrated as per the standard procedures and documents for the same will be maintained throughout. The accuracy of energy meters is 0.2; these are calibrated once in 4 years.
Any comment:	None

5. Data / Parameter:	**$EG_{Substation}$**
Data unit:	MWh
Description:	Net electricity generation from LKPL received (Phase II and Phase III) at the Substation
Source of data to be used:	Electronic meters installed at Nunna substation
Value of data applied for the purpose of calculating expected emission reductions in section B.5	-
Description of measurement methods and procedures to be applied:	The energy generated by LKPL's Phase – II and Phase – III project activities are supplied to the PGCIL grid through the Nunna substation, through a double circuit line. This parameter denotes the sum of energy received at Nunna through each of the lines (measured using dedicated 2 meters – one for each line). These values are published in Southern Regional Load Dispatch Center (SRLDC) on a fortnightly basis. These values will be stored in electronic

	format for crediting period +2 years.
QA/QC procedures to be applied:	The meters will be calibrated as per the standard. The accuracy of energy meters is 0.2; these are calibrated once in 4 years by PGCIL.
Any comment:	None

5. Data / Parameter:	**$EG_{PJ,y}$**
Data unit:	MWh/ year
Description:	Net electricity generation in the project plant during the year
Source of data to be used:	Electronic meters installed at the PGCIL sub-station at Nunna
Value of data applied for the purpose of calculating expected emission reductions in section B.5	5,359,184 MWh (Based on a normative PLF of 85 % and auxiliary power consumption of 3%)
Description of measurement methods and procedures to be applied:	As per exclusive actual meter readings at Nunna sub station of PGCIL; this data is published in the website of the Southern Regional Load Despatch Center. The energy generated by the candidate project (Phase III) and the Phase II project is supplied to the Nunna sub-station through a common double circuit line. Hence, an apportioning procedure is required to ascertain the quantity of energy supplied by the candidate project. Please refer section B.7.2 for details about the same. The daily reading will be archived electronically for a minimum of crediting period + 2 years. .
QA/QC procedures to be applied:	The meters will be calibrated as per the standard procedures and documents for the same will be maintained throughout. The accuracy of energy meter located at Nunna substation (main meters) is 0.2s,; these are calibrated once in 4 years. The check meters maintained by LKPL at the generating site is of accuracy 0.2 and are calibrated annually.. Refer Annex 4 for more details.
Any comment:	

6. Data / Parameter:	**$EF_{BM,y}$**
Data unit:	tCO_2/MWh
Description:	Build Margin Emission factor for Southern grid
Source of data used:	"CO_2 Baseline Database for Indian Power Sector" published by the Central Electricity Authority, Ministry of Power, Government of India. The "CO_2 Baseline Database for Indian Power Sector" version 7 dated January 2012 available on website of Central Electricity Authority (http://cea.nic.in)
Value of data applied for the purpose of calculating expected emission reductions in section B.5	0.7339
Description of measurement methods	Build Margin Emission Factor will be taken from the CO_2 baseline database published by CEA. In case the CEA database is not updated, the project

and procedures to be applied:	proponent will calculate the Build Margin number using the available CEA data. This data will be computed annually based on latest available information and will be archived in electronic/paper form. Archived data will be kept up to two years from the end of crediting period or the last issuance, which ever occurs later.
QA/QC procedures to be applied:	No additional QA/QC procedures are planned.
Any comment:	-

7. Data / Parameter:	$EF_{BL,upstream,CH4}$
Data unit:	tCO_2e/MWh
Description:	Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation
Source of data to be used:	CEA CO_2 baseline database or calculated value based on available CEA data in case the database is not updated
Value of data applied for the purpose of calculating expected emission reductions in section B.6	**22.60** tCO_2 e /MWh (Refer Appendix 2 of this document for calculations)
Description of measurement methods and procedures to be applied:	$EF_{BL,upstream,CH4}$ is calculated for power plants included in the Build Margin, inline with the baseline emission factor selection. Therefore in line with the AM0029 requirement of ex-post determination of the Build Margin, the Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity electricity generation (tCH_4 or tCO_2e/MWh) will also be determined *ex-post*. This data will be computed annually based on latest available information and will be archived in electronic/paper form. Archived data will be kept up to two years from the end of crediting period or the last issuance, which ever occurs later.
QA/QC procedures to be applied:	No additional QA/QC procedures are planned.
Any comment:	-

8.Data / Parameter:	PE_y
Data unit:	tCO_2e
Description:	Project emission due to combustion of fuel
Source of data to be used:	Calculated
Value of data applied for the purpose of calculating expected emission reductions in section B.6	2,400,732
Description of measurement methods and procedures to be applied:	Project emission due to combustion of fuel is calculated using (i)Total volume of natural gas combusted in the project plant and (ii) CO2 Emission coefficient for natural gas as follows:

	$PE_y = \sum_f FC_{f,y} \times COEF_{f,y}$
QA/QC procedures to be applied:	No additional QA/QC procedures are planned.
Any comment:	-

B.7.2. Description of the monitoring plan:

>>

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

1. Establishing and maintaining the appropriate monitoring systems for consumption of NG and electricity generated by the proposed project.
2. Quality control at Project Activity and measurements.
3. Assigning monitoring responsibilities to personnel.
4. Data storage and filing system.

Monitoring plan for energy generation

The energy generated by the project activity would be supplied to the PGCIL grid through the Nunna Substation. A dedicated 400 kV double circuit line is available from LKPL's facility to the substation. It is to be noted that the double circuit lines are common to both LKPL's phase III (candidate project activity of 742 MW) and Phase II (366 MW). Hence an apportioning procedure is necessary for ascertaining the quantum of electricity that is being supplied by the candidate project activity.

Each GTG and STG in LKPL's phase III and phase II projects have a meter to measure the net quantity of electricity supplied. Each of the 400 kV lines has a separate metering arrangement at the substation.

There are 3 meters maintained by the substation for each line. A main meter and a check meter are available at the sub-station and a third meter is available near LKPL's facility, which will be used in case of failure of both the main and check meters at the substation.

The apportioning procedure to be followed is illustrated as below. Consider the following:

<u>Lanco phase III (candidate CDM project activity of 742 MW)</u>

Electricity generated by GTG – 3(A) = a

Electricity generated by STG – 3(A) = b

Electricity generated by GTG – 3(B) = c

Electricity generated by GTG – 3(B) = d

Total generation by LKPL's phase III project activity = a+b+c+d = $EG_{Phase\text{ - }III}$

<u>Lanco phase II project activity (366 MW)</u>

Electricity generated by GTG – 2 = e

Electricity generated by STG – 2 = f

Total generation by LKPL's phase II project activity = e+f = $EG_{Phase\text{ - }III}$

Electricity received at the substation:

Through Line-1: X_1

Through Line-2: X_2

Total net energy supplied by both LKPL phase III and phase II projects as recorded at the substation = $X_1 + X_1 = EG_{Substation}$

Net energy supplied by LKPL phase III (candidate project activity)

= ($EG_{Phase - III}$ **/** ($EG_{Phase - III +}$ $EG_{Phase - II}$**))*** $EG_{Substation}$

The main and check meters installed at the site of the generating units of both phase II and candidate phase III (GTG 3(A) & 3(B) and STG 3(A) & 3(B)) are of accuracy 0.2 accuracy class. LKPL undertakes calibration of these meters once in 4 years.

The meter readings recorded by the Nunna substation are the ones used for billing purpose; these meters are of accuracy class 0.2S and are calibrated by the PGCIL once in 4 years.

These quantity of electricity supplied to the PGCIL grid (through Nunna substation) is reported in the website of the Southern Regional Load Despatch Centre.

Emergency provisions

Generator sets are available at site in case of emergencies and the plant to proceed to shut down; in case of a black-out, power will be drawn from the grid and the same is accounted for in auxiliary consumption.

Monitoring plan for gas consumption

Gas Quantity

Reliance Industries Limited (RIL), the gas supplier has established a receiving substation in the premises of LKPL. There are 2 lines for supply of gas to the candidate project activity from this sub station (steams A & B), although at any point in time gas will be supplied through only one line (the other line is for the purpose of redundancy).

Each of these lines has a meter installed (main meter) to measure the quantum of gas being supplied;

Joint calibration of these meters is carried out by Reliance and LPKL personnel. A check meter has also been installed by LKPL, for the purpose of cross checking.

Calorific Value

A gas chromatograph is also maintained on site by the gas supplier which monitors the calorific value of the gas being supplied.

The gas supplied is monitored continuously and recorded in gas tickets on 24-hour cycles (06:00 AM to 06:00 AM). The gas supplier provided 'gas tickets' the provide the quantity of gas supplied, NCV and the net energy supplied (in MMBTU terms).

The energy supplied by the project activity will be made available in the SRLDC (Southern Regional Load Despatch Center) website – providing day - wise values; although the invoicing is done by the gas supplier on a fortnightly basis, daily gas tickets will also be available and hence estimation of emission reductions from the date of registration will be possible. In the event that documentary sources for the purpose of estimation of CERs is not available due to date of registration not coinciding with the billing cycle, CERs would be conservatively estimated by excluding the partial billing cycle. This approach will be followed for the first and the last billing cycles in the crediting period.

The detailed monitoring plan for the proposed CDM project activity has been presented in Annex-4.

Action Plan for Monitoring of 2% CER Revenue Committed Towards Sustainable Development

LKPL is committed to contribute a minimum of 2% of the CDM revenue realized from the sale of CERs towards sustainable development. The expected CER revenue generation from the project and the annual revenue committed towards sustainable development are summarized in the table below:

Year	Estimation of overall emission reductions (tCO2e)	CER Revenue (Million INR)[41]	Contribution to Sustainable Development (2% of CER revenue) (Million INR)
2013	1,387,555	757.61	15.15
2014	1,387,555	757.61	15.15
2015	1,387,555	757.61	15.15
2016	1,391,357	759.68	15.19
2017	1,387,555	757.61	15.15
2018	1,387,555	757.61	15.15
2019	1,387,555	757.61	15.15
2020	1,391,357	759.68	15.19
2021	1,387,555	757.61	15.15
2022	1,387,555	757.61	15.15
Total	**13883154**	**7580.20**	**151.60**

LKPL will undertake an annual review process of the actual CERs accrued and the price transacted. On the basis of the actual price and exchange rate, LKPL will commit 2% of the revenue for sustainable development activities in the local areas.

LKPL would implement these activities for sustainable development through its trust/foundation that has been established for undertaking CSR activities.

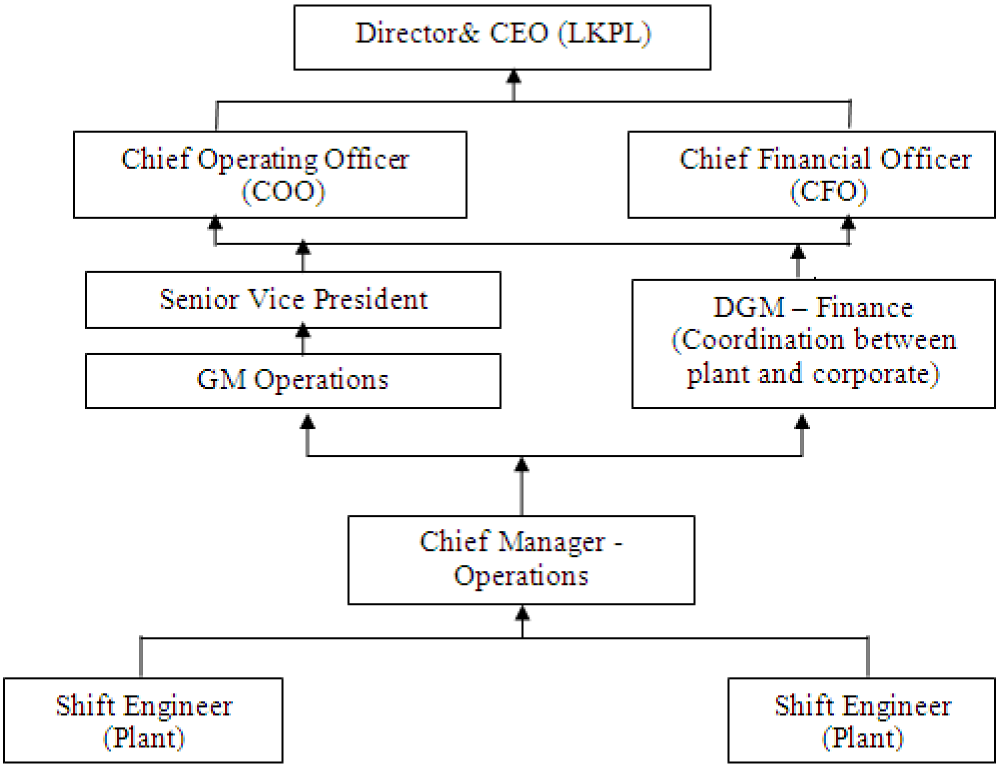
As part of the annual review, LKPL will undertake informal discussions with the locals at the project site and commit the revenue towards society / community developmental activities in areas that are of most concern to the local population. These areas could include health, education, sanitation, skill development, infrastructure development, etc. The annual review process will detail the exact activities that would be undertaken using the 2% revenue and the detailed mode of implementation of the proposed activity.

LKPL commits that a CSR team will be appointed to oversee the activities towards sustainable development and also that the activities are undertaken and concluded in a timely manner each year.

Project Management Structure

The schematic organogram of the project management team as maintained in LKPL is as follows

[41] CER revenue at 8.4 (spot price on 21 September 2011 – www.bluenext.fr) euro/CER and euro @ 65 INR



At the power plant level the project management team is basically engaged performing day to day activities related to operation and maintenance of the project. The team at the power plant level will primarily be collecting the CDM data and maintaining all records related to CDM activities of the project. The shift engineers would be primarily responsible for primary data collection at the respective verticals & calibration. Shift engineer will report to Chief Manager (Operation). The Chief Manager (Operation) would be responsible for reviewing the data and will report to the GM Operations. If the data reported by the shift engineers are found satisfactory the same will be recorded in the Management Information System (MIS). In the event of any discrepancy, Manager (Operation) will propose the corrective action in discussion with GM Operations. GM Operations will report to COO.

The project management at the corporate level is basically engaged in overall project monitoring. The team at corporate level will review power plant operations and also the data related to CDM activity of the project. DGM – Finance (Corporate) would be responsible for overall project coordination between the plant level and corporate office. Information pertaining to plant operation including CDM related data will be reviewed by DGM Finance. DGM – Finance will report to CFO. In the event of any disconnect, DGM – Finance will suggest the corrective action to the plant officials in discussion with the COO & CFO. Director & CEO would be responsible for overall plant operation. COO & CFO will report to the Director.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

>> The baseline study and application of baseline methodology was completed on 27/12/2011.

Lanco Kondapalli Power Ltd. (The project proponent) has completed the application of the baseline study and monitoring methodology. The contact details appear in Annex 1 of this document.

SECTION C. Duration of the project activity / crediting period

C.1. Duration of the project activity:

C.1.1. Starting date of the project activity:

>> Date of start: 1st January 2010.

The start date of the project is based on the date of Notice To Proceed (NTP).[42]

C.1.2. Expected operational lifetime of the project activity:

>>20 years 0 months.

C.2. Choice of the crediting period and related information:

Fixed crediting period

C.2.1. Renewable crediting period:

C.2.1.1. Starting date of the first crediting period:

>> Not applicable.

C.2.1.2. Length of the first crediting period:

>> Not applicable.

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

>> The 1st year of crediting will start from the date of registration of this project activity or **01/01/2013** whichever is later.

C.2.2.2. Length:

>>10 years 0 months

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including trans-boundary impacts:

>>

The proposed project is an expansion of the existing natural gas based power plant. The Environmental Impact Assessment study for the proposed project activity was carried out by M/s Pioneer Consultants Pvt. Ltd., Hyderabad to assess the likely environmental impact and suggest mitigation measures.

[42] Evidence has been shared with DOE during the validation site visit

The project has received the Environmental Clearance from MoEF and Consent for Establishment from Andhra Pradesh Pollution Control Board (APPCB).
Environmental Impact Statement: The impact statement focuses on the study area of 10km radius around the project site. The environmental components discussed are air, noise, water, land and socio – economic environment. For each of these components, the impacts were identified, predicted and evaluated through Battelle Environmental Evaluation System. The summary of findings of this EIA study as related to the construction of CCPP is presented below:

Air:
The meteorological data such as wind direction, wind speed, maximum temperature, minimum temperature and relative humidity are collected and confirmed that it is consistent with the regional meteorology. Vegetation and human settlement in the vicinity is not likely to be affected. The existing greenbelt will further attenuate air, water or noise emissions that arise due to the power project.

Water:
The entire water requirement for the project will be met from Krishna River. A dedicated pipeline has already been laid from Old Ibrahimpatnam to the project site to meet the water requirement for the project. Waste water will be treated in the Effluent Treatment Plant (ETP). Most quantity of the treated effluent will be used for green belt within the plant premises to the extent possible and the remaining will be discharged into the Budameru drain after ensuring compliance with APPCB standards.
Noise:
The impact of noise generated by the project on the community will be insignificant. It is observed that the general noise level in the plant premises would be within the limits. However, average noise level may increase due to operation of gas turbines, steam turbines and compressors. The increase in the noise levels due to this activity will be limited to the plant premises only.

Land:
There is absolutely no adverse impact on land environment due to the project. There are no important plant species that are rare and endangered or threatened either at plant site or in adjoining areas. The water requirement for green belt development will be met from treated effluents. The soil chemistry will not be affected much.

Socio-economic environment:
The impact of the project will be more on the positive side than on the negative side. These positive impacts can be attributed to development of area with increase in job opportunities, health status, educational status, economic output and other social benefits.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

The project activity uses natural gas in preference over other fossil fuels such as coal and hence results in lower GHG emissions. Other air and liquid pollutants are minimal. There are no significant solid wastes such as fly ash. The EIA study revealed that there are no significant environmental impacts.

SECTION E. Stakeholders' comments

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

The Local Stakeholder Consultation meeting to discuss stakeholder concerns on proposed Clean Development Mechanism (CDM) project of LANCO Kondapalli Power Limited (LKPL) at Kondapalli, Krishna District, Andhra Pradesh was conducted on 15th September, 2011.

LKPL invited the local stakeholders for the meeting through notices dated 26/08/2011.

Venue	:	LKPL project office at Conference Room
Date	:	15 September, 2011 Thursday
Time	:	11:00 AM to 12:30 PM

The meeting was attended by several stake-holders including representatives from government agencies (APTRANSCO), APSPDCL, Panchayat Surpanch, technology supplier (GE), Contractors, Operation and Maintenance personnel, LKPL employees and other participants from the vicinity of the plant.

The meeting began with an introductory note by Mr. K. Satyanarayana, Executive Director & Company Secretary, LKPL; upon Mr. K. Satyanarayana's request to select one of the participants to chair the meeting, the participants unanimously choose Mr. K. Guravaiah, Surpanch, Kondapalli Gram Panchayat.

Upon the Chairperson's approval, Mr. A. Suresh Babu, DGM, (Finance), LKPL made a brief presentation covering the following topics :

- The phenomenon of global warming
- Kyoto Protocol and the objective of the same - how this was formed and the necessity to do the CDM.
- What is important in CDM and the objectives of the same
- How this helps the local community
- Importance of Local Stakeholder Consultation process
- The proposed CDM project activity by LKPL
- Technology used by the project activity
- The environmental benefits of going for NG based power generation
- Credentials of the project proponent LKPL

Once the presentation was over the stake holders were requested to share their thoughts about this project and the floor was open to questions.

E.2. Summary of the comments received:

>>

All the stakeholders agreed that the implementation of the project activity would not have any adverse effect on environment and would result in the development of local communities. No adverse comments were received from the Stakeholders.

Following are the questions raised by stake holders and responses provided by LKPL/O&M / Equipment supplier representatives :

Sl. No.	Name of the person who raised the question	Question	Response provided by LKPL/Equipment Supplier/O&M Contractor
1	Mr. V. Madhusudan, Manager, GAIL	Will the project lead to any increase in pollution load?	The project uses a cleaner fuel (NG) and state-of-the-art technology. The project leads to significant pollution reduction as compared to other fuel sources like coal .
2	Mr. A. Sambasiva Rao, Divisiona Engineer, A.P TRANSCO	What pollution control measures would the project be undertaking?	The plant uses very lean fuel and advanced DLN technology etc., which would lead to very low NO_x and SO_x emission. This is an advanced and latest (and expensive) technology.
3	Mr. K. Guruvaiah, Sarpanch, Kondapalli	How will the project lead to the development of local community development	The project would be lead to sustainable development around the project area by contributing to the development of local economy and create employment in and around the project site.
4	Mr. K. Guruvaiah, Sarpanch, Kondapalli	What type of employment will be created?	The project would employs local labour during construction phase as well as operating phase. Further, indirect employment opportunities would be created.
5	Mr. Satyanandam, Divisional Engineer, A.P SPDCL	What is the expected life-time of the project?	The expected life-time of the project activity is about 20 years.

The participants were satisfied with the responses provided.

E.3. Report on how due account was taken of any comments received:

>>

No adverse comments (or comments that require any action by the project proponent) on the candidate project activity were received during the Local Stakeholder Consultation process.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Lanco Kondapalli Power Limited
Street/P.O.Box:	Lanco House, Plot No. 4, Software Units Layout,
Building:	HITEC City, Madhapur
City:	Hyderabad
State/Region:	Andhra Pradesh
Postcode/ZIP:	500 081
Country:	India
Telephone:	+91 40 4009 0400
FAX:	+91 40 2311 6127
E-Mail:	lkpl@lancogroup.com
URL:	www.lancogroup.com
Represented by:	
Title:	Executive Director (Finance)
Salutation:	Mr.
Last name:	
Middle name:	Satyannarayana
First name:	K
Department:	Lanco Kondapalli Power Limited
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding has been used for the proposed CDM activity.

Annex 3

BASELINE INFORMATION

Grid Emission Factors[43]:

The Operating Margin data for the most recent three years and the Build Margin data for the Southern Region Electricity Grid as published in the CEA database are as follows:

Simple Operating Margin

	Southern Grid (tCO_2e/MWh)
Simple Operating Margin - 2007-08	0.973
Simple Operating Margin - 2008-09	0.942
Simple Operating Margin - 2010- 11	0.942
Average Operating Margin of last three years	**0.952**

Build Margin

	Southern Grid (tCO2e/MWh)
Build Margin	0.7339

Combined Margin Calculations

	Southern Grid (tCO2e/MWh)
Combined Margin	0.843

[43] Source: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm ; version -07

CALCULATION OF ENERGY EFFICIENCY OF BASELINE ALTERNATIVE

According to Equation 3 of AM0029, Version 3,

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

Where,

$EF_{BL,CO2}$ = The fuel emission coefficient (tCO2e/GJ), based on national average fuel data, if available, otherwise IPCC defaults can be used

$COEF_{BL}$ = The fuel emission coefficient (tCO_2e/GJ)

η_{BL} = the energy efficiency of the technology, as estimated in the baseline scenario analysis

Sub Critical Coal fired stations	Coal consumption	NCV	Input Energy	Generation	Output Energy	Efficiency
	1000 tons	Kcal/Kg	GJ	GWh	GJ	
RAYAL SEEMA	896.41	3,620	13,582,846	1,398.64	5,035,111	37.07%
RAYAL SEEMA	926.53	3,620	14,039,276	1,447.22	5,209,978	37.11%
RAYAL SEEMA	94.35	3,620	1,429,573	145.49	523,778	36.64%
R_GUNDEM STPS	2497.82	3,620	37,848,314	3,811.14	13,720,110	36.25%
SIMHADRI	0	3,620	0	0.00	0	0.00%
RAICHUR	276.79	3,620	4,194,090	357.44	1,286,788	30.68%
BELLARY TPS	1986.51	3,620	30,100,675	2,486.20	8,950,320	29.73%
VIJAYWADA TPP-IV	2202.81	3,620	33,378,172	3,584.89	12,905,608	38.66%
TORANGALLU EXT	1420.67	3,620	21,526,828	2,309.78	8,315,208	38.63%
TORANGALLU EXT	1420.67	3,620	21,526,828	2,309.78	8,315,208	38.63%
STERLITE TPP	257.19	3,620	3,897,136	317.14	1,141,710	29.30%
STERLITE TPP	469.66	3,620	7,116,510	579.13	2,084,862	29.30%
KAKATIYA TPP	1135.37	3,620	17,203,755	1,694.06	6,098,612	35.45%
UPUPI TPP	1120.12	3,620	16,972,640	1,595.94	5,745,384	33.85%

Average Efficiency 34.72%

Coal emission coefficient (IPCC)	**96.07**	tCO_2/TJ
	0.096	tCO_2/GJ
Emission factor for baseline option	**0.996**	tCO_2/MWh

Annex 4

MONITORING INFORMATION

Monitoring Plan for CDM activity:
The general conditions set out in this monitoring plan for metering, recording, meter inspections, test & checking; and communication shall be applicable for both electrical energy and natural gas, where relevant and applicable.

Data for Calculation of CER:
The Emission Reductions (ER_y) will be calculated based on calculations for Project Emissions (PE_y); Baseline Emissions (BE_y) and Leakage (LE_y)

$$ER_y = BE_y - PE_y - LE_y$$

The parameters that would be monitored for PE_y are:

1. **Natural Gas Consumption ($FC_{f,y}$):** Based on daily meter readings and fortnightly gas tickets for the total natural gas consumption archived electronically
2. **Net Calorific Value of Natural Gas ($NCV_{f,y}$):** Based on daily arithmetic average value of net calorific value, archived electronically
   The parameters that would be monitored for BE_y are:
3. **Net Electricity Generation (EG_y):** Based on the energy meter readings at the grid interconnection point at 400kV PGCIL Nunna substation and the individual generation of each of the generating units of LKPL phase II and candidate phase III project activities.
4. **Emission Factor based on Build Margin ($EF_{BM,y}$) for the Southern regional grid of India:** This value would be taken from the database published annually by Central Electric Authority (CEA) on their website http://cea.nic.in. In case for any particular year CEA does not publish the value then $EF_{BM,y}$ will be calculated based on the electricity generation and other relevant data published by CEA.

I. Monitoring for Net Electricity Generation (EG_y):

Metering Plan The Energy (kwh) delivered to the grid is measured by energy meters (0.2 class accuracy) at the grid interconnection point at the 400 kV PGCIL Nunna substation. The meter reading will be recorded by PGCIL. The meters at LKPL site are also of accuracy class 0.2. Details of the calculation procedure are explained in sections B.7.1 and B.7.2
Meter Test / Checking for Energy Meter Reading (Gross Energy Generated):

All the related energy meters used to record energy delivered to the grid by the project activity will undergo periodical calibration as per Central Electricity Authority (CEA) regulation, 2006[44] on installation and operation of energy meters.

II. Monitoring for Natural Gas Consumption ($FC_{f,y}$):

Metering Plan

[44] http://www.powermin.nic.in/whats_new/pdf/Metering_Regulations.pdf

The natural gas consumed is metered by the Project Proponent at the following locations

1. Main meter - Measurement would be recorded at the M&R (receiving and measurement) station of ~~RIL~~ transporter located within the plant boundary i.e RGTIL. ~~RIL~~ Transporter would subsequently issue a daily (06 to 06 hrs) gas ticket to LKPL clearly specifying total flow. The meter reading is archived by LKPL on daily basis.
2. Check meter - The similar measurement facility is available at LKPL gas conditioning skid.

Transporter will issue a joint ticket to LKPL every fortnight. The fortnight joint ticket will also be considered for the purpose of cross verification.

Metering Equipment for Natural Gas Consumption:

Metering equipments for natural gas consumption consists of ultrasonic meters along with , pressure transmitters and temperature transmitters. The Natural Gas Consumption metering is done using a main meter. The main meter is located at the transporter gas conditioning/metering skid . The main meter is installed and owned by the Gas transporter . The metering equipment shall be maintained in accordance with OEM guidelines as per relevant standards.

The measurement shall include all corrections in installations practices recommended for accurate metering of gas by the AGA as applicable and shall be binding to Gas transporter as well as project proponent.

Metering Equipment for Natural Gas Gross/Net Calorific Value: Gross/Net calorific value of the natural gas is measured by using an online chromatograph installed by Gas transporter . The metering equipment shall be maintained in accordance with OEM guidelines as per relevant standards. The measurements are obtained daily by Gas transporter and are transmitted to Project Proponent on daily and every fortnight basis.

Meter Test Checking for Natural Gas Meter Reading (Natural Gas Consumed): The natural gas meter shall be tested at site for accuracy periodically against an accepted laboratory standard meter in accordance with prescribed standards. The consumption registered by the meter will hold well as long as the error in the meters is within the permissible limits.

If on calibration, the Gas transporter's meter registers a variation of more/less than 1(one) percent or if the Gas Supplier's meter is out of service, the procedure for the quantity of Gas during the period between the last calibration and the present shall be followed as per the provisions of GSA:

I. By using recording by the meter of the Project Proponent and accurately registering: or
II. By correcting the error if the percentage of error is ascertainable by calibration, test or mathematical calculation: or
III. By estimating the volume of Gas delivered by comparison with deliveries during the period under similar conditions when the Gas transporter's meter was registering accurately.

Calculation of ratio of RLNG and NG in the gas supplied:

LKPL will receive gas from Reliance's KG basin. As of now, the fuel source would not have any R-LNG. In the future, if LKPL has to use co-mingled gas (mixture of natural gas and regasified LNG) from its gas supplier, the ratio of NG and RLNG in the received in such gas would be calculated using the following procedure.

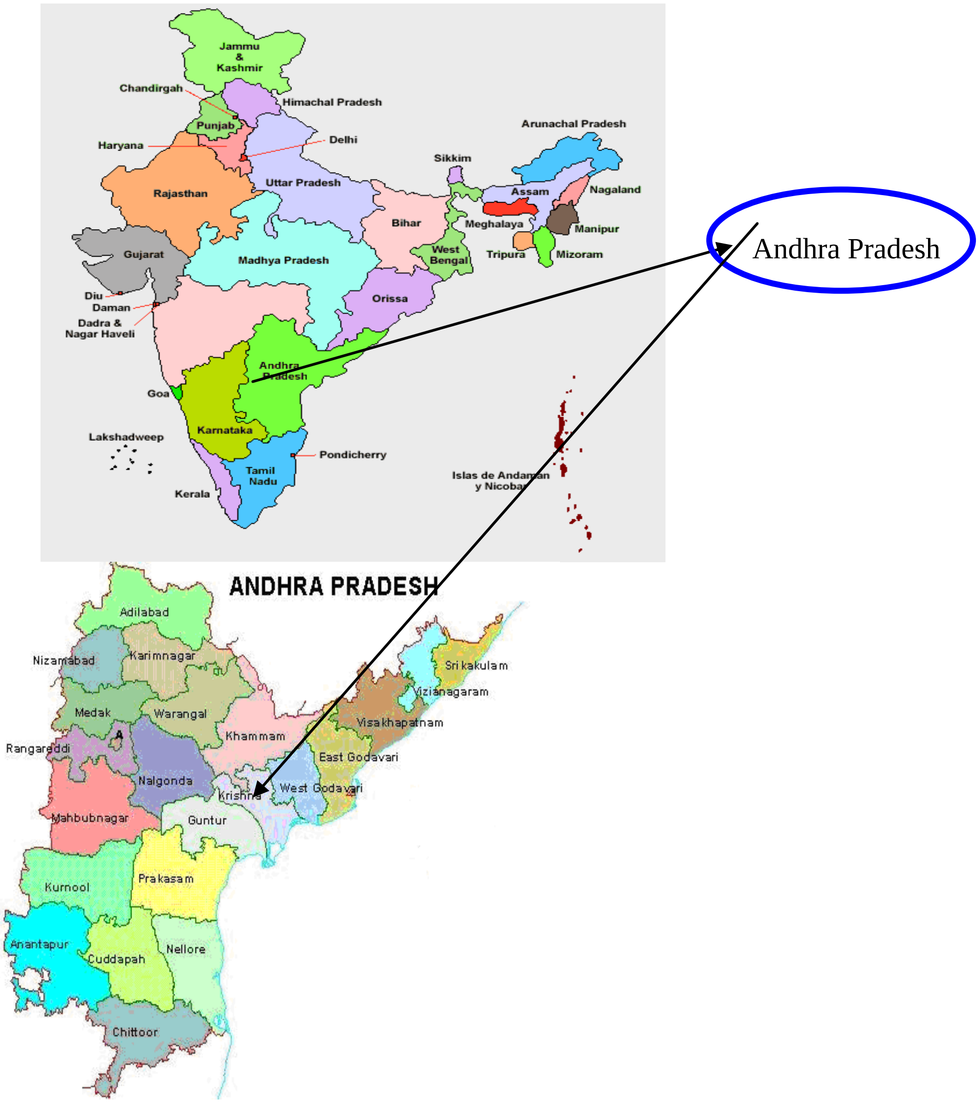
$$\%\text{ of NG in the gas received} = \frac{(NCV_{RLNG} - NCV_f)}{(NCV_{RLNG} - NCV_{NG})}$$

$$\%\text{ of RLNG in the gas received} = \frac{(NCV_f - NCV_{NG})}{(NCV_{RLNG} - NCV_{NG})}$$

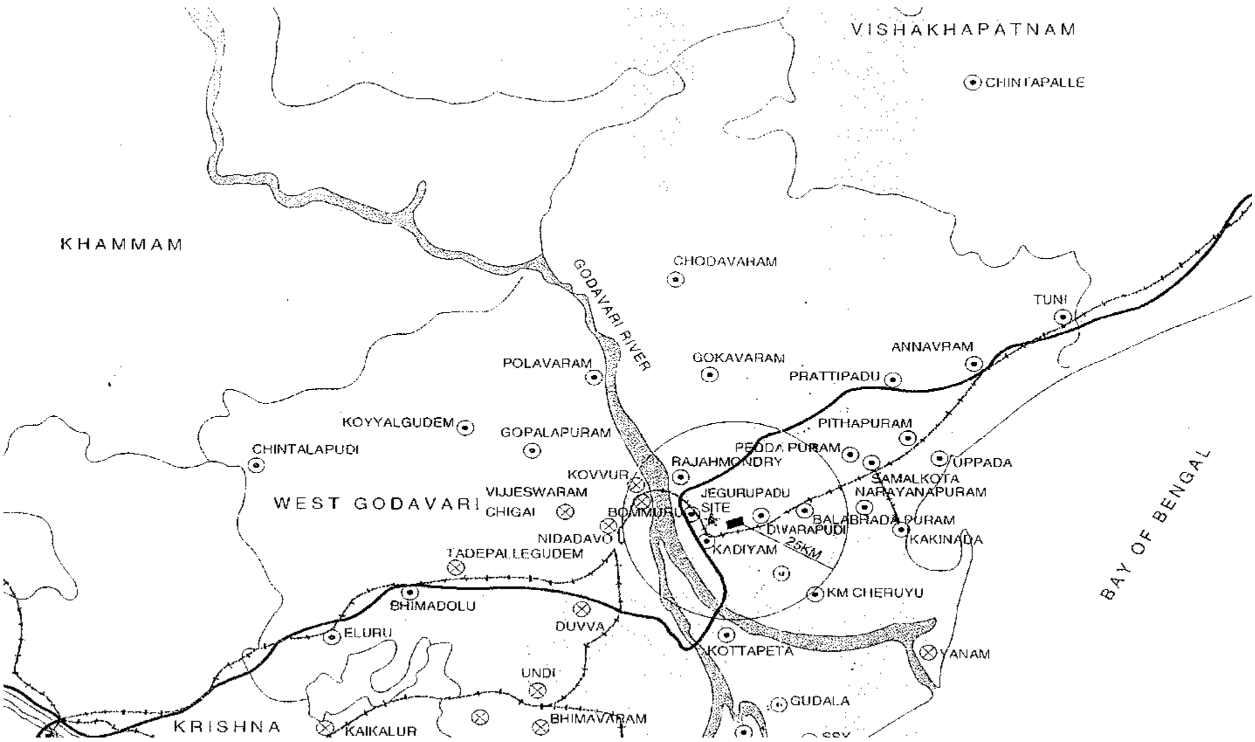
% NG and RLNG will be calculated on a monthly basis using the above formulae while NCVf is the monthly arithmetic average value of NCV for the month calculated as described earlier in the monitoring plan.

Appendix 1

Project Location Map




Khammam
Nalgonda
Huzurnagar
West Godavari
KRISHNA
Guntur
Prakasam
Bay
of
Bengal
Tiruvuru
Nuzvid
Jaggayyapeta
Nandigama
Konduru
Kondapalle
Gannavaram
Gudivada
Kaikalur
MACHILIPATNAM
Avanigadda
Bandar Fort


VISHAKHAPATNAM
CHINTAPALLE
KHAMMAM
CHODAVARAM
GODAVARI RIVER
TUNI
ANNAVRAM
POLAVARAM
GOKAVARAM
PRATTIPADU
KOYYALGUDEM
GOPALAPURAM
PITHAPURAM
CHINTALAPUDI
PEDDA PURAM
RAJAHMONDRY
UPPADA
KOVVUR
SAMALKOTA
WEST GODAVARI
VIJJESWARAM
JEGURUPADU
NARAYANAPURAM
CHIGAI
BOMMURU
SITE
BALABHADRAPURAM
DIVARAPUDI
NIDADAVO
KADIYAM
25KM
KAKINADA
TADEPALLEGUDEM
BAY OF BENGAL
KM CHERUYU
BHIMADOLU
ELURU
DUVVA
KOTTAPETA
YANAM
UNDI
GUDALA
KRISHNA
KAIKALUR
BHIMAVARAM

Appendix 2

LEAKAGE CALCULATIONS

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

where:

LE_y Leakage emissions during the year y in tCO_2e

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

$LE_{LNG,CO2,y}$ Leakage emissions due to fossil fuel combustion / electricity consumption associated with the liquefaction, transportation, re-gasification and compression of LNG into a natural gas transmission or distribution system during the year y in t CO_2e

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

where:

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

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

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

$EF_{NG,upstream,CH4}$ Emission factor for upstream fugitive methane emissions of natural gas from production, transportation, distribution, and, in the case of LNG, liquefaction, transportation, re-gasification and compression into a transmission or distribution system, in tCH_4 per GJ fuel supplied to final consumers

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

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

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

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

where:

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

j Plants included in the build margin

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

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

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

In the present context only NG will be used as fuel. Hence leakage 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 is ignored.

Upstream fugitive emissions on account of use of natural gas by the project activity

Fugitive CH4 emission factor	tCH4/PJ	296.00
Gas consumption	Mcum	1,193.78
Calorific Value	kCal/SCM	8,562.00
Conversion value kCal to TJ	*4.1858/10^9	0.0000000042
Converstion value SCM to Mcum	*1/10^6	0.000001
Calorific Value	TJ/Mcum	35.84
TJ to PJ conversion	1/10^3	0.0010
Energy content in Gas consumed	PJ	42.78
Fugitive CH4 emissions	tCH4	12,663.94
Global Warming Potential (GWP) of CH4		21.00
Equivalent CO2 emissions	tCO2e	265,943

Upstream fugitive emissions on account of use of LNG by the project activity

There is no LNG consumption in the proposed CDM project activity at present In the event of LNG consumption in future the percentage combination of NG and RLNG could be readjusted to arrive at the fugitive emission.

Upstream fugitive emission occurring in the absence of the project activity

Upstream fugitive emission occurring in the absence of the project activity = $EG_{PJ,y}$ x $EF_{BL,upstream,CH4}$

Fugitive emission factor	tCO2e/GWh	22.60
Conversion MWh to GWh	1/10^3	0.001
Net Electricity generations from the Project activity	GWh	5,359.18
Fugitive Emissions in the absence of project activity	tCO2e	**121,126**

Leakage = 265,943 tCO2e – 121,126 tCO2e = 144,817 tCO2e

Calculation of $EF_{BL, upstream, CH4}$ is shown in the table below:

	Emissions	**Emission factor**	**Fuel consumption**		**Fugitive emission factor**		**Fugitive emissions**
	tCO2e	**tCO2e/1000 t or Mcum**	**1000 t**	**PJ**	**tCH4/1000t**	**tCH4/PJ**	**tCO2e**
Coal	21,409,343	1,456	14705		0.8		247,042

	Emissions	Emission factor	Fuel consumption		Fugitive emission factor		Fugitive emissions
	tCO2e	tCO2e/1000 t or Mcum	1000 t	PJ	tCH4/1000t	tCH4/PJ	tCO2e
Lignite	0	1,101	0		0.8		0
Natural gas	4,473,543	1,860		79.74		296	495,678
Naphtha	0	2,505		0.00		4.1	0
Total							742,720

Plants included in the Build Margin (SR)

S_NO	NAME	UNIT_NO	FUEL 1	FUEL 2	2010-11 Net Generation GWh	2010-11 Absolute Emissions t CO2	2010-11 Specific Emissions t CO2/MWh	2010-11 in Build Margin
5	RAYAL SEEMA	3	COAL	OIL	1,399	1,305,108	0.93	1
5	RAYAL SEEMA	4	COAL	OIL	1,447	1,348,964	0.93	1
5	RAYAL SEEMA	5	COAL	OIL	145	137,361	0.94	1
7	R_GUNDEM STPS	7	COAL	OIL	3811.14	3,636,656	0.95	1
8	SIMHADRI	3	COAL	OIL	0.00	0	0.94	1
14	RAICHUR	8	COAL	OIL	357	402,989	1.13	1
120	BELLARY TPS	1	COAL	OIL	2486.20	2,892,224	1.16	1
122	VIJAYWADA TPP-IV	1	COAL	OIL	3584.89	3,207,143	0.89	1
124	TORANGALLU EXT	1	COAL	OIL	2309.78	2,068,406	0.90	1
124	TORANGALLU EXT	2	COAL	OIL	2309.78	2,068,406	0.90	1
126	STERLITE TPP	1	COAL	OIL	317	374,456	1.18	1
126	STERLITE TPP	2	COAL	OIL	579	683,790	1.18	1
128	KAKATIYA TPP	1	COAL	OIL	1,694	1,653,023	0.98	1
129	UDUPI TPP	1	COAL	OIL	1,596	1,630,817	1.02	1
Total Coal						**21,409,343**		
11	KONDAPALLI GT	4	GAS	NAPT	1,271	554,060	0.44	1

S_NO	NAME	UNIT_NO	FUEL 1	FUEL 2	2010-11 Net Generation GWh	2010-11 Absolute Emissions t CO2	2010-11 Specific Emissions t CO2/MWh	2010-11 in Build Margin
11	KONDAPALLI ST	5	GAS	NAPT	726	316,266	0.44	1
31	VALUTHUR GT	3	GAS	n/a	0.00	0	0.39	1
31	VALUTHUR GT	4	GAS	n/a	0.00	0	0.39	1
31	VALUTHUR GT	5	GAS	n/a	0.00	0	0.39	1
117	VALANTHARVI GT	1	GAS	n/a	305.42	145,937	0.48	1
117	VALANTHARVI GT	2	GAS	n/a	85.61	40,907	0.48	1
118	VEMAGIRI CCCP	1	GAS	n/a	1767.07	645,279	0.37	1
118	VEMAGIRI CCCP	2	GAS	n/a	962.58	351,504	0.37	1
123	GAUTAMI CCCP	1	GAS		1087.52	423,828	0.39	1
123	GAUTAMI CCCP	2	GAS		1087.52	423,828	0.39	1
123	GAUTAMI CCCP	3	GAS		1171.73	456,646	0.39	1
125	KONASEEMA CCCP	1	GAS	n/a	1,636	773,234	0.47	1
125	KONASEEMA CCCP	2	GAS	n/a	724	342,054	0.47	1
Total Gas						**4,473,543**		

Type of FUEL	Net Calorific Value (TJ/ 1000 tonnes or TJ/Mcum)	Carbon Emission Factor (t C/ TJ)	Fraction of Carbon Oxidised Oxidation Factor	Emission Coefficient (tCO2/ 103 tonnes or tCO2/Mcum)	Density (kg/Lt)	Emission factor (tCO2/1000 t or tCO2/Mcum)
(Non coking) Coal	15.16	26.20	1.00	1,456	1.00	1,456
Lignite	10.99	27.30	1.00	1,101	1.00	1,101
Natural Gas	33.16	15.30	1.00	1,860	1.00	1,860
Naphtha	44.95	20.00	1.00	3,296	0.76	2,505

Note: The NCV has been calculated by multiplying the GCV with the ratio of NCV to GCV as provided by CEA.

Appendix 3

Assumptions - Levelized Cost of Generation

I. Levelized Cost of Generation for Natural Gas based CCPP:

Cost of Gas

Particulars	Unit		Value	Basis
Gas Cost				
Supply Cost of gas	US$/mmbtu		$ 4.20	As per financial DPR
Marketing Cost	US$/mmbtu		$ 0.13	As per financial DPR
VAT		12.50%	$ 0.54	As per financial DPR
Total	US$/mmbtu		$ 4.87	Calculated
Exchange rate	INR/US$		48.41	http://data.worldbank.org/indicator/PA.NUS.FCRF
Gas cost	INR/mmBTU		235.82	Calculated
NCV of Gas	kCal/SCM	8,562		As per financial DPR
	kCal/mmbtu	252,000		http://www.engineeringtoolbox.com/heat-units-d_664.html
Cost of Gas	INR/SCM		8.01	Calculated
Gas Transportation Cost				
Transportation cost	US$/mmbtu	$	0.6	As per financial DPR
Service Tax on Transportation		10%	0.06	As per financial DPR
Transportation cost inclusive of tax			0.66	Calculated
Educational Cess		3%	0.0198	Calculated
Total			0.6798	Calculated
Exchange rate	INR/US$		48.41	http://data.worldbank.org/indicator/PA.NUS.FCRF
Transportation cost in INR	INR/mmBTU		32.91	Calculated

Transportation cost per SCM	INR/SCM		1.12	Calculated
Landed Cost of Gas	INR/SCM		9.13	Calculated

Project Cost			
Plant EPC	Rs. Crores	2,106.00	As per DPR
Land costs	Rs. Crores	37.00	As per DPR
Other cost	Rs. Crores	217.40	As per financiel DPR; Includes initial spares, Non EPC costs, Reliance gas pipeline, pre-op and establishment costs, Training O&M and staff and 6% contingency not including EPC and spares
Margin Money - Working Capital	Rs. Crores	-	As per DPR
Interest During Construction	Rs. Crores	214.60	As per DPR
Financing Charges	Rs. Crores	35.00	As per DPR
Project cost including IDC	Rs. Crores	2,610.00	Calculated
Project Specifications			
Project capacity	MW	742	As per DPR
Project life	Years	20	As per DPR
Project cost per MW	Rs. Crores	3.518	Calculated
CoD - Combined cycle		Apr-12	As per Detailed Project Report (DPR)
Project Financing			
Project Equity	%	30%	As per DPR
Project Debt	%	70%	As per DPR
Project Equity	Rs. Crores	783.0	Calculated
ROE	%	16.00%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	1,827.00	Calculated

Term of Debt	Years	12.0	As per DPR
Interest on Debt	%	11.50%	Prime Lending Rate at the time of investment decision making. Reference : http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	As per Detalied Project Report (DPR)
Operating Norms			
Heat Rate			
Combined Cycle	Kcal/Kwh	1,850	As per DPR
Auxiliary Consumption			
Combined Cycle	%	3.00%	As per DPR
PLF		85%	As per Detailed Project report (DPR) page 1-4 of 135
Discounting factor	%	10.19%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf
Fuel Specifications			
Primary Fuel - Natural Gas			
NCV of Natural Gas	kCal/SCM	8,562	As per Detailed Project Report (DPR), page 4-1 of 135, and density of gas is 0.72 kg/SCM
Specific Gas consumption - Combined cycle	SCM/kWh	0.22	Calculated
Landed Cost of NG	Rs. / scm	9.13	Calculated
Annual Gas Price Escalation	%	~~10%~~1.31%	~~The escalation has been considered based on GERC's approval of GSEC's tariff order which considers 10% annual escalation for gas price (case no. 861/2006, page 52; available at: http://www.gercin.org/index.php?option=com_tariffOrder&Itemid=32&year=2006&lang=en~~http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf
Annual Gas Transportation cost escalation	%	17.95%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf

Depreciation			
Recovery of Depreciation	%	90%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 39)
Rate of Depreciation - Book Depreciation	%	3.60%	Considering depreciation as above and provision for Advance Against Depreciation
Advance Against Depreciation	of loan amount	10%	CERC: http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Depreciation for first 12 years	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Depreciation for the rest of the project lifetime	%	3.33%	Calculated based on the above
O&M			
O&M Expenses	INR Million / MW	1.75	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 68)
Escalation Factor	%	5.72%	As per financial DPR
Tax			
Tax Rate	%	33.99%	Income Tax Act; budget of 2008-09 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00%	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income tax act
Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Spares	% of O&M Cost	30%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 49)
Escalation factor for	%	~~5.72~~0%	The CERC order states spares to be 30% of O&M

spares			cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.~~The CERC order states spares to be 30% of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~
Primary Fuel Stock	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Working Capital	%	11.50%	As per Detailed Project Report (DPR)

II. Levelized Cost of Generation for Lignite Based Alternative:

Project Cost			
Project cost including IDC	Rs. Crores	2,030.73	http://mospi.nic.in/status_report_july_sept07.pdf (Page 15 of 237 mentions Expansion of NLC TPS - II to be of cost INR 2030.78 Crores; this project is of capacity 500 MW)

Project Specifications			
Project capacity	MW	500	
Project life	Years	25	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Paragraph 5.3.3)
Project cost per MW	Rs. Crores	4.061	http://mospi.nic.in/status_report_july_sept07.pdf
Commercial Operation Date		Apr-12	Considered similar to the candidate project activity

Project Financing			
Project Equity	%	30%	Considered similar to the candidate project activity
Project Debt	%	70%	Considered similar to the candidate project activity
Project Equity	Rs. Crores	609.2	Calculated
ROE	%	16.0%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	1,421.5	Calculated
Term of Debt	Years	12.0	Considered similar to the candidate project activity
Interest on Debt	%	11.50 %	Prime Lending Rate at the time of investment decision making. Reference : http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	Considered similar to the candidate project activity

Operating Norms			
Heat rate	Kcal/Kwh	2,668	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (using multiplication factor 1.1 dependent on liginite moisture content; 1.1 is the highest value available in the tariff order; considering this is the most

			conservative approach - pages 122 and 123 of the tariff order)
Auxiliary Consumption		9.00%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 129; additional 0.5% provided for draft cooling tower has also been taken into account for conservativeness)
PLF		85%	Considered similar to the candidate project activity
Discounting Factor	%	10.19 %	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf

Fuel Specifications			
Primary Fuel - Coal			
NCV of Coal	kCal/kg	2699	CEA expert committee report on fuel for power generation; page 4 0f 17 http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf
Landed Cost of Coal	Rs. / kg	0.80	CEA expert committee report on fuel for power generation; page 4 0f 17 http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf
Annual Coal Price Escalation		6.12%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf (the escalation rate as applicable for domestic coal has been considered for lignite as well)
Secondary Fuel - Oil			
NCV of Oil	kCal / lt	9,595	CEA CO2 Emission Database version 6: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Specific Oil consumption	ml / kWh	1.5	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page126, paragraph 30.1)
Cost of Oil	Rs. / kl	7,152	As per GERC tariff order 861/ 2006 ; Table 36, Page no 55 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en
Escalation for oil	%	10.50 %	As per GERC tariff order 861/ 2006 ; Page no 52 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en

Depreciation

Recovery of Depreciation	%	90%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 39)
Rate of Depreciation - Book Depreciation	%	3.60%	Considering depreciation as above and provision for Advance Against Depreciation
Rate of Depreciation for the first 12 years	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Rate of depreciation for the remaining lifetime of the project	%	2.05%	Calculated based on the above

O&M			
O&M Expenses	Rs. Lakhs/MW	15.36	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 64)
Escalation Factor	%	5.72%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf

Tax			
Tax Rate	%	33.99 %	Income Tax Act; budget of 2009-10 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00 %	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income Tax Act

Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Spares	% of O&M Cost	20%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 49)
Escalation factor for spares	%	~~5.72~~0 %	~~The CERC order states spares to be 20 % of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~The CERC order states spares to be 20% of

			O&M cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.
Primary Fuel Stock	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Secondary Fuel Stock	days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Working Capital	%	11.50 %	Considered to be similar to candidate CDM project activity

III. Levelized Cost of Generation for Coal - Super-critical Alternative using imported fuel:

Project Cost			
Project cost including IDC	Rs. Crores	3,133.1	Calculated value

Project Specificati			
Project capacity	MW	660	
Project life	Years	25	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Paragraph 5.3.3)
Project cost per M	Rs. Crores	4.747	British High Commission Report on UMPP Risk Analysis, April 2007 ; Page no 12 of 151(USD 1227 per kW ; exchange rate USD @ 40.23 INR).The specific cost as considered corresponds to low supercritical category using international coal (Mount Arthur coal). Please refer to page no 10 of the same report that specifies the unit size of low super critical category as 660 MW. The exchange rate has also been referred from the British High Commission Report on UMPP Risk Analysis, April 2007 ; Page no 14 of 151. http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20energy/tackling%20climate%20change/intl_strategy/dev_countries/india/umpp-risk-analysis.pdf
Commercial Operation Date		Apr-12	Considered similar to candidate CDM project activity

Project Financing			
Project Equity	%	30%	Considered to be similar to candidate project activity
Project Debt	%	70%	Considered to be similar to candidate project activity
Project Equity	Rs. Crores	939.9	Calculated
ROE	%	16.0%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	2,193.2	Calculated
Term of Debt	Years	12.0	Considered to be similar to candidate project activity
Interest on Debt	%	11.50%	Prime Lending Rate at the time of investment decision making. Reference : http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	Considered to be similar to candidate project activity

Operating Norms			
Heat Rate	Kcal/Kwh	2,274	NTPC, the state owned power generating company has suggested that, for super-critical technology adoption in the county, most preferred parameters of pressure and temperature would be 246 kg/cm2 and 538/566 degree celcius respectively (http://www.egcfe.ewg.apec.org/publications/proceedings/CleanerCoal/HaLong_2008/Day%202%20Session%203A%20-%20Pankaj%20Gupta%20Supercritical%20Technology%20in%20.pdf - slide 13).Accordingly, the heat rate as available in CERC's 2009 tariff order closest to NTPC's recommendation - 247 kg/cm2 (page 120 of the tariff order) has been taken; this has further been increased by a factor of 6.5% in line with paragraph (c) in page 119 of the tariff order
Auxiliary consumption		9.00%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 129; electrically driven boiler feed pump and additional 0.5% provided for draft cooling tower has also been taken into account for conservativeness)
PLF		85%	Considered to be similar to project activity
Discounting Factor	%	10.19%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf

Fuel Specifications			
Primary Fuel - Coal			
NCV of Coal	kCal/kg	5,206	CEA expert committee report on fuel pricing (Page 4 of 17) The difference between GCV and NCV has been considered at 3.6%.(Reference: CEA CO2 database; version 02 dated 21st June, 2007 Weblink: http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm
Landed Cost of C	Rs. / kg	1.925	CEA expert committee report on fuel pricing (Page 4 of 17)
Annual Coal Pric Escalation		6.12%	The project participant observes that from the start of the year 2010 till decision date, there has been a fall in the price of imported coal - please refer slide 10 in in the attached link: http://www.infraline.com/coal/presentations/VinayaVarma-mjunction.pdf For conservativeness, PP has considered the same escalation rate as considered for domestic coal (6.12%

			CEA tariff order: http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf)
Secondary Fuel -Oi			
NCV of Oil	kCal / lt	9,595	CEA CO2 Emission Database version 6: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Specific Oil consumption	ml / kWh	1.0	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (paragraph 30.4 in page127)
Cost of Oil	Rs. / kl	7,152	As per GERC tariff order 861/ 2006 ; Table 36, Page no 55 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en
Escalation for oil	%	10.50%	As per GERC tariff order 861/ 2006 ; Page no 52 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en

Depreciation			
Recovery of Depreciation	%	90%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Rate of Depreciatio for the first 12 year:	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Rate of depreciatio for the remaining lifetime of the proje	%	2.05%	Calculated based on the above

O&M			
O&M Expenses	Rs. Lakhs/MW	13.82	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 64)
Escalation Factor	%	5.72%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf

Tax			
Tax Rate	%	33.99%	Income Tax Act; budget of 2009-10 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00%	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-

			07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income Tax Act

Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Spares	% of O&M Cost	20%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Escalation factor spares	%	~~5.72%~~0%	The CERC order states spares to be 20% of O&M cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.~~The CERC order states spares to be 20 % of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~
Primary Fuel Sto	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Secondary Fuel Stock	days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Work Capital	%	11.50%	Considered similar to candidate CDM project activity

IV. Levelized Cost of Generation for Coal - Super-critical Alternative using domestic fuel:

Project Cost			
Project cost including IDC	Rs. Crores	3,133.1	Calculated value

Project Specifications			
Project capacity	MW	660	
Project life	Years	25	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Paragraph 5.3.3)
Project cost per MW	Rs. Crores	4.747	British High Commission Report on UMPP Risk Analysis, April 2007 ; Page no 12 of 151(USD 1227 per kWe ; exchange rate USD @ 40.23 INR).The specific cost as considered corresponds to low supercritical category using international coal (Mount Arthur coal). Please refer to page no 10 of the same report that specifies the unit size of low super critical category as 660 MW. Weblink: http://www.decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20energy/tackling%20climate%20change/intl_strategy/dev_countries/india/umpp-risk-analysis.pdf The exchange rate has also been referred from the British High Commission Report on UMPP Risk Analysis, April 2007 ; Page no 14 of 151.
Commercial Operation Date		Apr-12	Considered similar to candidate CDM project activity

Project Financing			
Project Equity	%	30%	Considered to be similar to candidate project activity
Project Debt	%	70%	Considered to be similar to candidate project activity
Project Equity	Rs. Crores	939.9	Calculated
ROE	%	16.0%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	2,193.2	Calculated
Term of Debt	Years	12.0	Considered to be similar to candidate project activity
Interest on Debt	%	11.50%	Prime Lending Rate at the time of investment decision making. Reference :

			http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	Considered to be similar to candidate project activity

Operating Norms			
Heat Rate	Kcal/Kwh	2,380	NTPC, the state owned power generating company has suggested that, for super-critical technology adoption in the county, most preferred parameters of pressure and temperature would be 246 kg/cm2 and 538/566 degree celcius respectively (http://www.egcfe.ewg.apec.org/publications/proceedings/CleanerCoal/HaLong_2008/Day%202%20Session%203A%20-%20Pankaj%20Gupta%20Supercritical%20Technology%20in%20.pdf - slide 13).Accordingly, the heat rate as available in CERC's 2009 tariff order closest to NTPC's recommendation - 247 kg/cm2 (page 120 of the tariff order) has been taken; this has further been increased by a factor of 6.5% in line with paragraph (c) in page 119 of the tariff order
Auxiliary consumption		9.00%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 129; electrically driven boiler feed pump and additional 0.5% provided for draft cooling tower has also been taken into account for conservativeness)
PLF		85%	Considered to be similar to project activity
Discounting Factor	%	10.19%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf

Fuel Specifications			
Primary Fuel - Coal			
			CERC Tariff petiotion (140/2005 ; page no 25 of 34) in respect of Ramagundam Super Thermal Power Station Stage (III) for the period 25.03.2009 to 31.03.2009. The value corresponding to the month of February, 2005 (the latest month) has been considerd. (Weblink : http://cercind.gov.in/03022007/No-140-05-doh-22-5-07.pdf
NCV of Coal	kCal/kg	3,946	The difference between GCV and NCV has been considered at 3.6%.(Reference: CEA CO2 database; version 02 dated 21st June, 2007 Weblink: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_

			co2.htm As per http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf, NCV of coal varies from 3750 kCal/kg to 4150 kCal/kg
Landed Cost of Coal	Rs. / kg	1.2849	CERC Tariff petiotion (140/2005 ; page no 25 of 34) in respect of Ramagundam Super Thermal Power Station Stage (III) for the period 25.03.2009 to 31.03.2009. The value corresponding to the month of February, 2005 (the latest month) has been considerd. Weblink: http://cercind.gov.in/03022007/No-140-05-doh-22-5-07.pdf
Annual Coal Price Escalation		6.12%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf
Secondary Fuel - Oil			
NCV of Oil	kCal / lt	9,595	CEA CO2 Emission Database version 6: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Specific Oil consumption	ml / kWh	1.0	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (paragraph 30.4 in page127)
Cost of Oil	Rs. / kl	7,152	As per GERC tariff order 861/ 2006 ; Table 36, Page no 55 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en
Escalation for oil	%	10.50%	As per GERC tariff order 861/ 2006 ; Page no 52 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en

Depreciation			
Recovery of Depreciation	%	90%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Rate of Depreciation for the first 12 years	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Rate of depreciation for the	%	2.05%	Calculated based on the above

remaining lifetime of the project			

O&M			
O&M Expenses	Rs. Lakhs/MW	13.82	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 64)
Escalation Factor	%	5.72%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf

Tax			
Tax Rate	%	33.99%	Income Tax Act; budget of 2009-10 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00%	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income Tax Act

Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Spares	% of O&M Cost	20%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Escalation factor for spares	%	~~5.72%~~0%	The CERC order states spares to be 20% of O&M cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.~~The CERC order states spares to be 20 % of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~
Primary Fuel Stock	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Secondary Fuel Stock	days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Working Capital	%	11.50%	Considered similar to candidate CDM project activity

V. Levelized Cost of Generation for Coal (Sub-critical) Based Alternative:

Project Cost			
Project cost including IDC	Rs. Crores	2,000.0	Calculated value

Project Specifications			
Project capacity	MW	500	
Project life	Years	25	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Paragraph 5.3.3)
Project cost per MW	Rs. Crores	4.0	http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf (page11)
Commercial Operation Date		Apr-12	

Project Financing			
Project Equity	%	30%	Considered to be similar to candidate project activity
Project Debt	%	70%	Considered to be similar to candidate project activity
Project Equity	Rs. Crores	600.0	Calculated
ROE	%	16.0%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	1,400.0	Calculated
Term of Debt	Years	12.0	Considered to be similar to candidate project activity
Interest on Debt	%	11.50%	Prime Lending Rate at the time of investment decision making. Reference : http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	Considered to be similar to candidate project activity

Operating Norms			
Heat Rate	Kcal/Kwh	2,450	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf; page 124 & 125f the tariff order; highest heat rate from the various alternative is considered for conservativeness. The same has been multiplied by a factor of 6.5% as suggested in the tariff order

Auxiliary consumption		9.00%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Page 129; electrically driven boiler feed pump and additional 0.5% provided for draft cooling tower has also been taken into account for conservativeness)
PLF		85%	As per Detailed Project report (DPR) page 1-4 of 135
Discounting Factor	%	10.19%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf

Fuel Specifications			
Primary Fuel - Coal			
NCV of Coal	kCal/kg	3,946	CERC Tariff petiotion (140/2005 ; page no 25 of 34) in respect of Ramagundam Super Thermal Power Station Stage (III) for the period 25.03.2009 to 31.03.2009. The value corresponding to the month of February, 2005 (the latest month) has been considerd. (Weblink : http://cercind.gov.in/03022007/No-140-05-doh-22-5-07.pdf The difference between GCV and NCV has been considered at 3.6%.(Reference: CEA CO2 database; version 02 dated 21st June, 2007 Weblink: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm As per http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf, NCV of coal varies from 3750 kCal/kg to 4150 kCal/kg
Landed Cost of Coal	Rs. / kg	1.2849	CERC Tariff petiotion (140/2005 ; page no 25 of 34) in respect of Ramagundam Super Thermal Power Station Stage (III) for the period 25.03.2009 to 31.03.2009. The value corresponding to the month of February, 2005 (the latest month) has been considerd. Weblink: http://cercind.gov.in/03022007/No-140-05-doh-22-5-07.pdf
Annual Coal Price Escalation		6.12%	http://www.cercind.gov.in/Escalation-rate/Notification-dated-30-09-09.pdf
Secondary Fuel -Oil			
NCV of Oil	kCal / lt	9,595	CEA CO2 Emission Database version 6: http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm
Specific Oil consumption - Combined cycle	ml / kWh	1.0	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (paragraph 30.4 in page127)

Cost of Oil	Rs. / kl	7,152	As per GERC tariff order 861/ 2006 ; Table 36, Page no 55 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en
Escalation for oil	%	10.50%	As per GERC tariff order 861/ 2006 ; Page no 52 of 109, Link:http://www.gercin.org/index.php?option=com_tarifforder&Itemid=32&year=2006&lang=en

Depreciation			
Recovery of Depreciation	%	90%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Rate of Depreciation for the first 12 years	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Rate of depreciation for the remaining lifetime of the project	%	2.05%	Calculated based on the above

O&M			
O&M Expenses	Rs. Lakhs/MW	15.36	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 64)
Escalation Factor	%	5.72%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf

Tax			
Tax Rate	%	33.99%	Income Tax Act; budget of 2009-10 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00%	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income Tax Act

Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)

Spares	% of O&M Cost	20%	**CERC:** http://www.cercind.gov.in/13042007/Terms_and_conditions_of_tariff.pdf
Escalation factor for spares	%	~~5.72~~0%	The CERC order states spares to be 20% of O&M cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.~~The CERC order states spares to be 20 % of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~
Primary Fuel Stock	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Secondary Fuel Stock	days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Working Capital	%	11.50%	Considered similar to candidate CDM project activity

VI. Levelized Cost of Generation for Naphtha Based Alternative:

Project Cost			
Project cost including IDC	Rs. Crores	2,610.36	Since there are no new naphtha based power projects coming up,project cost equivalent to candidate CDM project has been considered

Project Specifications			
Project capacity	MW	742	Since there are no new naphtha based power projects coming up, capacity equivalent to candidate CDM project has been considered
Project life	Years	20	For conservativeness, lifetime of a coal based plant has been considered
Project cost per MW	Rs. Crores	3.518	Assumed to be same as the project cost
Commercial operation Date		Apr-12	Considered similar to candidate CDM project activity

Project Financing			
Project Equity	%	30%	Considered similar to candidate CDM project activity
Project Debt	%	70%	Considered similar to candidate CDM project activity
Project Equity	Rs. Crores	783.1	Calculated
ROE	%	16.00%	CERC Order (page 31): http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Project Debt	Rs. Crores	1,827.2	Calculated
Term of Debt	Years	12.0	Considered similar to candidate CDM project activity
Interest on Debt	%	11.50%	Prime Lending Rate at the time of investment decision making. Reference : http://www.rbi.org.in/scripts/WSSView.aspx?Id=14091
Moratium Peirod	Months	6.0	Considered similar to candidate CDM project activity

Operating Norms

Heat Rate	Kcal/Kwh	2,117	http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm; Version 4 of the database available at the time of project decision making (Please refer to the assumptions sheet)
Auxiliary Consumption		3.50%	http://www.cea.nic.in/reports/planning/cdm_co2/cdm_co2.htm; Version 4 of the database available at the time of project decision making (Please refer to the assumptions sheet)
PLF		85%	Considered similar to candidate CDM project activity
Discounting factor	%	10.19%	Considered similar to candidate CDM project activity

Fuel Specifications Primary Fuel - Naphtha			
NCV of Naphtha	kCal/kg	9,975	CEA expert committee report on fuel pricing (Page 5 of 17) http://www.cea.nic.in/reports/articles/thermal/expert_committee_report_fuel.pdf; the difference between GCV and NCV has been considered as 5%, in line with the CEA database Version 7.
Specific Naphtha consumption	kg/kWh	0.20	Calculated
Landed Cost of Naphtha	Rs. / kg	27.00	http://www.cmtevents.com/eventdatas/070523/pdf/ONGC.pdf (Slide 41)
Annual Naphtha Price Escalation		10%	~~The escalation applicable for NG has been considered for Naphtha as well~~http://www.gercin.org/tarifforderpdf/en_1304750473.pdf

Depreciation			
Recovery of Depreciation	%	90%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
Depreciation for first 12 years	%	5.28%	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (Last paragraph of page 44), Appendix- III available at: http://cercind.gov.in/2009/Whats-New/tariff-pdf/Appendix-III.pdf
Depreciation for the rest of the project lifetime	%	3.33%	Calculated based on the above

O&M

O&M Expenses	% of total capital cost	2.50%	http://www.thegef.org/gef/sites/thegef.org/files/repository/09.PAD.Annex_9.pdf (Page 5 of 13 provides the value of O&M cost for exisiting naphtha based power plants.)
Escalation Factor	%	5.72%	Considered similar to the candidate CDM project activity.

Tax			
Tax Rate	%	33.99%	Income Tax Act; budget of 2008-09 states the rate of corporate tax is 33.99% (http://www.madaan.com/taxrates.htm)
MAT Rate	%	17.00%	Income Tax Act http://articles.economictimes.indiatimes.com/2009-07-07/news/27634848_1_mat-rate-zero-tax-companies-minimum-alternate-tax
80IA Exemption	Years	10.00	Income Tax Act

Working Capital norms			
Receivables	Days	60	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Spares	% of O&M cost	30%	Considered similar to gas based project: http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 49)
Escalation factor for spares	%	~~5.72~~0%	The CERC order states spares to be 20% of O&M cost; no separate escalation rate has been considered for the cost of spares as the escalation in O&M costs is already being considered.~~The CERC order states spares to be 30% of O&M cost; hence the escaltion rate of O&M cost has been considered for spares as well~~
Primary Fuel Stock	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf
O&M Expenses	Days	30	http://cercind.gov.in/2009/February09/SOR-regulations-on-T&C-of-tariff-05022009.pdf (page 48)
Interest on Working Capital	%	11.50%	Considered similar to candidate CDM project

Appendix 4

Calculation of Weighted Average Capital Cost (WACC)

Weighted Average Cost of Capital:

WACC = [D/ (D+E)]*[Cost of Debt] + [E/ (D+E)]*[Cost of Equity]

Cost of Debt:
Cost of debt is defined as the rate at which the lenders agree to lend money to the project. In the context of the current project, the prevailing Prime Lending Rate (PLR) at the time of project decision making has been considered as the cost of debt. The PLR at the time of decision making was in the range of 11.00% to 12.00%. Hence, the PLR is considered as 11.50%

Interest costs are tax deductible, therefore in order to arrive at the post tax cost of debt, the cost of debt is reduced by tax rate.

Calculation of Cost of Equity:
The expected return on equity has been determined using the Capital Asset Pricing Model (CAPM)[45]. The CAPM economic model is used worldwide to determine the required/expected return on equity based on potential risk of an investment. The CAPM framework is the Nobel award winning work of financial economist Dr. William Sharpe.

Ke = Rf + B x (Rm - Rf)
where:
Ke = Rate of return on equity capital;
Rf = Risk-free rate of return;
B = Beta;
Rm – Rf = Market risk premium;

Risk free rate:
The risk free rate is understood as the rate of return on an asset that is theoretically free of any risks, therefore the rate of interest on government bonds are considered as risk free rates. Page 191 of text book on "Corporate Finance Theory and Practice" by Dr. Aswath Damodaran[46] of Stern School of Business, New York University describes that the long term government bond rates are suitable indicators of risk free rates since the time horizon for this investment is long term.

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[45] The Capital Asset Pricing Model (CAPM) was published in 1964 by William Sharpe, for his work on CAPM Sharpe received the Nobel Prize in 1990. http://www.investopedia.com/articles/06/CAPM.asp

[46] Dr. Damodaran is one of the foremost authorities in the world in the field of Investment Analysis

Accordingly the risk free rate has been taken from government securities market (SGL rate), published by the Reserve Bank of India, with a maturity period of 20 years (equivalent to project lifetime). The most recent data as available on project decision date has been considered (12 month average)[47].

The applicable risk free rate is 7.70 %.

Risk Premium:
The most common approach for estimating the risk premium is to base it on historical data, in the CAPM, the premium is estimated by looking at the difference between average return on stocks and average return on government securities over an extended period of history [page 190, Corporate Finance Theory and Practice, Dr. Aswath Damodaran.[48]]. It is preferred to use long term premiums, i.e. over a period of 25 years, since considering shorter time periods can lead to large standard errors because volatility in stock returns [page 191, Corporate Finance Theory and Practice, Dr. Aswath Damodaran.] It is also preferred to calculate the risk premium based on geometric mean of the returns since arithmetic mean overstates the risk premium. Geometric mean is defined as the compounded annual return over the same period [page 191, Corporate Finance Theory and Practice, Dr. Aswath Damodaran]. Therefore the risk premium has been calculated as the difference in compounded annual return between the BSE-Sensex and the Government bond rates since the year of inception of BSE Sensex, i.e. 1979 – 80. The detailed calculations are presented in the attached excel sheet. Source: BSE Stock Exchange (www.bseindia.com)

The applicable risk premium is 10.67 %.

Beta:
Beta (B) indicates the sensitivity of the company to market risk factors. For companies that are not publicly listed, the beta is determined by referring beta values of publicly listed companies that are engaged in similar types of business. The project activity type is gas based power generation; the approach therefore should be to base the beta for the project on the beta values of listed power generation companies in India.

The applicable Beta value has been determined on the basis of the Beta values of all power generating companies in India which were listed on the stock exchange at the time of this investment. Beta values of individual companies have been sourced from Bloomberg and screenshots (attached below). The table below summarises the beta values:

Company	Bloomber Symbol	Betas (5 year)
BF Utilities LTd.	BFUT IN Equity	1.218
CESC Ltd.	CESC IN Equity	1.102
Neyveli Lignite Corpn.	NLC IN Equity	1.194
Tata Power Co. Ltd.	TPWR IN Equity	1.029
Gujarat Industries Power Co. Ltd.	GIP IS Equity	0.956
GVK Power	GVKP IN Equity	1.444
Reliance Infrastructure Ltd.	RELI IN Equity	1.574
Torrent Power	TPW IN Equity	1.108
JPVL	JPVL:IN Equity	1.259
Average		**1.209**

[47] http://rbi.org.in/scripts/BS_ViewBulletin.aspx?Id=10652

[48] All such related sources would be submitted to the DOE during validation.

Source:Bloomberg[49]

WACC = [D/ (D+E)]*[Cost of Debt] + [E/ (D+E)]*[Cost of Equity]

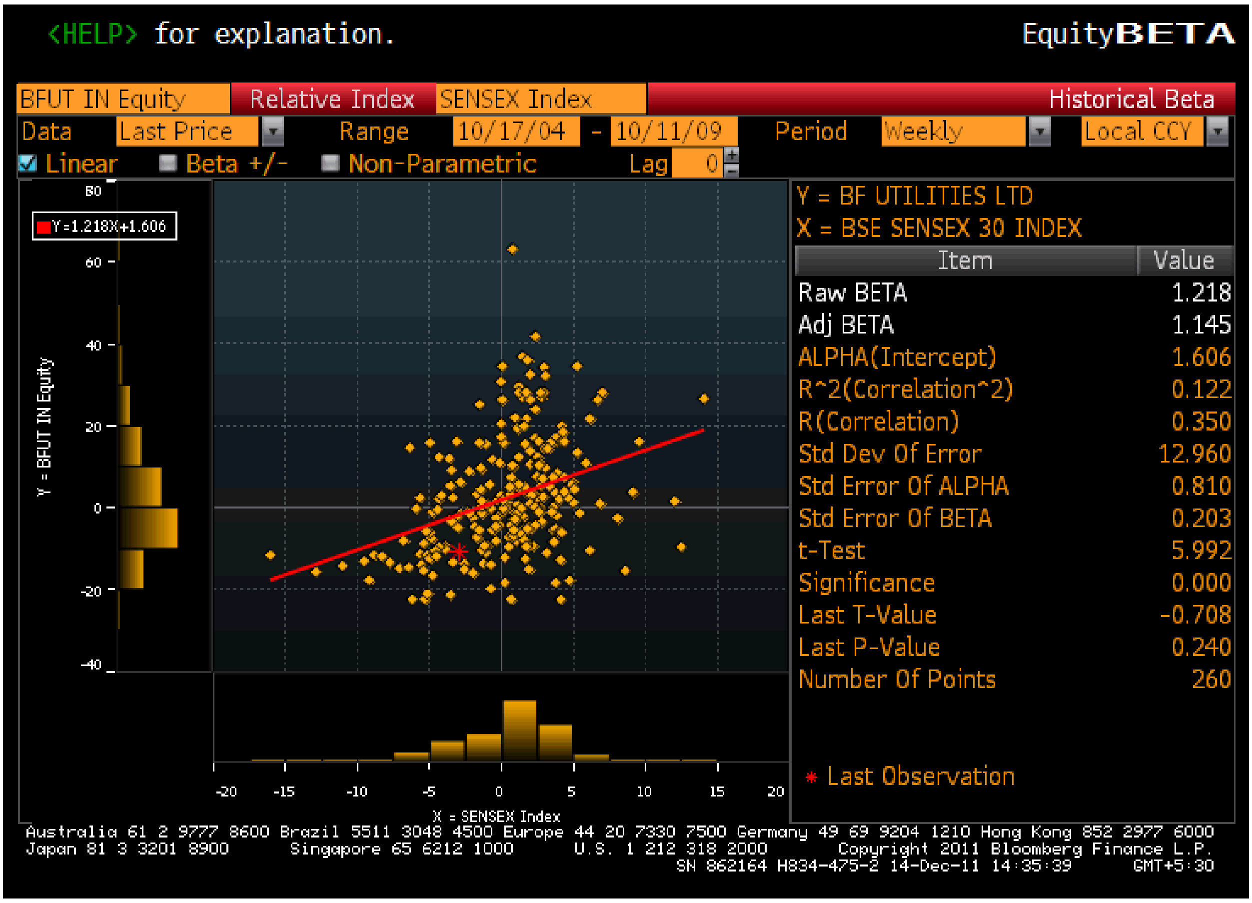
WACC = 70%* 11.5%*(1-17%) + 30%*((10.68 *1.210) + 7.70)
Therefore, **WACC = 12.86%**

[49] The beta value used, are the regression betas calculated by Bloomberg based on periodic stock returns. Bloomberg also provides an adjusted beta value after making the following adjustments:
Adjusted Beta=Regression Beta (denoted as Raw beta) *(0.67) +1.00*(0.33)

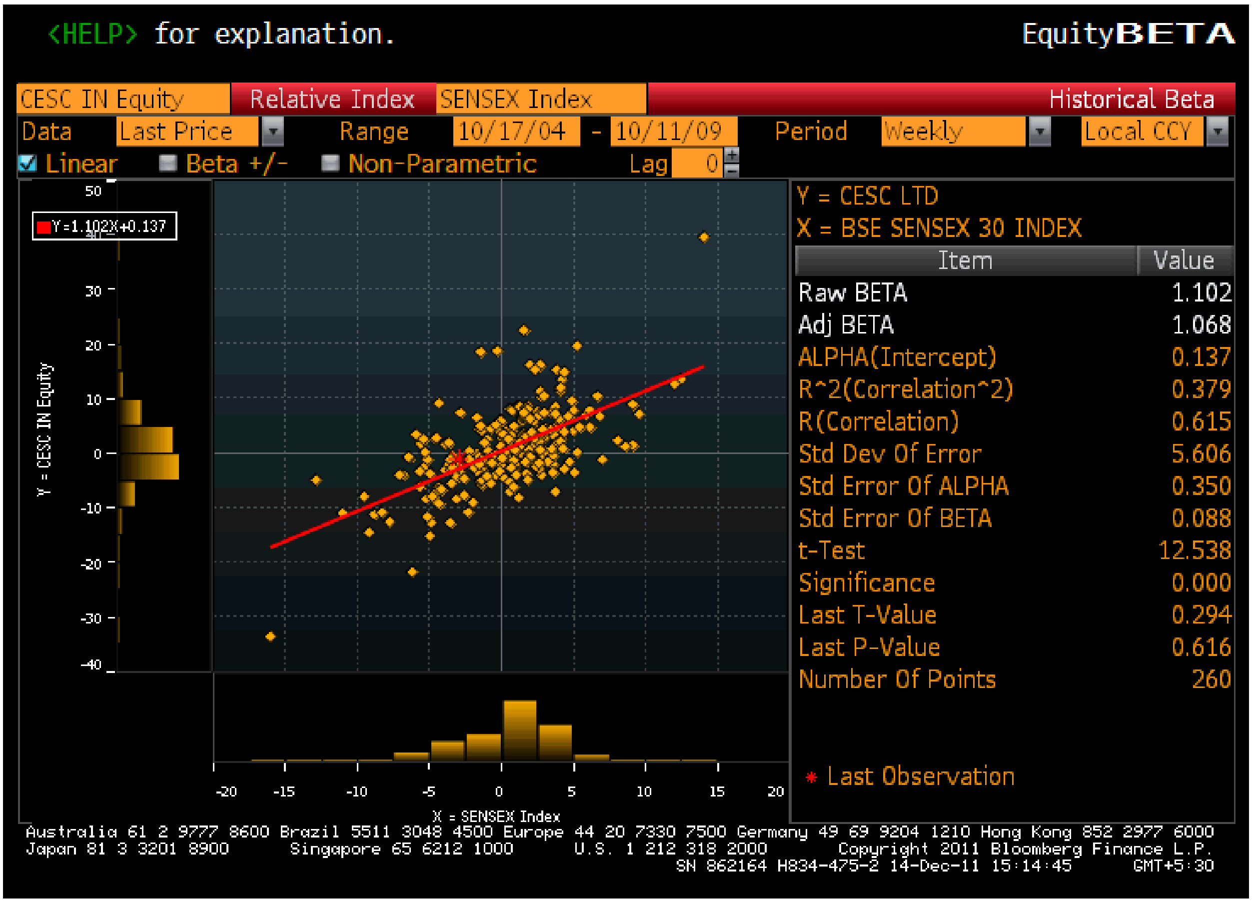
Bloomberg states that this is a default adjustment on the assumption that in future, over a period of time all betas may tend towards the average beta i.e. one. The approach outlined in corporate finance states: the conventional approach to estimate the beta of an investment is a regression of return on investment against returns on a market index (page no. 196 from "Corporate Finance Theory and Practice by Aswath Damodaran). Accordingly, the regression beta (and not the adjusted beta) value has been considered.

Bloomberg Screenshots

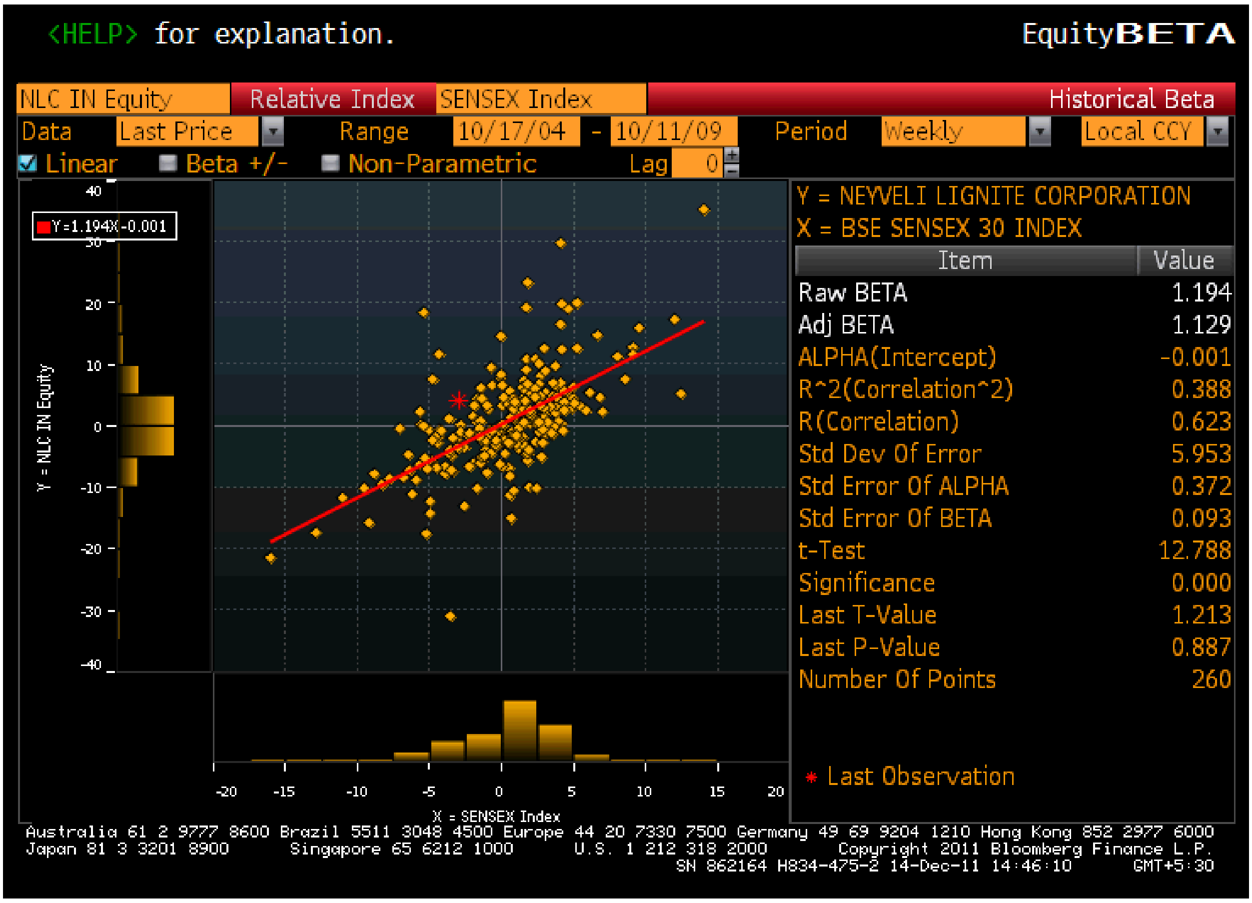
BF Utilities



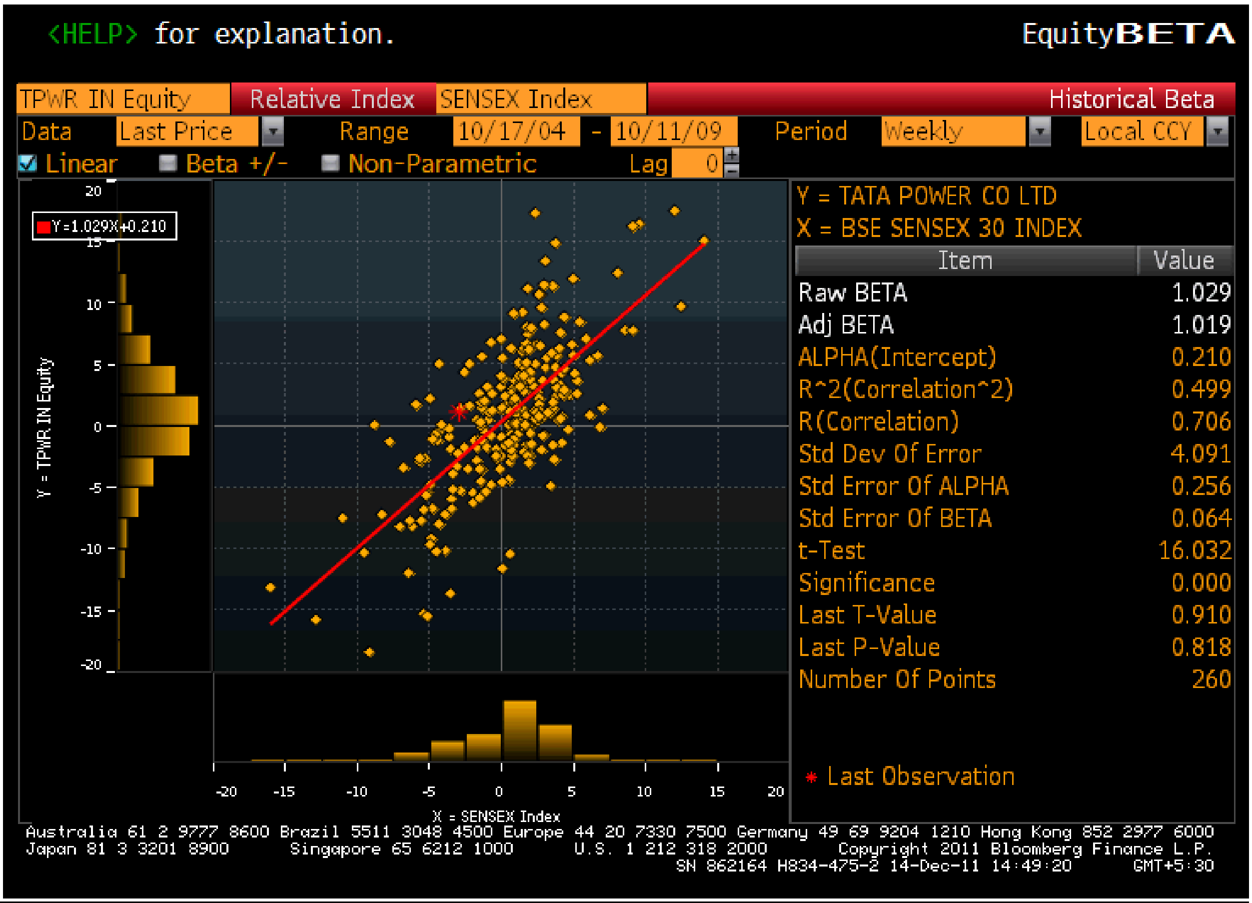
CESC Limited



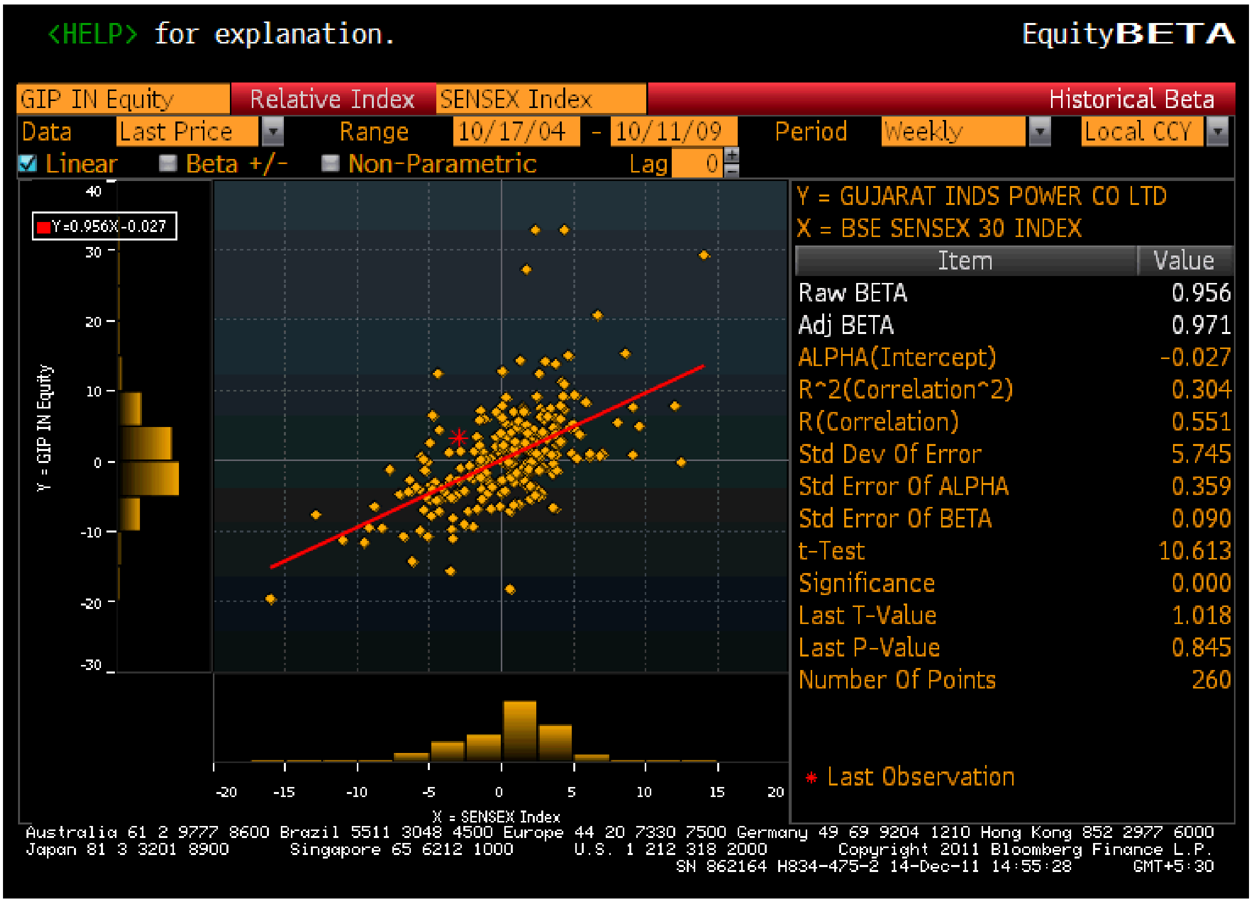
Neyveli Lignite Corporation



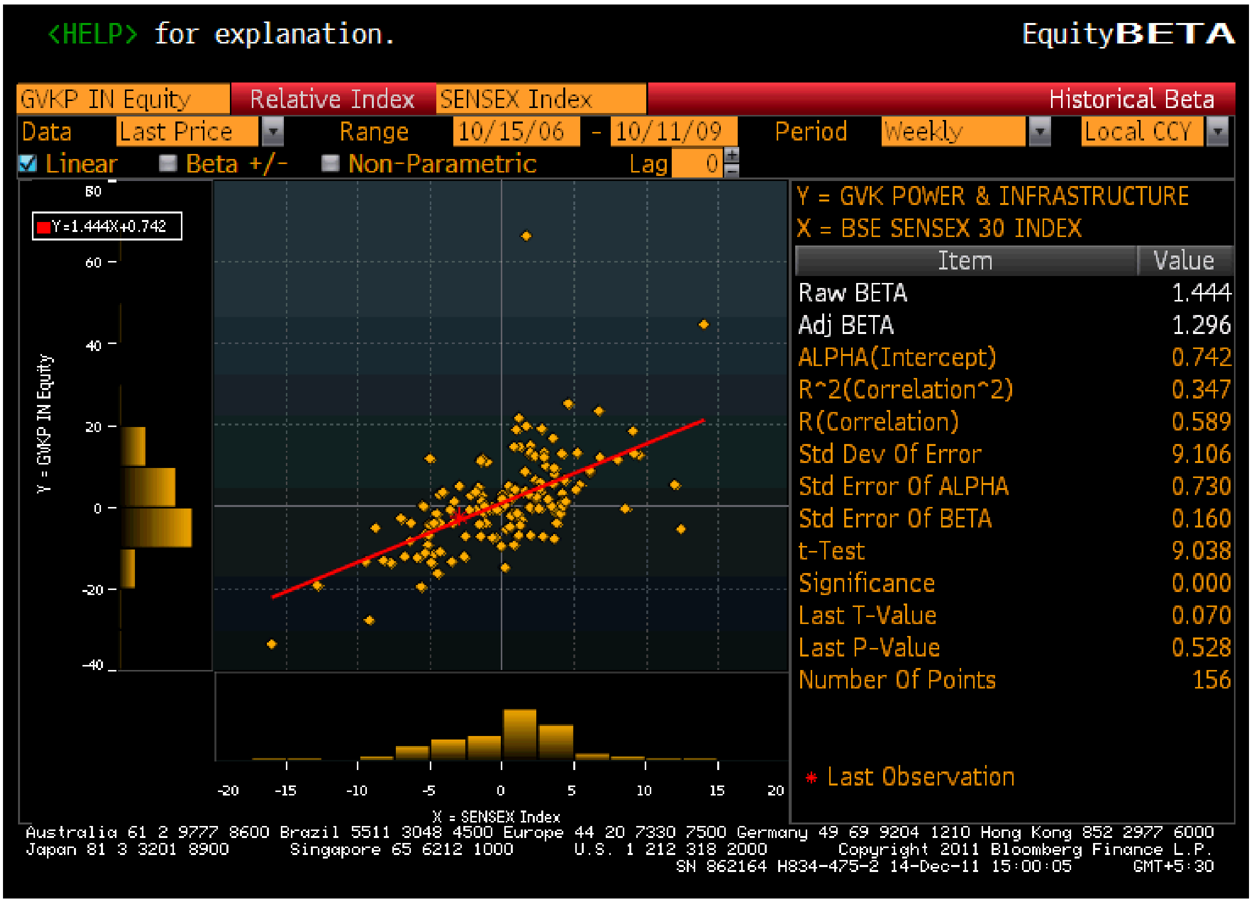
Tata Power Company Limited



Gujarat Industrial Power Co. Limited



GVK Power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EquityBETA
GVKP IN Equity
Relative Index
SENSEX Index
Historical Beta
Data
Last Price
Range
10/15/06
-
10/11/09
Period
Weekly
Local CCY
Linear
Beta +/-
Non-Parametric
Lag
0
Y=1.444X+0.742
Y = GVKP IN Equity
X = SENSEX Index
Y = GVK POWER & INFRASTRUCTURE
X = BSE SENSEX 30 INDEX
Item
Value
Raw BETA 1.444
Adj BETA 1.296
ALPHA(Intercept) 0.742
R^2(Correlation^2) 0.347
R(Correlation) 0.589
Std Dev Of Error 9.106
Std Error Of ALPHA 0.730
Std Error Of BETA 0.160
t-Test 9.038
Significance 0.000
Last T-Value 0.070
Last P-Value 0.528
Number Of Points 156
Last Observation
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2011 Bloomberg Finance L.P.
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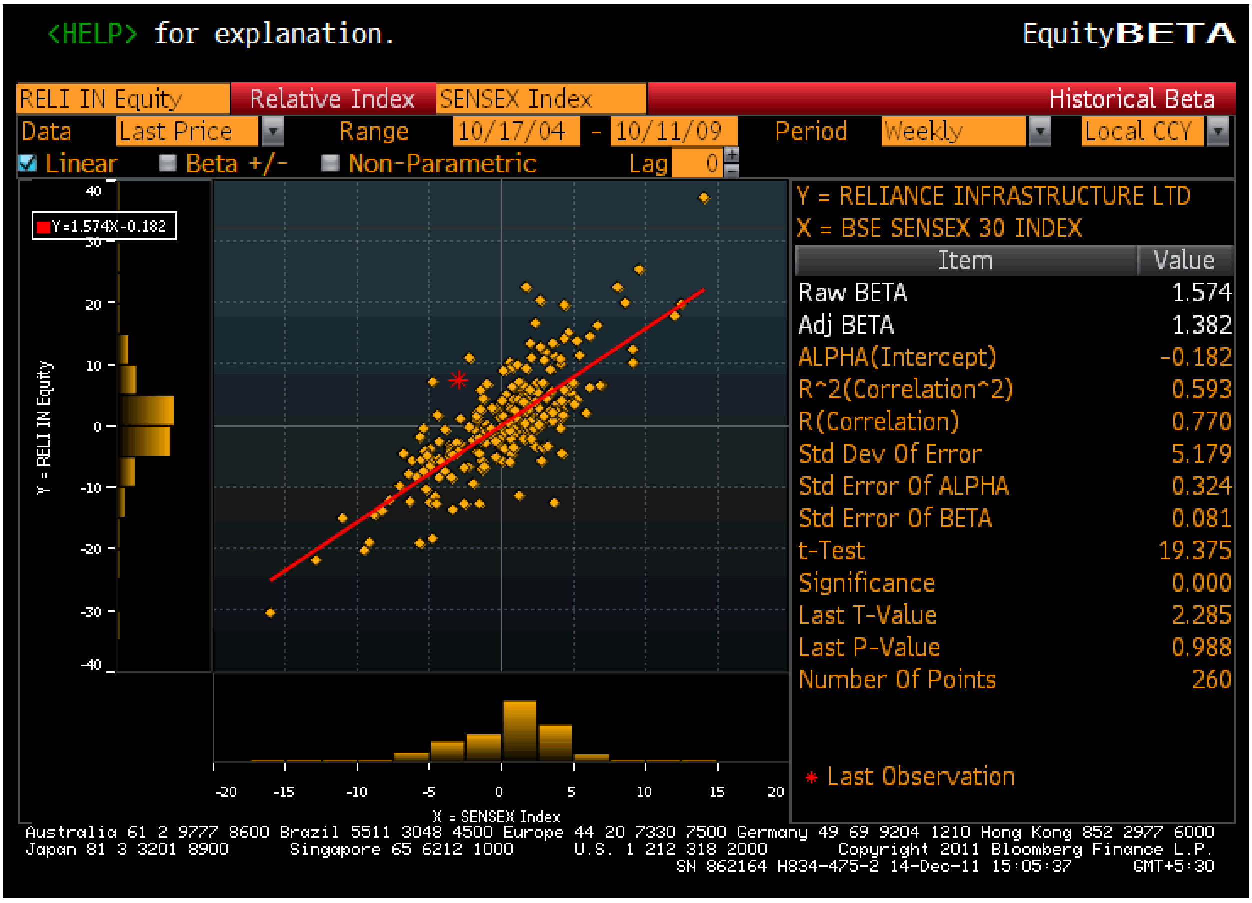
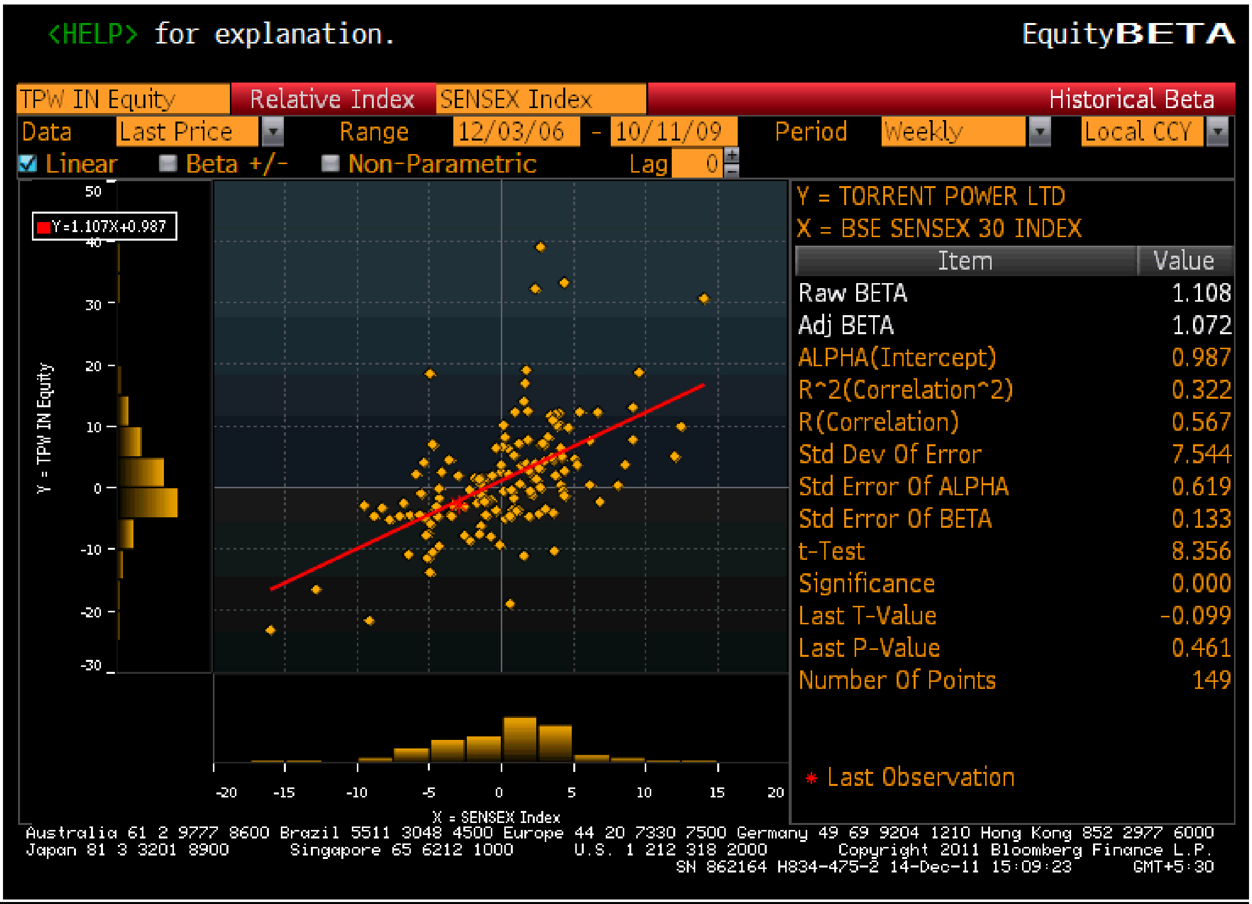
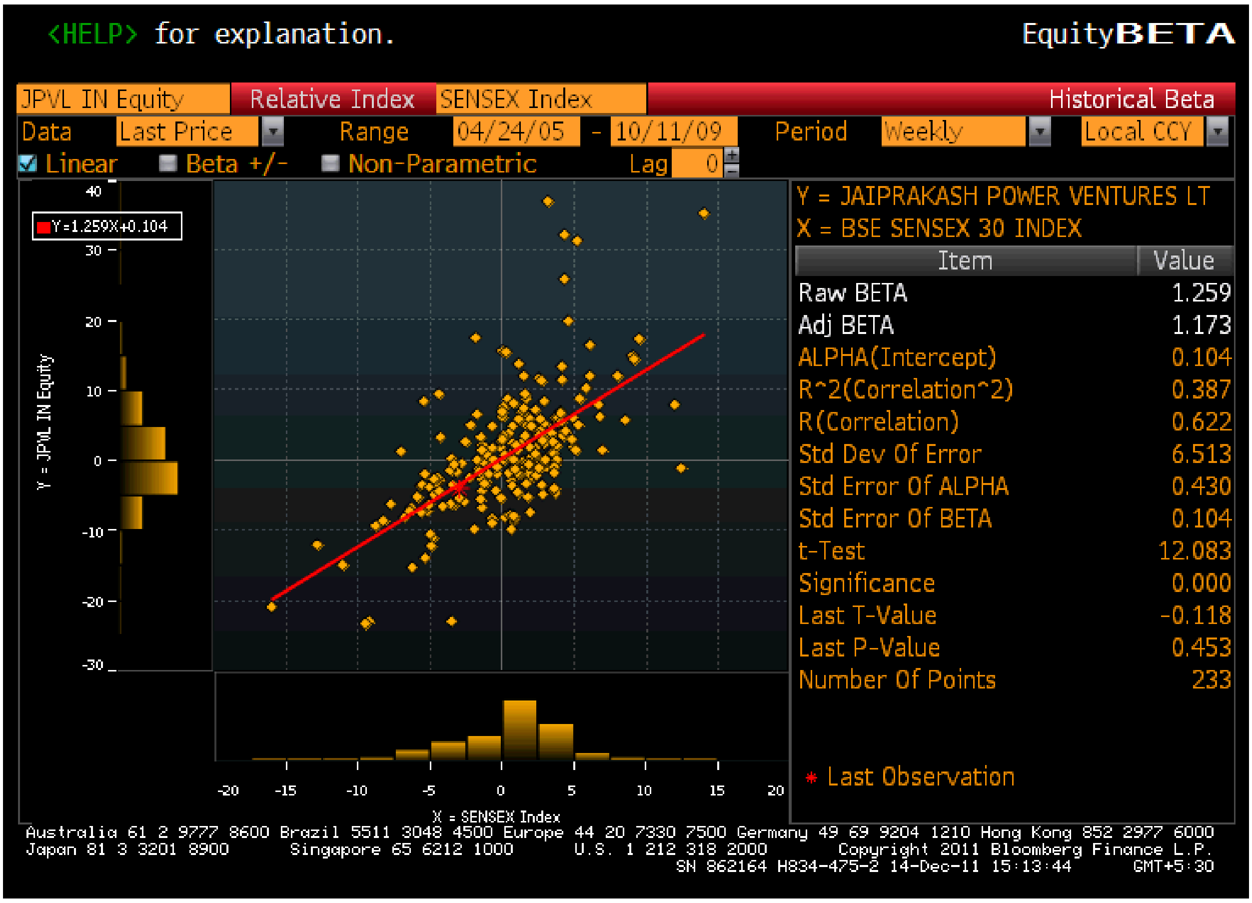
Reliance Infrastructure Limited



TORRENT POWER



JPV Limited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EquityBETA
JPVL IN Equity
Relative Index
SENSEX Index
Historical Beta
Data
Last Price
Range
04/24/05 - 10/11/09
Period
Weekly
Local CCY
Linear
Beta +/-
Non-Parametric
Lag 0
Y=1.259X+0.104
Y = JPVL IN Equity
X = SENSEX Index
Y = JAIPRAKASH POWER VENTURES LT
X = BSE SENSEX 30 INDEX
Item Value
Raw BETA 1.259
Adj BETA 1.173
ALPHA(Intercept) 0.104
R^2(Correlation^2) 0.387
R(Correlation) 0.622
Std Dev Of Error 6.513
Std Error Of ALPHA 0.430
Std Error Of BETA 0.104
t-Test 12.083
Significance 0.000
Last T-Value -0.118
Last P-Value 0.453
Number Of Points 233
Last Observation
Australia 61 2 9777 8600 Brazil 5511 3048 4500 Europe 44 20 7330 7500 Germany 49 69 9204 1210 Hong Kong 852 2977 6000
Japan 81 3 3201 8900 Singapore 65 6212 1000 U.S. 1 212 318 2000 Copyright 2011 Bloomberg Finance L.P.
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