Voluntary Carbon Standard
Project Description

17/11/2009
Version 1.4

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1 Description of Project:

1.1 Project title

Natural Gas Based Grid Connected Power Generation Project at Valantharavai

1.2 Type/Category of the project

- Project Type: I - Energy Industries (Renewable / Non-renewable sources)
- Category: AM0029 – Baseline Methodology for Grid Connected Electricity Generation Plants using Natural Gas

- According to the VCS 2007.1 programme guidelines, any combination of GHG projects or project categories that meets the requirements of the VCS 2007.1 can be registered as a grouped project. This project is neither a combination of GHG projects nor a combination of project categories, and therefore, not a Grouped project.

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

- According to the VCS program guidelines paragraph 5.1, the project activity falls under the "projects" group whose estimated emissions reductions are between 5,000 and 1,000,000 tCO2e. The implementation of this project activity is estimated to result in annual emissions reductions of 43,418 tCO2e and 434180 tCO2e over the ten year crediting period as tabled below:

Year	Estimate of GHG abatement (in tCO2e)
2006- 2007	43,418
2007- 2008	43,418
2008- 2009	43,418
2009- 2010	43,418
2010- 2011	43,418
2011- 2012	43,418
2012- 2013	43,418
2013- 2014	43,418
2014- 2015	43,418

2015- 2016	43,418
Total emission reductions (tCO2e)	434180
Total number of crediting periods	Ten years
Annual average over the crediting period of emission reductions (tCO2e)	43,418

1.4 A brief description of the project:

Coromandel Electric Company Limited (CECL) is an associate company of The India Cements Limited (ICL), the leading producer of cement in South India. The Company has well established cement brands- Sankar Super Power, Coromandel Super Power and Raasi Super Power. ICL operates three cement manufacturing units in the state of Tamil Nadu, India (at Salem, Tirunalveli and Trichy). The power requirements of the three units were mainly being sourced from the state owned electricity supply company, Tamil Nadu Electricity Board (TNEB). CECL was established by ICL with the objective of setting up a grid connected power generation plant from which electricity would be "wheeled" through the TNEB grid to ICL's three cement units and thereby substitute import of TNEB grid electricity.

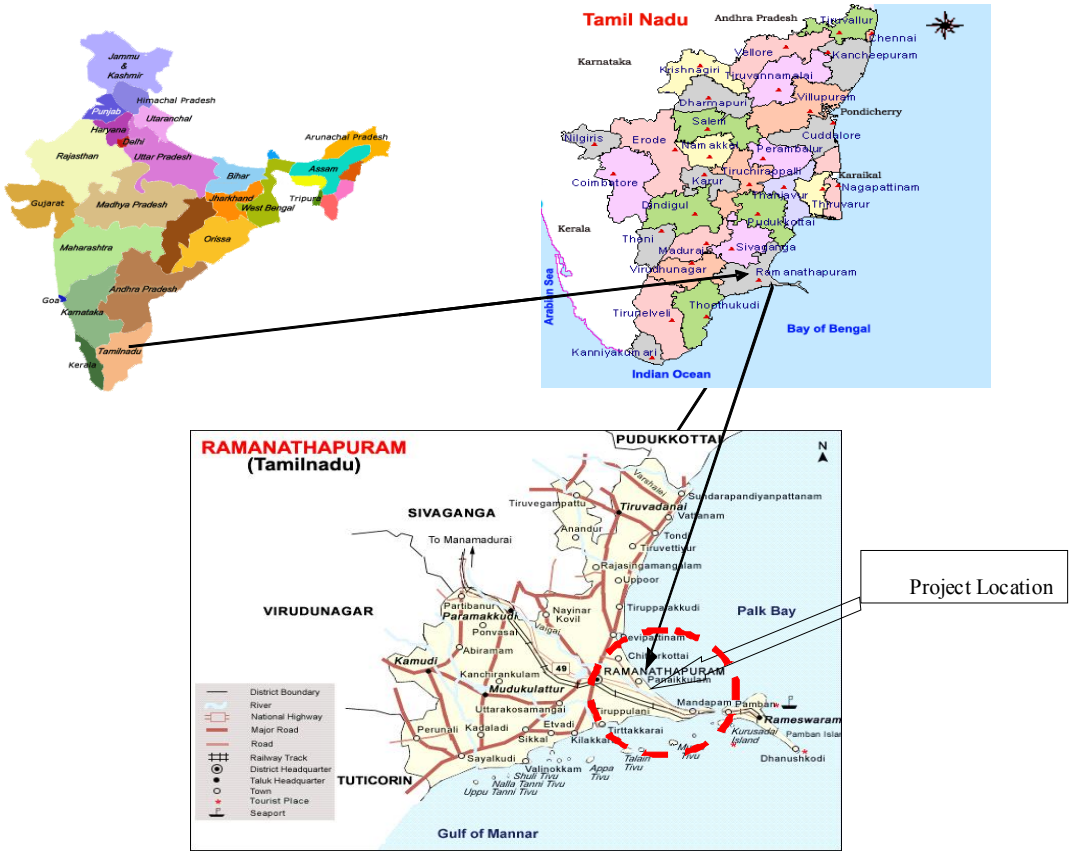
CECL explored various fuel and technology options for the power plant. Though coal based power plant worked out to be economical compared to a Natural Gas based power plant, CECL opted to implement the Natural Gas (NG) based plant considering that it is a cleaner/less GHG intensive fuel. By displacing the GHG intensive coal based power with equivalent NG based power, the project activity results in CO2 emission reductions.

CECL has set up a 26.19 MW Natural Gas Based power Plant in Ramanathapuram district, Tamil Nadu (project activity) in two phases (Phase I: 17.46 MW + Phase II: 8.73 MW). The project activity is connected to the Tamil Nadu Electricity Board (TNEB) grid, through which it supplies electrical energy to the three factories of ICL. CECL receives its NG supplies from GAIL. It receives a total of 1,19,000 scm/d of NG (Phase I – 80,000 scm/d and Phase II –

39,000 scm/d) from the ONGC field at Perungulam/Ramnad. A pipeline of 375m has been constructed from the GAIL gas distribution header (located at GAIL terminal -TNEB Valuthur Gas Turbine Power Plant - VGTPP power station) to the project activity for a distance of 375 m.

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

CECL has set up the project activity at Valantharavai village, Ramanathapuram district, (Latitude: 9°22′05″ North Longitude: 78°57′18″ East)[1], India. The nearest airport is at Madurai, which is 110 km from the plant location. The geographical location of the project activity is depicted in the following map:.



1.6 Duration of the project activity/crediting period:

[1] Source: Environmental Assessment Report

- Project start date: 26/11/2004[2] (the date the project activity began reducing or removing GHG emissions – based on the policy announcement from VCS dated September 10, 2008)
- Crediting period start date: 30/03/2006
- VCS project crediting period: Ten years

1.7 Conditions prior to project initiation:

The project is a greenfield project and there was no activity prior to the project initiation.

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

The project activity displaces greenhouse gas emissions which would otherwise have been emitted to the atmosphere by coal based electricity generation, which is a common practice in the region. Natural gas is a less carbon intensive fuel among the fossil fuels, and therefore will have lower GHG emissions.

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

The Internal Combustion (IC) reciprocating engine mechanism has been implemented in this project activity. The incoming fuel, natural gas, produces energy on combustion which drives a piston inside a cylinder causing a reciprocating motion. This is converted to rotary motion which in turn drives a rotor in the alternator where electric energy is generated. The energy generation is at 11kV which is stepped up to 110kV using transformers and transferred to the TNEB grid. It is then imported by ICL's three cement manufacturing units located elsewhere in the State and utilised to meet their power requirements.

The power plant includes three IC engines; each of 8.73 MW rated capacity. The total rated capacity of the natural gas based power plant is 26.19 MW (Phase I: 17.46 MW + Phase II: 8.73 MW). The project activity is expected to operate at an average plant load factor of 87.82% and generate approximately 0.196

[2] Source : Commissioning certificate – Wartsila India Limited

Million MWh of electricity per annum. The gas engines are expected to consume around 0.23 Standard Cubic Metre (SCM) of natural gas per kWh of electricity generated at a calorific value of 8744 kCal/SCM. Technical details of the power plant and components are as follows:

- Type: 3 X 20V34SG Gas Engine Generator Sets [GEG's]
- Make: Wartsila, Finland OY
- Capacity each : 8.73 MW
- Heat rate: 2038 kCal/kWh
- Frequency: 47.5 – 51.5 HZ
- Power evacuation: 110 kV Switchyard
- 25MVA, 11/115KV Generator transformer for 2 x 20V34SG GEG's [Phase-I]
- 15MVA, 11/115KV Generator Transformer for 1 x 20V 34SG GEG [Phase – II]

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

All statutory compliances required for the project activity have been sought.

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

Economic Viability – The rate of return from the project activity is lower than the cost of capital employed. This is mainly due the higher cost of natural gas. The cost of gas is expected to increase drastically in the future which might make the project economically unviable.

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

The project activity is a natural gas based power generation plant. Natural gas is a less GHG intensive fuel when compared to coal, lignite and other fossil fuels. The promoter had the choice of opting for a coal based power plant, but with the objective of GHG emission reduction, they set up a NG based plant. Therefore,

it is clear that there was no intention to create GHG emissions during its implementation for its subsequent removal.

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

The project has not created any form of environmental credit for itself. There are no renewable energy certification programs in the region.

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

The project has not applied for any other GHG programme to claim credits for emissions reduction.

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

Project proponent:

Organization:	Coromandel Electric Company Limited
Street/P.O.Box:	827, Anna Salai,
Building:	Dhun Building
City:	Chennai
State/Region:	Tamil Nadu
Postfix/ZIP:	600002
Country:	India
Telephone:	+91 044 28521526
FAX:	+91 044 28572100
E-Mail:	
URL:	www.indiacements.co.in
Represented by:	
Title:	President (Manufacturing)
Salutation:	Mr.
Last Name:	Sivagurunathan
Middle Name:	
First Name:	D
Department:	Manufacturing
Mobile:	
Direct FAX:	+91 044 28521344
Direct tel:	+91 044 28413294
Personal E-Mail:	sivagurunathan@indiacements.co.in

Coromandel Electric Company Limited would be the project participant, and all communication with the validator and/or verifier as well as with the VCS registry would be the entity listed in the table above.

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

Apart from GHG emission reductions, the project activity also contributes to sustainable development.

The project activity contributes to sustainable development which can be categorized under the following categories:

Social well being: The project activity has created a general awareness in the community on global warming and its impacts. Social, economic and environmental well being has been ensured through this activity thereby leading to sustainable development.

Economic well being: Employment opportunities are created for the communities dwelling in and around the vicinity of the plant both during the construction as well as the operation of the project. CECL provides direct employment to about 30 people at different cadres. Also, the project activity enhances trading opportunities due to increased mobility to cities.

Environmental well being: The project activity contributes to a significant amount of GHG reduction which would have otherwise been emitted into the atmosphere adding to global warming. Switching to cleaner fuels for power generation reduces use of fossil fuels thereby reducing GHG emissions as well as this initiative sets an example for other industries to adopt. By avoiding use of carbon intensive fuels like coal/lignite, the project activity prevents emissions associated with such fuels (SOx, NOx etc). Further, it avoids generation of fly ash and bottom ash, the disposal of which poses environmental hazard.

Technological well being: The engines operate at a lower gas pressure compared to the combined cycle. The project activity uses advanced gas engine technology, imported from a globally reputed manufacturer. The space required and water consumption is much lower when compared to conventional power plants. The requirement of water is negligible for a water treatment in this technology.

1.17 List of commercially sensitive information (if applicable):

Not applicable

2 VCS Methodology:

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

Title: "AM0029 Methodology for Grid Connected Electricity Generation Plants using Natural Gas" Version 3 which is an approved methodology under the VCS.

The project utilises natural gas for electricity generation and therefore, this methodology has been adopted.

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

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

The project activity falls under the following project category:

Classification	Justification
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 is the construction and operation of a new natural gas fired power plant which is connected to the TNEB grid, which is a part of the Southern Regional Grid of India. Natural gas is the primary fuel being used, and start up fuels High Speed Diesel (HSD) for Plant Black Start DG are being used and its consumption is negligible ie. <1% of total primary fuel Qty.
The geographical/ physical boundaries of the baseline grid can be clearly identified and information pertaining to the grid and estimating	In India, the electricity grids are divided into five regional grids. Each regional grid consists of a combination of different state electricity grids among which significant electricity import/export exist. The project activity is connected to the Tamil Nadu state grid, which is a part of the southern regional

baseline emissions is publicly available	grid. The Central Electricity Authority (CEA) acts as the apex body that monitors and governs the regional grids. CEA has published detailed information pertaining to the various grids. Thus, the project boundary can be clearly defined and information pertaining to grid and estimating baseline emissions is publicly available.
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	CECL receives its NG supplies from GAIL, from the ONGC field at Perungulam/Ramnad. Tamil Nadu has NG supplies in several districts including Cuddalore, Nagapattinum and Ramanathapuram (location of project activity)[3]. On the gas supply and potential, GAIL has a 200-km network of pipeline in Tamil Nadu and supplies 30 lakh standard cubic metres of gas a day (scmd) from five zones – Narimanam, Kuttalam, Ramnad, Kovilkalappal and Bhuvanagiri, an area expected to have a huge gas potential – to 31 industrial units. Expansion activities to increase supplies in the region are also in the pipeline[4]. Therefore, there is no possibility of displacing NG that would have otherwise been used elsewhere.

[3] Source : http://www.thehindubusinessline.com/2008/06/07/stories/2008060751222100.htm

[4] Source : http://www.tidco.com/news11.html

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.	Gas Availability: GAIL gas supply in the region in 2003-04[5]: 1.32 MSCMD[6] GAIL gas supply in the region in 2004-05[7]: 1.72 MSCMD GAIL gas supply in the region in 2005-06[7]: 2.33 MSCMD

Therefore, the project activity satisfies all the applicability criteria of the methodology.

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

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

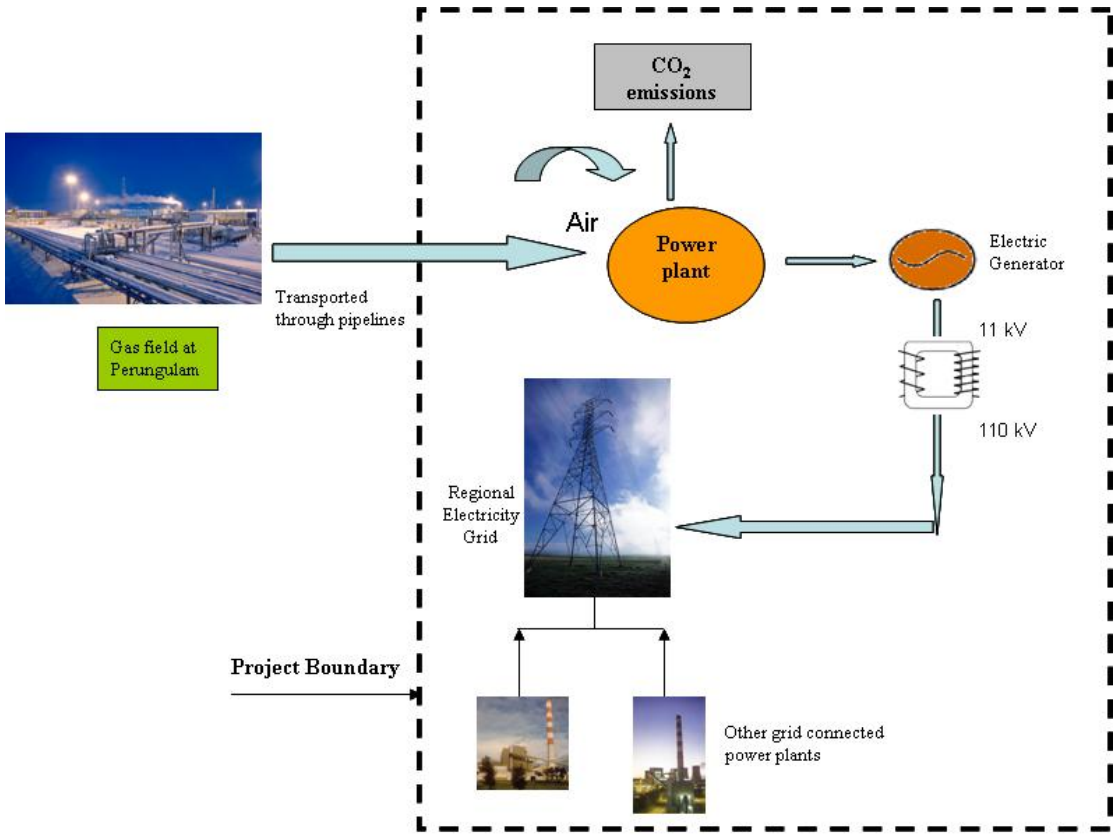
Table 1: Overview of emissions sources included in or excluded from the project boundary

	Source	Gas	Included?	Project Applicability
Baseline	Power Generation in baseline	CO2	Yes	Main emission source
		CH4	No	Excluded for simplification. This is conservative.
		N2O	No	Excluded for simplification. This is conservative.
Project Activity	On-site fuel combustion due to the project activity	CO2	Yes	Main emission source
		CH4	No	Excluded for simplification.
		N2O	No	Excluded for simplification.

The project boundary can be depicted as below.

[5] http://petroleum.nic.in/ng.htm
[6] million standard cubic meters per day

[7] Source: ONGC Press release dated 12.02.2006
http://www.blonnet.com/2006/02/13/stories/2006021303350500.htm



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

The project activity is electrical energy generation using natural gas which is supplied to the grid and wheeled to the consumption points. The baseline scenario, which would have existed in the absence of the project activity, is determined as follows. As per the methodology, the most plausible baseline scenario will be determined based on the following steps;

Step 1: Identify plausible baseline scenarios

All possible alternate scenarios meeting the below requirements shall be identified:

- Realistic and credible
- Provide outputs or services comparable with the proposed emission reduction project activity
- In compliance with all applicable legal and regulatory requirements

The following list of alternatives has been identified for the project activity:

- The project activity not implemented as an emission reduction project activity
- Power generation using natural gas, but technologies other than the project activity
- Power generation technologies using energy sources other than natural gas
- Import of electricity from connected grids, including the possibility of new interconnections

Baseline Scenario 1 - The project activity not implemented as an emission reduction project

This option is a plausible alternative to the project activity, wherein the project activity could have been taken forward without it being an emission reduction project.

Baseline Scenario 2 - Power generation using natural gas, but technologies other than the project activity

This project activity uses the internal combustion reciprocating engine mechanism with capacity of 26.19 MW (Phase I – 17.46 MW, Phase II – 8.73 MW). The other technology that is usually adopted for Natural gas power generation is the Combined cycle gas turbine (CCGT) system (Brayton cycle). This technology will result in an efficiency of 43%[8] and has a lifetime of 15 years[9]. Though the efficiency is slightly higher, it will not be a plausible alternative, since it is not realistic and credible for the promoter. CCGTs involve a high specific investment cost and therefore are economical only for higher capacity gas turbines (above 200MW). "Combined cycle gas turbine has higher efficiency than steam injected gas turbines. However, the combined cycle has a relatively high specific investment cost and therefore requires reasonable or even high grade steam to be generated from the flue gases. Due to this, combined cycles are often built around big gas turbines or medium sized industrial gas turbines, which are optimized for the application with high exhaust temperatures. Large industrial gas turbines with power outputs well in excess of 200 MW are suited, in thermodynamic terms, to the combined cycle concept because their operating conditions-pressure ratio 15:1, turbine inlet

temperature about 1250 deg.C- provides the basis for near optimum overall efficiency.", states a technical paper on Gas Turbines by Indian Institute of Technology.

Baseline Scenario 3 - Power generation technologies using energy sources other than natural gas

There are various other options for power generation that the proponent could have chosen from, apart from using natural gas.

Energy Source 1- Coal

The conventional form of energy generation in India is by using coal. The efficiency of a capacity coal plant is about 34.4%[8] with a lifetime of 25 years[9]. This is a plausible alternative, since it is capable of delivering a similar output as the project activity. Coal based power occupies the major share in prevailing and planned capacity expansions of the region[10]. Further, it is a common practice for cement industries in the region to install coal based power plant. This is a plausible alternative.

Energy Source 2- Lignite

The other source of energy generation is Conventional Lignite based power plant (Rankine cycle). The estimated lifetime is 25 years[9] with an efficiency of 31.2%[8]. It is a plausible alternative, since it is capable of delivering services comparable to the project activity and the technology is prevalent in the country and is proven. The lignite deposits in the southern and western regions have emerged as an important source of fuel supply for states like Tamil Nadu, Rajasthan and Gujarat. Over the years, considerable emphasis has been placed on the development of lignite for power generation[11]. This is a plausible alternative.

Energy Source 3- Diesel

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[8] Based on the Heat rate of NG – 2000 KCal/kWh, Coal - 2500 KCal/kWh, lignite – 2750 KCal/kWh, – CERC Norms 2001

[9] Page 25, Discussion Paper of Depreciation Norms, ICRA April 2000

[10] http://www.agtn.cag.gov.in/AGAudit2/AUDIT%20REPORT/COMMERCIAL/20032004/com_chapter_3.1.pdf

[11] http://www.planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch7_3.pdf

This is not a plausible baseline option. The lifetime of a 25 MW DG set based power generation would be 15 years. In India, it is known that the cost of power generation using diesel based generation sets is highest compared to other fuels. The cost of Diesel at the time of decision making was around Rs.20[12] per litre (Rs.19.73 per kg[13]). The specific fuel consumption for diesel based DG sets is around 160[14] grams/kWh (0.16 kg/kWh).

The fuel cost of generation = 0.16 X 19.73 = Rs.3.158 per kWh. The cost of generation including the fixed cost (interest, depreciation, O&M cost etc) would be even higher. It may be noted that the fuel cost of generation alone is higher than the cost of generation using other fuels worked out elsewhere in this section of PD - natural gas Rs.3.60/kWh, coal Rs.2.17/kWh and lignite Rs.2.32/kWh.

It may be noted that the last DG based power plant in the southern regional grid[15] was installed in 2001 when the price of diesel was lower. Further, these plants are operated to serve only the peak load. This is evident from their low load factors, which keep decreasing over the years, inline with the increasing diesel prices. Therefore, as prescribed by AM0029, this alternative need not be considered for further analysis.

Energy Source 4- Nuclear power

To set up a nuclear power plant of a similar capacity of 25 MW, the cost incurred would be very high and hence not a feasible option for the proponent. Moreover, the national policy does not allow private sector[16] power generation in nuclear power.

Energy Source 5- Renewable power

The various forms of renewable energy are wind, hydro, tidal, geothermal etc. Wind and hydro are the most widely used sources. In the case of hydro power[17], though the lifetime is 20-30 years, the seasonal availability of water would

[12] Diesel prices as of March 2003 - http://uk.reuters.com/article/oilRpt/idUKDEL1697420080214

[13] At a density of 0.85 as per Bureau of Energy Efficiency (BEE) data – Refer page 4, Chapter 1, Book 2 of BEE reference material.

[14] Refer page 4, Chapter 9, Book 3 of BEE reference material

[15] Refer CEA CO2 database version 03, worksheet "data", rows "909, 922, 935, 943, 947, 949, 956, 994, 1003 and 1005"

[16] http://www.thehindu.com/2008/02/12/stories/2008021255351000.htm

[17] http://greenbusinesscentre.com/Documents/smallhydro.pdf

affect continued power generation. Similarly, in the case of wind power[18] the initial cost would be much higher. Therefore, these options are not plausible. Biomass based power generation is another form of renewable power. As per the Tamil Nadu Energy Development Agency (TEDA), there was only one biomass based power generation plant of a small capacity in Tamil Nadu during conceptualisation of the project activity[19]. The first commissioned plant was in the year 1997 and then only in the year 2004. This justifies the fact that during the decision making time of the project activity, biomass based projects were not in vogue as there were no recently commissioned plants. Therefore, there was no clear understanding or know-how of this technology. Hence, it is not a plausible baseline option.

Baseline Scenario 4 - Import of electricity from connected grids, including the possibility of new interconnections

Electricity import from connected grids (other regional grids)

Not plausible. The choice of importing electricity from other grids is available only to the government utilities (TNEB in this case). The powers of managing the distribution and transmission of electricity in the state lie only with TNEB and no private players are allowed.[20]

Therefore, this alternative is not available for CECL and need not be considered for further analysis.

Electricity import from third party power plant promoters

Not Plausible. Third party power purchase was not allowed[21] in the state. As per Tamil Nadu government's policy on "Captive Power Generation", purchase of power from third party promoters was not allowed. As prescribed by AM0029, this alternative need not be considered for further analysis.

As per the identification of the plausible scenarios, the following options are plausible:

[18] Directory of Indian Wind Power, 2002

[19] Source: http://www.teda.gov.in/page/biomass.pdf

[20] http://www.tn.gov.in/policynotes/energy.htm#1

[21] TamilNadu government's "Policy on Captive Power Generation"

1. The project activity being taken forward without an emission reduction activity
2. A Coal based power plant of similar capacity
3. A Lignite based power plant of similar capacity

As per the methodology, the most financially attractive options from the above are to be analysed. The levelized cost of electricity generation (Rs/kWh) of the alternatives are calculated and used as a financial indicator for comparison in the investment analysis. The general assumptions for all baselines have been included in Annex 1.

A comparative financial analysis has been carried out between the identified baseline options.

The general assumptions for all the three baseline options are as per the table.

S.No	Parameter	Value	Reference
1	Debt:Equity	70:30	As per actual loan terms. Inline with CERC norms[22]
2	Interest on loan	11.00%	As per actual term loan
3	Moratorium	9 months	As per actual loan
4	Repayment period (incl. moratorium)	7 years	As per actual loan
5	Corporate tax rate	35.88%	Income tax (IT) provisions. Refer "Taxmann's Direct Tax Ready Reckoner, Table D-15"
6	Minimum Alternate Tax	7.875%	As per Income Tax Rules

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

7	Depreciation for IT (Machinery)	25% (WDV)	As per Income Tax Act. Refer "Taxmann's Direct Tax Ready Reckoner, page 54"
8	Depreciation for IT (Buildings)	10% (WDV)	
10	Wheeling charges	15% of energy exported	Power Purchase Agreement with TNEB
11	Energy sale tariff to consumers (Rs/kWh)	3.68	As per TNEB's industrial tariff
12	Annual Escalation	4%	Conservative assumption considering inflation rate
12	Fixed cost escalation	6%	CERC norms[22]**Error! Bookmark not defined.**
13	Cost of Equity	16%	CERC norms[22]**Error! Bookmark not defined.**
14	Electricity duty (Rs/kWh)	0.1	As per Tamil Nadu Sale of Electricity Act, 2003[23]
15	Working Capital	1 month receivables + 1 month fuel cost	
16	Contingencies	5% of capital cost	

Assumptions for Gas based Generation.

S.No	Parameter	Unit	Value – Phase I	Value - Phase II	Reference
1	Rated power capacity	MW	17.46	8.73	Supplier specification
2	Plant load factor	%	87.82	87.82	Supplier specification
3	Auxiliary	MW	0.14	0.07	Supplier specification

[23] http://www.tn.gov.in/acts-rules/energy/electricityact_2003.htm

	consumption				
4	Calorific value	kCal/SCM	8744	8744	Supplier specification
5	Heat rate	kCal/kWh	2038	2038	Supplier specification
6	Specific fuel consumption	SCM/kWh	0.22	0.22	Calculated
7	Annual fuel consumption	Mn SCM	31307	15653	
8	Basic fuel cost	Rs/000'SCM	8480	8883	Average natural gas price prevailing at the time of decision making.
	Sales tax (8%)Total Cost		677	711	
	Total Cost		9137	9594	
	Fuel cost escalation		5	5	Historic escalation trend
	Gas transmission cost		80.09	-	GAIL Fuel Supply Agreement. Rs.6.67 Lakhs per month
9	Project capital cost	Rs. (Lakhs)	4736	2367	Based on purchase orders from suppliers. The per MW cost (271 lacs/MW) is lower than that incurred by TNEB's gas power plant commissioned in 2003 (370 lacs/MW) which is conservative. http://www.tn.gov.in/policynotes/archives/policy2003-04/energy.pdf
10	Book Depreciation (Machinery)	%	6	6	CERC norms[24]
11	Book Depreciation (Buildings)	%	3.6	3.6	CERC norms
13	O&M cost	Rs. (Lakhs)			As per Operation and Maintenance offer till 10th year. Subsequently, 6% escalation as per CERC norms

[24] http://www.cercind.gov.in/131205/appendix_2.pdf

14	Years				
	1		187.1	93.55	
	2		383.82	191.91	
	3		277.19	138.595	
	4		658.59	329.295	
	5		245.22	122.61	
	6		565.23	282.615	
	7		307.15	153.575	
	8		1385.49	692.745	
	9		405.11	202.555	
	10		577.76	288.88	

Assumptions for Coal based Generation.

S.No	Parameter	Unit	Phase I - Value	Phase II – Value	Reference
1	Rated power capacity	MW	19.03	9.51	Capacity to match annual net energy generation equal to the project activity
2	Plant load factor	%	87.82	87.82	Same as project activity**Error! Bookmark not defined.**
3	Auxiliary consumption	%	9%	9%	CERC norms[22]**Error! Bookmark not defined.**
4	Calorific value	kCal/kg	4090	4090	Grade F coal from Mahanadi Coal Fields Limited
5	Heat rate	kCal/kWh	2500	2500	CERC norms
6	Specific fuel consumption	kg/kWh	0.16	0.16	Calculated based on heat rate
7	Annual fuel consumption	Tonnes	89486	44719	
8	Basic fuel cost	Rs/Tonnes	513	513	Cost of Grade F coal from Mahanadi Coal Fields Limited - Refer Page 114-115, Chapter 4, TNERC Tariff order 2003[25]
	Transportation cost		951	951	
	Total fuel cost		1310.68	655.34	
9	Escalation rate	%	4	4	

[25] http://tnerc.nic.in/tarorder/chapter4.pdf

	Transportation cost		3	3	
10	Project capital cost	Rs. (Lakhs)	8447	4257	Based on average capital costs of private sector thermal power plants approved by Central Electricity Authority (Rs.4.47 crores/MW) - around the same time: as indicated in "Questionable Economics of LNG-based Power Generation: Need for Rigorous Analysis (Page 6)"
11	Contingency	%	5	5	
12	Book Depreciation (Machinery)	%	3.6	3.6	CERC norms[26]
13	Book Depreciation (Buildings)	%	3.6	3.6	CERC norms
14	O&M cost	% of Capital cost	2.5	2.5	CERC norms
	Escalation rate	%	6	6	

Assumptions for Lignite Based Generation

S.No	Parameter	Unit	Phase I – Value	Phase II – Value	Reference
1	Rated power capacity	MW	19.03	9.51	Capacity to match annual energy generation equal to the project activity
2	Plant load factor	%	87.82	87.82	Same as project activity**Error! Bookmark not defined.**
3	Auxiliary consumption	%	9%	9%	CERC norms[22]**Error! Bookmark not defined.**
4	Calorific value	kCal/kg	2400	2400	Neyveli Lignite Corporation data - http://www.nlcindia.com/about/about_01bindex.htm

[26] http://www.cercind.gov.in/131205/appendix_2.pdf

5	Heat rate	kCal/kWh	2750	2750	Central Electricity Regulatory Commission Norms. Applying factor of 1.10 for 50% moisture in lignite as per CERC norms
6	Specific fuel consumption	kg/kWh	1.15	1.15	Calculated based on heat rate
7	Annual fuel consumption	Tonnes	167748	83830	
8	Basic fuel cost	Rs/Tonnes	974	974	Cost of Lignite from Neyveli Lignite Corporation (NLC) for year 2003-04 approved by CERC - http://www.cercind.gov.in/03022007/orderin5of2002.pdf
	Transportation cost		149	149	
	Total fuel cost		1883.85	941.92	
9	Escalation rate	%	4	4	
	Transportation cost		3	3	
10	Project capital cost	Rs. (Lakhs)	8431	4235	Based on average capital costs of private sector thermal power plants approved by Central Electricity Authority (Rs.4.47 crores/MW) - around the same time: as indicated in "Questionable Economics of LNG-based Power Generation: Need for Rigorous Analysis (Page 6)"
11	Contingency	%	5	5	
12	Book Depreciation (Machinery)	%	3.6	3.6	CERC norms
13	Book Depreciation (Buildings)	%	3.6	3.6	CERC norms
14	O&M cost	% of Capital cost	2.5	2.5	CERC norms
	Escalation rate	%	6	6	

Levelized cost of Generation

The levelized cost of generation for the three baseline options – gas, coal and lignite based generation have been computed in the table below.

Project Activity	Levelized Cost of Generation (Rs/kWh)
Gas Based	3.60
Coal Based	2.17
Lignite Based	2.32

The gas based option has the least attractive financial indicator (cost of generation) and coal based option has the most attractive indicator among the alternatives. A sensitivity analysis has been performed to confirm the conclusion regarding the financial indicator.

Sensitivity Analysis

The sensitivity analysis of the financial indicators has been performed by subjecting them to reasonable variation in the critical parameters: fuel price and plant load factor (PLF). The financial indicators are calculated for a 10% deviation in the fuel prices and a 10% deviation in the PLF.

Levelised Cost of generation for various scenarios (Rs./kWh)

Sensitivity	**Cost of Generation (Gas)**	**Cost of Generation (Coal)**	**Cost of Generation (lignite)**
10% increase in PLF	3.59	2.17	2.32
10% decrease in PLF	3.60	2.19	2.32
10% increase in fuel cost	3.95	2.22	2.50
10% decrease in fuel cost	3.24	2.13	2.14

As per the sensitivity analysis, the project activity which is - Gas based: "Project activity not implemented as an emission reduction project activity" is least financially attractive among the alternatives. Further, it still remains financially less attractive even when there are changes in the important techno-economic parameters.

The methodology AM0029 states that,

If sensitivity analysis confirms the result, then select the most economically attractive alternative as the most plausible baseline scenario. In case the sensitivity analysis is

not fully conclusive, select the baseline scenario alternative with the lowest emission rate among the alternatives that are the most financially and/or economically attractive.

Therefore, "Coal based power generation" is the economically most attractive baseline scenario

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

According to ISO 14064-2:2006, clause 5.8,(Voluntary Carbon Standard 2007.1 – page 21) the project proponent would like to demonstrate additionality using the following steps:

Test 1 – Project test

Step 1: Regulatory Surplus

There is no legal or regulatory mandate for the implementation of this project. This is completely a voluntary initiative.

Step 2: Implementation Barriers

The proponents had seriously considered GHG emission reductions early as September 2003 and the barriers faced by the promoters in case of this project activity have been described below:

As per AM0029, the additionality is to be demonstrated using the "Benchmark analysis" approach of the latest "Tool for the demonstration and assessment of additionality". The same is described below:

Sub-step 2a. Identify the financial indicator most suitable to the project activity

In India, the financial viability of power projects are normally represented as the Internal Rate of Return (IRR). Therefore, the project IRR is selected as the most suitable financial indicator to the project activity and has been compared against a suitable benchmark to check the financial feasibility of the project activity.

Sub-step 2b. Identification of suitable benchmark

As per the Additionality Tool, version 5.2 and the Guidance on Assessment of Investment Analysis, Version 02 (Annex 45, EB 41), "Local commercial

lending rates or weighted average costs of capital (WACC) are appropriate benchmarks for a project IRR." Therefore, the WACC has been considered as the benchmark to be compared against the project IRR. The WACC is calculated as follows:

Calculation of WACC		
Parameter	Value	Reference
Debt: Equity ratio	70:30	CERC norm for power projects. Also adopted by the project activity
Required return on equity	14.45%	Using the Capital Asset Pricing Model (CAPM) method, (Please refer benchmark working sheet).
Cost of debt	11.0%	Commercial Lending Rate available to the project activity
WACC	12.04%	

Sub-step 2c. Calculation and comparison of financial indicators

According to the detailed IRR computation, the project IRR (without emission reduction benefits included) is 5.4%, which is way below the benchmark of 12.04%.

Sub-step 2d. Sensitivity Analysis

The sensitivity analysis of the IRR has been performed by reasonable variations in the critical parameters: fuel price and plant load factor (PLF). The financial indicators are calculated for a 10% deviation in the fuel prices, PLF and O&M costs.

	Project IRR	Benchmark
Base case	5.39%	12.04%
Project IRR with carbon revenue	26.02%	12.04%
Sensitivity		
10% increase in PLF	10.00%	12.04%
10% decrease in PLF	-0.60%	12.04%
10% increase in fuel cost	0.00%	12.04%
10% increase in O&M	0.00%	12.04%
10% decrease in O&M	9.10%	12.04%

A sensitivity analysis for a 10% decrease in fuel cost has not been considered, since the natural gas prices are projected to be on an upward trend from year 2002 through 2025. The "Early Release of the Annual Energy Outlook 2003" by the US Department of Energy (dated November 2002) states as follows:

"After 2002, natural gas prices are projected to move higher as technology improvements prove inadequate to offset the impacts of resource depletion and increased demand. Natural gas prices are projected to increase in an uneven fashion as[27]….."

Further, report on "Questionable Economics of LNG-based Power Generation: Need for Rigorous Analysis" by Prayas Energy Group, May 2001 states as follows:

"LNG-based generation is economical only in a very unlikely situation when, LNG cost are very low, capital cost of coal-based plants are much higher than the prevailing costs, and coal prices are much higher than the prevailing prices. In all other situations, the LNG is uneconomical for power generation[28]."

It is evident from the above that the natural gas is expected to continue in an increasing price trend. Further, as per the CRISIL report dated July 2006, the actual natural gas prices in the period 2003 to 2006 too show a steep escalation in the gas prices confirming the projections.

The sensitivity analysis confirms that the Project IRR of the project activity is still lower than the benchmark, and it remains below the benchmark in circumstances subjected to reasonable variations in the critical techno-economic parameters. Therefore, it may be concluded that the project activity is not economically viable in the business as usual scenario.

[27] http://www.bo.cnr.it/www-sciresp/OLD/GdL/Energia-Crisi_Globali/Materiali/DOE/DOE-Eia/index.html#prices

[28] http://www.prayaspune.org/energy/22_EPW_LNG%20.pdf

Common practice analysis

Analyze other activities similar to the proposed project activity

The other activities similar to the project activity are:

- Private sector grid connected power plants
- Of similar scale
- That take place in a comparable environment with respect to regulatory framework, investment climate, access to technology etc: Within Tamil Nadu (since power tariffs between states are variable)
- Those activities that are implemented previously or currently underway

The prevalence of gas based power plants is analysed from statistics provided in "Natural Gas in India" – A reference book published by GAIL-Infraline (2003). As per the list of existing and proposed gas based power plants in the book, the installed capacity of gas based power plants in Tamil Nadu are as follows:

- State owned: 331 MW
- Private sector: 331 MW
- Total: 662 MW

Discuss any similar options that are occurring

As mentioned above, a 331 MW gas based power plant existed in the region during the conceptualisation of the project activity. As indicated in the reference book, this private sector power plant, PPN Power, comes under the "merit-order" ranking of TNEB. As per TNEB's PPA with this plant, TNEB is liable to pay the fixed charges[29] (allowing for 16% Return on Equity - ROE) irrespective of whether it purchases power from the plant or not. The variable costs are also paid by the TNEB at actual irrespective of fuel prices. This ensures the returns for this plant whereas CECL project activity does not have such provisions. Whereas PPN power can sustain its financial viability irrespective of fuel and other cost factors, CECL cannot do so. It may be stated that PPN power and CECL are differentiated by the policy/regulatory framework and therefore are not similar to each other.

[29] TNERC Tariff order Chapter 4, Page 34 to 37 - http://tnerc.nic.in/tarorder/chapter4.pdf

Since there are no other similar options occurring in the region, the project activity is not a common practice.

The project activity meets all the criteria prescribed in the baseline methodology and demonstrates that it may be considered additional.

3 Monitoring:

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

Title: "AM0029 Methodology for Grid Connected Electricity Generation Plants using Natural Gas", Version 3

Reference:

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html

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

The project activity is the generation of electricity using a less carbon intensive fuel. The differential emissions from carbon based electricity generation will provide the emission reductions for the project activity. The estimated baseline for the project activity is based on the methodology specified in the applicable project category for large-scale emission reduction project activities.

Section 3.4 provides the detailed information on the monitoring frequency, and roles and responsibilities.

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

Describe each data and parameter using this table.

Data / Parameter:	$FC_{NG,y}$
Data unit:	Mn SCM (Standard[30] Cubic Metre)
Description:	Annual quantity of natural gas consumed in project activity
Source of data to be used:	Online Natural gas flow meter readings
Value of data applied for the purpose of calculating expected emission reductions	46.972
Description of measurement methods and procedures to be applied:	The data would be measured continuously in online flow meters of the gas supplier (Gas Authority of India Limited – GAIL)

[30] 1 bar pressure and 273 degree Kelvin

	and recorded electronically on a daily basis. 100% of the data is monitored. Accuracy: +/-0.1%
QA/QC procedures to be applied:	The gas flow meters will be subject to calibration periodically. The consumption will be double checked with the readings from the gas supply company [GAIL] invoices.
Any comment:	

Data / Parameter:	$NCV_{NG,y}$
Data unit:	GJ/m3
Description:	Net calorific value of natural gas
Source of data to be used:	"Customer Fortnight Statement" provided by Fuel supplier (GAIL). The statement contains daily quantity of fuel consumed, NCV and fortnightly weighted average values. Fortnightly weighted average values will be used for calculations. The NCV values will be provided in kCal/M3 which will be converted to GJ/M3.
Value of data applied for the purpose of calculating expected emission reductions	0.0366
Description of measurement methods and procedures to be applied:	The data is measured by GAIL. CECL will record and archive data from GAIL documents on paper. 100% of the data would be recorded.
QA/QC procedures to be applied:	Since supplier-provided data is used, no additional QA/QC procedures need to be applied as per AM0029.
Any comment:	

Data / Parameter:	$OXID_{NG}$

Data unit:	-
Description:	Oxidation factor for natural gas
Source of data to be used:	IPCC current default value
Value of data applied for the purpose of calculating expected emission reductions	1.0 (Default value as per IPCC 2006 guidelines)
Description of measurement methods and procedures to be applied:	100% of the data would be monitored annually
QA/QC procedures to be applied:	Since IPCC default value is used, no additional QA/QC procedures need to be applied as per AM0029.
Any comment:	

Data / Parameter:	$EF_{CO2,NG,y}$
Data unit:	tCO2/GJ
Description:	Emission factor for natural gas
Source of data to be used:	IPCC default value is applied since national data is not available
Value of data applied for the purpose of calculating expected emission reductions	56.1 (IPCC 2006 default value)
Description of measurement methods and procedures to be applied:	Latest IPCC default value would be adopted
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

Data / Parameter:	CO_{EFy}
Data unit:	tCO2/m3
Description:	CO2 emissions coefficient of natural gas
Source of data to be used:	Calculated under project activity
Value of data applied for the purpose of calculating expected emission reductions	0.0020539
Description of measurement methods and procedures to be applied:	The data is calculated as per AM0029 formula and archived electronically. 100%

	of the data is to be monitored annually
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

Data / Parameter:	PE_y
Data unit:	tCO2
Description:	Project emission due to combustion of natural gas
Source of data to be used:	Calculated under project activity
Value of data applied for the purpose of calculating expected emission reductions	96475
Description of measurement methods and procedures to be applied:	The data is calculated as per AM0029. 100% of the data is to be monitored.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	-

Data / Parameter:	$EF_{BL,CO2,y}$
Data unit:	tCO2/MWh
Description:	Baseline emission factor of the Southern Regional Grid of India
Source of data to be used:	CEA (Central Electricity Authority) CO2 Baseline Database for the Indian Power Sector
Value of data applied for the purpose of calculating expected emission reductions	0.71 (BM emission factor for the year 2007-08 as per the latest CEA CO2 Baseline Database, Version 04)
Description of measurement methods and procedures to be applied:	Calculated as the Build Margin (BM) emission factor for the Southern Regional Grid as per the CEA CO2 Baseline Database for the Indian Power Sector. Formula and guidelines provided in the

	methodology ACM0002 has been used. Refer Annex 1 for details. When published data for the ex-post calculation of emission factor is not available for a particular year, the factor calculated for the previous year would be adopted.
QA/QC procedures to be applied:	No additional QA/QC procedures need to be applied as per AM0029.
Any comment:	This will be monitored ex-post as required by the methodology

Data / Parameter:	$EG_{PJ, y}$
Data unit:	MWh
Description:	Net electricity generated in the project activity
Source of data to be used:	Energy meters of CECL
Value of data applied for the purpose of calculating expected emission reductions	199916
Description of measurement methods and procedures to be applied:	Net electricity generation is calculated as follows: Net electricity generation = Gross electricity generation – Auxiliary consumption Accuracy class of energy meters: Class 0.2s or better
QA/QC procedures to be applied:	Since this data is based on monitored Gross generation and auxiliary consumption data, separate QA/QC procedures are not necessary.
Any comment:	

3.4 Description of the monitoring plan

The monitoring plan is formulated to monitor the electricity generated by the project activity. The metered parameters would be used to calculate emission

reductions. The various parameters monitored are Consumption of Natural Gas, Net Calorific Value of Natural Gas, Net Energy Generation, Gross Energy Generation, Auxiliary Consumption using equipments like Gas Flow Meters and Energy Meters.

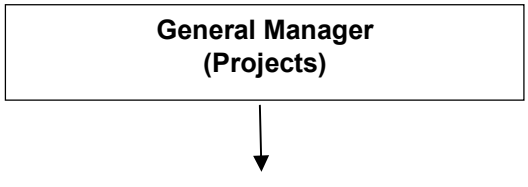
The energy and flow meter readings are noted on a daily basis and recorded in a log book which is further verified by the appointed personnel regularly. A monthly generation report is prepared using flow meter readings and aggregated for the project.

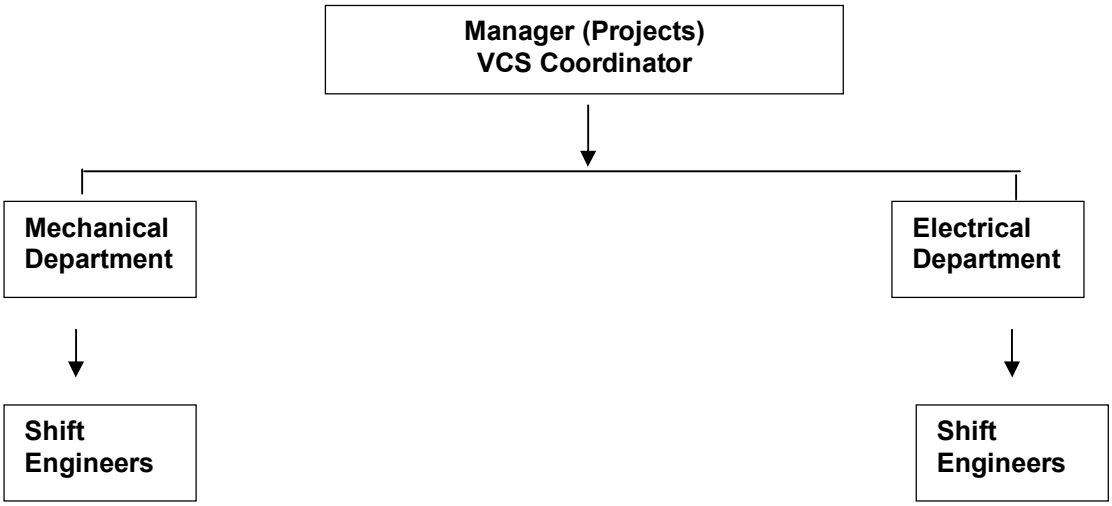
The monitoring plan has been prepared in accordance with AM0029. The project proponent has a well defined project management structure for monitoring the project activity. The monitoring methodology will essentially aim at measuring and recording through devices, which will enable verification of the emission reductions achieved by the project activity that qualifies as Voluntary Carbon Units (VCUs). The monitoring procedure for the project activity is given as follows:

Objective of Monitoring Procedure:

This procedure will set guidelines for the project proponent to monitor the parameters regularly and to ensure quality and accuracy in monitoring. It elaborates on the functions of the Monitoring team and procedures to be followed in monitoring of the emission reduction parameters.

A special team comprising of personnel from the various departments at the plant has been formulated to monitor the plant operations and emission reduction parameters. Operators from the mechanical and electrical divisions in the plant will report to respective (shift engineers) who in turn will report to the Plant Manager. The Plant Manager will provide necessary inputs to the VCS Co-ordinator. The team is headed by GM (Projects). The organization structure of the VCS Team is given below.





Functions of the Team

- Ensure operation of the project activity to comply with the VCS Project Document
- Log periodically the data relevant to project activity
- Ensure accuracy of data by proper maintenance and calibration of monitoring equipment
- Take necessary permission from GM (Projects) before changing any monitoring equipment related to project activity
- Monitor emissions reduction generated by the project activity and maintain records of relevant data for verification of VCUs
- Review performance of the project activity periodically

Data Monitoring:

In order to ensure delivery of VCUs, relevant data was identified which needs to be monitored

Data to be Monitored

1. Consumption of Natural Gas
2. Net Calorific Value of Natural Gas
3. Net Energy Generation
4. Gross Energy Generation

5. Auxiliary Consumption

List of Monitoring Equipments

1. Gas Flow Meters
2. Energy Meters

Frequency of Monitoring and Recording

1. Consumption of Natural Gas: Continuous. Flow meter readings will be recorded by GAIL personnel and inform the plant shift incharge. Daily consumption will be arrived. The daily report will be aggregated to arrive at monthly production and monthly report will be generated
2. Net Calorific Value: Fortnightly. Supplier data will be used. Fortnightly data will be complied as a monthly report.
3. Net Energy Generation: Daily. The daily report will be aggregated to arrive at monthly generation and monthly report will be generated.
4. Gross Energy Generation: Continuous. Energy meter readings will be recorded by shift engineers in the plant. Log books will be maintained. The daily report will be aggregated to arrive at monthly generation and monthly report will be generated
5. Auxiliary Consumption: Continuous. Energy meter readings will be recorded by shift engineers in the plant. Log books will be maintained. The daily report will be aggregated to arrive at monthly generation and monthly report will be generated

$FC_{NG, y}$ – Annual quantity of natural gas consumed in the project activity (Standard M3)	
Monitoring methods and procedures	This data will be measured continuously by online flow meters of the gas supplier (Gas Authority of India Limited-GAIL) and recorded electronically on a daily basis. 100 % of data is monitored.
QA/QC procedures	The gas flow meters will be subject to calibration once in three months. The consumption will be double checked with

	the readings from the gas supply company invoices.
Reporting	The Shift Engineer will review the gas consumption monitored on a daily basis and record the data in computer in the form of Daily Report. The daily report would be reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations).
Data archiving	The GM (Operations) would verify the daily and monthly natural gas consumption report and archive it.
Data uncertainties and adjustments	For this parameter, data uncertainties are likely during the following scenarios: • During error in meter • When meter is dismantled for O&M or calibration • When data is not recorded or records are lost • Delay in calibrating the flow meter – In some years, the period between two calibrations may be more than one year due to unavoidable circumstances. As far as possible, the calibration and maintenance of the meters would be scheduled when the plant is under shutdown to avoid any data uncertainties.
$NCV_{NG,y}$ - Net Calorific value of natural gas (GJ/Standard m3)	
Monitoring methods and procedures	This data is measured by GAIL and provided to CECL on a fortnightly basis. CECL will record and archive data from GAIL documents both on paper and electronically. 100% data would be recorded.
QA/QC procedures	Since supplier-provided data is used, no additional QA/QC procedures need to be applied as per AM0029
Reporting	The Manager will review the fortnightly data and record the data in computer. On a monthly basis, a compilation of the NCV recorded for the month would be prepared by the Manager and submitted

	to the GM (Operations) as monthly report.
Data archiving	The GM (Operations) would verify the daily and monthly energy report and archive it.
Data uncertainties and adjustments	For this parameter, data uncertainties are not likely.

$EG_{PJ,y}$ - Net energy generation (MWh)	
Monitoring methods and procedures	This data will be measured as the difference between gross generation and auxiliary consumption measured in CECL energy meters.
QA/QC procedures	Since this data is based on monitored Gross generation and auxiliary consumption data, separate QA/QC procedures are not necessary.
Reporting	The Shift Engineer will review and approve the log books (recorded by operators) on a daily basis and record the data in computer in the form of Daily Report. The daily report would be reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations).
Data archiving	The GM (Operations) would verify the daily and monthly energy report and archive it.
Data uncertainties and adjustments	Since this data is based on monitored Gross generation and auxiliary consumption data, separate procedures for data adjustments are not necessary.

$EG_{gross, y}$ – Gross energy generation of the project plant (MWh)	
Monitoring methods and procedures	This data will be measured continuously in CECL energy meters. The Operators will record the generation data on a daily basis in log books.
QA/QC procedures	A monthly energy balance will be prepared to cross-check the recorded generation data with other parameters. In case the

	deviation in recorded data is beyond the allowable limits for the energy meter used, the meter will be calibrated/rectified at the earliest. For the period of error, data would be adjusted as described under "Data uncertainties and adjustments". Annual calibration and maintenance of the energy meter will be arranged by the Electrical department.
Reporting	The Shift Engineer (SE) will review and approve the log books on a daily basis and record the data in computer in the form of Daily Report. The daily report would be reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations).
Data archiving	The GM (Operations) would verify the daily and monthly energy report and archive it.
Data uncertainties and adjustments	For this parameter, data uncertainties are likely during the following scenarios: • During error in meter • When meter is dismantled for O&M or calibration • When data is not recorded or records are lost • Delay in calibrating the energy meter – In some years, the period between two calibrations may be more than one year due to unavoidable circumstances. During the above circumstances, the below method would be adopted for emission reduction calculations: • Gross generation = Heat equivalent of gas fired X Historic efficiency of the system calculated with latest reliable data • When the period between two calibrations is more than a year, no adjustments need to be done if the meter error identified during next calibration is within limits. If meter error during calibration is above limits

	by "x%", then "x%" may be deducted from the monitored data for the non-calibrated period for calculating VCUs. As far as possible, the calibration and maintenance of the meters would be scheduled when the plant is under shutdown to avoid any data uncertainties.

$EG_{aux,y}$ - Auxiliary consumption (MWh)	
Monitoring methods and procedures	This data will be measured continuously in CECL energy meters. The operators will record the consumption data on a daily basis in log books.
QA/QC procedures	A monthly energy balance will be prepared to cross-check the recorded consumption data with other parameters. In case the deviation in recorded data is beyond the allowable limits for the energy meter used, the meter will be calibrated/rectified at the earliest. For the period of error, data would be adjusted as described under "Data uncertainties and adjustments". Periodic calibration and maintenance of the energy meter will be arranged by the Electrical department.
Reporting	The Shift Engineer (SE) will review and approve the log books on a daily basis and record the data in computer in the form of Daily Report. The daily report would be reviewed by the Manager and forwarded to the GM (Operations). On a monthly basis, a compilation of all the energy parameters recorded for the month would be prepared by the Manager and submitted to the GM (Operations).
Data archiving	The GM (Operations) would verify the daily and monthly energy report and archive it.
Data uncertainties and adjustments	For this parameter, data uncertainties are likely during the following scenarios: • During error in meter • When meter is dismantled for O&M or calibration

	• When data is not recorded or records are lost • Delay in calibrating the energy meter – In some years, the period between two calibrations may be more than one year due to unavoidable circumstances. During the above circumstances, the below method would be adopted for emission reduction calculations: • Auxiliary consumption = Gross generation X % Auxiliary consumption calculated based on most recent reliable data available • When the period between two calibrations is more than a year, no adjustments need to be done if the meter error during calibration is within limits. If meter error during calibration is above limits by "x%", then "x%" may be deducted from the monitored data for the non-calibrated period for calculating VCUs. As far as possible, the calibration and maintenance of the meters would be scheduled when the plant is under shutdown to avoid any data uncertainties.

The other parameters to be monitored; $OXID_{NG}$ and $EF_{CO2,NG,y}$ are based on latest IPCC default values available and therefore no detailed monitoring plan are necessary. $EF_{BL,co2,y}$ is adopted from the latest available CEA CO2 database and therefore no detailed monitoring plan are necessary.

Data Archiving

Log sheets and the other records archiving will be done for crediting period plus two years

Review Procedures & Frequency

Plant Manager will review the implementation of documented procedures and maintain necessary records. VCS Co-ordinator will review the procedures frequently. GM (Projects) will review once in six months.

Calibration Methods

Calibration procedures are adopted to maintain accuracy of equipments/instruments of the plant. Training is given for personnel on calibration of equipments and Instruments.

Calibration Frequency

Periodic calibration schedule which spreads over the year for all electrical, electronic and field instruments are prepared and maintained. As per the schedule, calibration of instruments and equipments will be carried out annually and recorded in calibration reports.

Quality Assurance:

The gas flow meters will be subject to calibration once in three months. The consumption will be double checked with the readings from the gas supply company invoices. For monitoring Auxiliary Consumption, a monthly energy balance will be prepared to cross-check the recorded generation data with other parameters. In case the deviation in recorded data is beyond the allowable limits for the energy meter used, the meter will be calibrated/rectified at the earliest. For the period of error, data would be adjusted as described under "Data uncertainties and adjustments". Annual calibration and maintenance of the energy meter will be arranged by the Electrical department.

Responsibilities:

- Take necessary steps to smoothly operate & maintain the NG power plant.
- Log continuously the list of parameters mentioned above.
- Compile the daily data of all parameters monitored, on monthly basis and send the report to GM (Projects) and VCS Co-ordinator
- Ensure functioning of the VCS instruments every time and arrange calibration, as per procedures
- Report to GM (Projects) and VCS Co-ordinator in case of any major break-down of the NG based power system.

VCS Committee Review Meeting

The committee meets once in 3 months to review the VCS performance of the plant. The VCUs generated are compared with the expected VCUs and corrective actions are taken.

Training of Personnel

Various member of the VCU team will be trained time to time according to the departmental needs.

4 GHG Emission Reductions:

4.1 Explanation of methodological choice:

The methodology was selected as per the UNFCCC Approved Baseline Methodology AM0029 / Version 03, Sectoral Scope: 01.

The estimated baseline for the project activity is based on the methodology specified in the applicable project category for large-scale CDM project activities. The project activity is the use of a cleaner fuel (natural gas) to produce electrical energy, thereby reducing the amount of GHG emissions. The baseline is the amount of emission reductions which would have occurred in a coal based power generation.

Emission Reductions

The emission reduction is calculated by using the following formula:

$$ER_y = BE_y - PE_y - L_y$$

Where,

ER_y = Total emission reductions due to the project activity during the year y in tons of CO2e

BE_y = baseline emissions during the year y in tons of CO2e

PE_y = project emissions during the year y in tons of CO2e

L_y = emissions due to leakage during the year y in tons of CO2e

Baseline Emissions

Baseline emissions are calculated by multiplying the electricity generated in the project plant ($EG_{PJ,y}$) with a baseline CO2 emission factor (EF_{Bl}, CO_{2y}), as follows:

$$BEy = EG_{PJ,y} . EF_{Bl,CO2,y}$$

Project Emissions

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

$$PE_y = \Sigma FC_{f,y} * CO_{EFf,y}$$

Where:

$FC_{f,y}$: is the total volume of natural gas or other fuel 'f' combusted in the project plant or other

Start up fuel (m3 or similar) in year(s) 'y'

$CO_{EFf,y}$: is the CO2 emission coefficient (tCO2/m3 or similar) in year(s) for each fuel and is obtained as:

$$CO_{EFf,y} = \Sigma NCV_y * EF_{CO2f,f,y} * OXID_f$$

Where:

$NCV_{f,y}$: is the net calorific value (energy content) per volume unit of natural gas in year 'y'

(GJ/m3) as determined from the fuel supplier, wherever possible, otherwise from local or national data;

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

$OXID_f$: is the oxidation factor of natural gas

Baseline Emission Factor ($EF_{BL,CO2,y}$):

AM0029 prescribes that the lowest emission factor among the following three options should be used as the baseline emission factor for the project activity:

Option 1 The build margin, calculated according to ACM0002; and

Option 2 The combined margin, calculated according to ACM0002, using a 50/50 OM/BM weight.

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

Central Electricity Authority (CEA) of India has published a CO2 baseline database for the regional grids of India. The database includes operating margin, build margin and combined margin emission factors for the regional grids calculated in accordance with the formula as prescribed by ACM0002 version 07 (Refer Annex 1 for details). For this project activity, the emission factor values for the southern regional grid have

been adopted from the CEA database. The emission factors as per CEA database is shown below:

$EF_{OM,y}$ = 0.99 tCO2/MWh

$EF_{BM,y}$ = 0.71 tCO2/MWh

$EF_{CM,y}$ = 0.85 tCO2/MWh

Option 1: Build Margin, calculated according to ACM0002

As described above, build margin calculated according to ACM0002 V7 is 0.71 tCO2/MWh.

Option 2: Combined Margin, calculated according to ACM0002

As described above, combined margin calculated according to ACM0002 V7 is 0.85 tCO2/MWh.

Option 3: Emission factor of technology identified as the most likely baseline scenario

In this case, the most likely baseline scenario identified is a coal based power plant, the emission factor of which is calculated using the below formula prescribed by AM0029:

$$EF_{BL,CO2} = \frac{COEF_{BL}}{\eta_{BL}} * 3.6$$

where,

$COEF_{BL}$ = the fuel emission coefficient (tCO2/GJ), based on national average fuel data. In this case, the value is adopted from India's CEA CO2 database as 0.0958[31] tCO2/GJ.

η_{BL} = the energy efficiency of the coal power plant. As per the heat rate (2500 kCal/kWh), it is 34.4%. (Efficiency = output/input = 860[32] / 2500 = 0.344)

Applying values in the above formula;

Emission factor of coal power plant = (0.0958/0.344)*3.6 = 1.00 tCO2/MWh

The build margin emission factor is the lowest of the three options and therefore the same will be adopted as the baseline emission factor.

$EF_{BL,CO2,y}$ = 0.71 tCO2/MWh

[31] Refer "Assumptions" sheet of CEA CO2 database version 04

[32] 1kWh = 860 kCal

As per AM0029, the build margin will be estimated ex post.

Leakage:

The leakage emission sources considered are the fugitive CH4 emissions associated with fuel extraction, Filtering Dust & Liquid collection, transportation, and distribution of natural gas used in the project plant and fossil fuels used in the grid in the absence of the project activity. Since LNG is not used in the project activity, emissions associated with it need not be considered in the leakage calculations.

AM0029 prescribes the following formula:

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

Since LNG component is not applicable[33],

$LE_y = LE_{CH4,y}$

Where,

LE_y Leakage emissions during the year y in tCO2e

LE_{CH4} Leakage emissions due to fugitive upstream CH4 emissions in year y in tCO2e, calculated using the below formula as prescribed by AM0029.

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

Where,

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

NCV_y Average net calorific value of natural gas combusted during year y in GJ/SCM

$EF_{NG,upstream,CH4}$ Emission factor for upstream fugitive methane emissions of natural gas from production, transportation and distribution in t_{CH4}/GJ

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

$EF_{BL,upstream,CH4}$ Emission factor for upstream fugitive methane emissions occurring in the absence of the project activity in t_{CH4}/MWh

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

As per AM0029, the emission factor for upstream fugitive CH4 emissions are calculated consistent with the baseline emission factor (in this case Option 1: Build Margin) used as shown below:

[33] No LNG component is involved.

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

Where,

j	Plants included in the build margin
$FF_{j,k}$	Quantity of fuel type k (coal or oil type) combusted in power plant j included in the build margin
$EF_{k,upstream,CH4}$	Emission factor for upstream fugitive emissions from production of fuel type k in tCH4 per MJ fuel produced
EG_j	Electricity generation in the plants j included in the build margin in MWh per year

For $EF_{NG,upstream,CH4}$, and $EF_{k,upstream,CH4}$, the IPCC default values as provided in Table 2 of AM0029 are used since reliable and accurate data on fugitive methane emissions associated with the production, transportation and distribution of fuels (natural gas, coal or gas) is not available.

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

$EF_{BL,CO2,y}$ = 0.71 tCO2/MWh

The emission reductions are computed as follows -

$$ER_y = BE_y - PE_y - L_y$$

Where,

$BE_y = EG_{PJ,y} . EF_{Bl,CO2\ y}$

$EG_{PJ,y}$ = Net generation – auxiliary consumption

= (26.19*24*365*0.87) – 1616

= 201481 MWh

$EF_{Bl,CO2y}$ = 0.71 tCO2/MWh

Therefore,

BE_y = 142567 tCO2e

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

Where,

FCf,y = 201481 * 0.233 /1000000

= 46.96 Mn SCM

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

Where,

NCV_y = NCV of gas * conversion factor

= (8744*4.187/1000000)

= 0.366 GJ/SCM

Therefore,

$COEF_{f,y}$ = 0.366* 0.0561* 1

= 0.002 tCO2/m3

= 46.96 * 0.002

= 96450 tCO2

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

Since, there is no LNG component $LE_{LNG,CO2,y} = 0$

Therefore,

$LE_y = LE_{CH4,y}$

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

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

= (275.08 – 146.60)*21

LE_{CH4} = 2698 tCO2

ER_y = 142567 – 96451 – 2698

= 43418 tCO2

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

PE_y = 46.97*0.002*1000000

= 96475 tCO2e

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

Year	Estimation of baseline emissions (tonnes of CO2e)	Estimation of project emissions (tonnes of CO2e)	Estimation of leakage (tonnes of CO2e)	Estimation of overall emission reductions (tonnes of CO2e)
2006	142567	96451	2698	43418
2007	142567	96451	2698	43418
2008	142567	96451	2698	43418
2009	142567	96451	2698	43418
2010	142567	96451	2698	43418
2011	142567	96451	2698	43418
2012	142567	96451	2698	43418
2013	142567	96451	2698	43418
2014	142567	96451	2698	43418
2015	142567	96451	2698	43418
Total (tonnes of CO2e)	1425670	964510	26980	434180

5 Environmental Impact:

A comprehensive Environmental Impact Assessment (EIA) was completed for this project activity and the 'Consent to Establish' from the Tamil Nadu Pollution Control Board (TNPCB) has been obtained. A detailed Environment Management Plan (EMP) has been designed for the construction and operational phases. Various environmental parameters such as land and water pollution, air quality, noise and fire hazard and explosion risk have been covered in the EMP.

As per the EMP, necessary mitigating measures for all environmental impacts have been devised. It can be summarized as follows.

Land & water pollution – Sewage and trade effluent treatment, recycling of cooling water, storm water drains, solar evaporation pan are the types of measures undertaken to reduce the impact on the environment.

Air Quality – Only low NOx burners have been deigned and stack emission velocity will be maintained at 25 m/s to ensure minimal air pollution.

Noise – Various acoustic measures have been implemented to control and reduce noise pollution.

Fire Hazard and explosion risk – An onsite energy plan has been devised to ensure risk preparedness.

Apart from the above, CECL has ensured other facilities have been provided for the employees of CECL. Community development activities have also been undertaken for the benefit of the people in the in the vicinity. Tree planting activities, education and health facilities, access to drinking water and conservation of natural resources are among the many initiatives undertaken by CECL. Creating employment opportunities for the local community is another area where CECL is actively involved in.

6 Stakeholders comments:

Stakeholders are an integral part of any development activity. Similarly, they are a vital component in the Clean Development Mechanism process, through its cycle. The project activity will bear either a direct or indirect effect on stakeholders and vice versa.

Local representatives from the various sectors of the community were identified and invited to be part of the stakeholder consultation process. Representatives from the local regulatory body (Panchayat), Tamil Nadu Electricity Board, peer organizations, consultants – CDM and technical, equipment suppliers, local residents, local NGOs were personally invited in advance prior to the consultation process. A notice was sent out in advance informing the stakeholders of the process. On the 15th of October 2004, at the CECL project site, Valantharavai village the stakeholder consultation process was conducted.

The objective was to keep these representatives informed of such a project activity taking place. Also, the outcomes and benefits of the project activity were elaborated to them during the consultation process. The participants elected the gram panchayat president as the chairman for the session. He then chaired the session that followed. CECL briefed the audience on climate change and its effects, CDM and the Kyoto Protocol. Brief understanding of the project, elucidating the likely environmental and social impacts of the project, followed by the salient technical and environmental features of the project and how the proposed project would reduce GHG emissions was also mentioned.

7 Schedule:

Year	Activity
15, October 2003	MoU between ICL and KSK Ventures
29, December 2003	Wheeling Agreement (TNEB)
14, January 2004	Purchase Order of Indigenous Power Plant Equipment – Phase I
3, June 2004	Loan Sanction – Andhra Bank (Phase I)
30, July 2004	GCSI – loan sanction letter for preparation of PDD
10, August 2004	GCSI – Screening methodology
25, August 2004	Contract with CDM consultant
28, September 2004	Request for Validation proposal from TUV – Nord
November 2004	Project Commissioned
18, February 2005	Invitation from MoEF
15 April 2005	Methodology submitted to UNFCCC[34]
2 – 22 March, 2005	Methodology not approved[35]
4, March 2005	Purchase Order – Phase II
23, March 2005	HCA received
2, February 2006	Phase II commissioned
19, May 2006	AM0029 Methodology approved
November 2006 – February 2008	ICL taking over KSK Ventures
11, February 2008	Second CDM consultant appointed

[34] Source : http://cdm.unfccc.int/UserManagement/FileStorage/CDMWF_B72LBX3HK8NJN2O5SIXTM6SU1CX88E

[35] Source : http://cdm.unfccc.int/methodologies/PAmethodologies/publicview.html?OpenRound=9&OpenNM=NM0089&cases=C#NM0089

8 Ownership:

8.1 Proof of Title:

The ownership of the plant, equipment and process generating emissions reductions will rest with project participant.

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

The project activity is currently under the validation phase of the Clean Development Mechanism. The pre-registration credits have been considered under the VCS programme.

Not applicable

Annex 1

The Central Electricity Authority (CEA) has published the baseline emission factors database for the various electricity grids in India. The emission factors have been calculated based on UNFCCC guidelines (based on ACM0002 V7). For further details on the calculation methods and data used, please refer the following web-link:

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

In the CEA database, the simple operating margin, build margin and combined margin emission factors of the regional electricity grids have been provided separately for two cases; Including electricity imports and Excluding electricity imports from other regional grids. Since, emission factors excluding imports are lower, the same has been considered as a conservative approach. The build margin emission factor for the southern regional grid (0.71 tCO2/MWh) has been considered for this project activity.

CENTRAL ELECTRICITY AUTHORITY: CO2 BASELINE DATABASE

VERSION	4.0
DATE	Sep-08
BASELINE METHODOLOGY	ACM0002 / Ver 07 and

"Tool to Calculate the Emission Factor for an Electricity System", Version 1.1

*Using approach (c) on p. 4 of "Tool to Calculate the Emission Factor for an Electricity System", Ver.01

Weighted Average Emission Rate (tCO2/MWh) (excl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	0.84	0.83	0.82
South	0.73	0.72	0.72

India	0.82	0.80	0.80
Simple Operating Margin (tCO2/MWh) (excl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	1.02	1.02	1.01
South	1.01	1.00	0.99
India	1.02	1.01	1.01
Build Margin (tCO2/MWh) (excl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	0.67	0.63	0.60
South	0.71	0.70	0.71
India	0.68	0.65	0.63
Combined Margin (tCO2/MWh) (excl. Imports)			
	2005-06	2006-07	2007-08
NEWNE	0.85	0.82	0.80
South	0.86	0.85	0.85
India	0.85	0.83	0.82