Voluntary Carbon Standard
Project Description Template

**19 November 2007**

***[Date of the VCS PD: Ver.2, 10 Sep 2009]***

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## List of Annexure

# 1 Description of Project:

## 1.1 Project title

4.5 MW Grouped Small Hydropower Projects for Grid system by Bhoruka Power Corporation Limited in Karnataka State, India.

## 1.2 Type/Category of the project

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

As Per Voluntary Carbon Standard (VCS) - 2007.1 the Project falls under Renewable energy [wind, PV, Solar thermal, Biomass, Liquid Bio-fuels, Geo thermal, run-of river hydro]

**Type** **:** Renewable Energy Projects-small hydro.

**Category** **:** Renewable energy technologies that supply electricity to a grid.

The project is a grouped project of two hydro power projects having combined capacity of 4.5 MW as listed below.

1) 1 MW Mini Hydel Power Project of Shahapur-D9 (hereafter referred to as Shahapur-D9 Project).

2) 2×1.75 MW Capacity Mini Hydel Power Project at Mandagere village, K.R Pet Taluk, Mandya Dist(hereafter referred to as Mandagere Project)

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

The total emissions reductions over the crediting period from the grouped project activity are estimated to be 155891 tonnes of $CO_2e$, as shown in the table below:

**Table-1**: Estimated amount of emission reductions over crediting period from the grouped activity.

| **Years** | **Estimation of annual emission reductions in tonnes of $CO_2e$** | | |
|---|---|---|---|
| | Shahpura-D9 Project | Mandagere Project | Total of two plants |
| **Retrospective Emission Reductions** | | | |
| 01.04.2006 to 31.12.2006 | 2225 | 4655 | 6880 |
| 2007 | 3050 | 6809 | 9859 |
| **Prospective Emission Reductions** | | | |
| 2008 | 3640 | 13227 | 16867 |
| 2009 | 3640 | 13227 | 16867 |
| 2010 | 3640 | 13227 | 16867 |
| 2011 | 3640 | 13227 | 16867 |
| 2012 | 3640 | 13227 | 16867 |
| 2013 | 3640 | 13227 | 16867 |

| | | | |
|---|---|---|---|
| 2014 | 3640 | 13227 | 16867 |
| 2015 | 3640 | 13227 | 16867 |
| 2016(till 31.03.2016) | 910 | 3306 | 4216 |
| **Total estimated reductions** ($tCO_2e$) | **35305** | **120586** | **155891** |
| **Total number of crediting years (in 1st crediting period)** | **10** | **10** | **10** |
| **Annual average estimated reductions over the crediting period of** ($tCO_2e$) | **3530** | **12059** | **15589** |

As the annual emission reductions are in the range of 5,000-1,000,000 $tCO_2e$, the activity falls under projects[1] as per VCS 2007.1

## 1.4 A brief description of the project:

This VCS PD presents a group of two small-scale, run-of-river/canal hydro power plants in Karnataka state of India. The purpose of the grouped project activity is optimising the utilization of the water resources to generate clean electrical energy in a sustainable manner and to deliver clean energy to the Southern regional grid, which is already overwhelmed by power production by thermal power plants utilizing fossil fuels.

The plants represent distinct investment projects at different locations and with start dates spanning a year. The rationale for grouping of the projects in one VCS PD is based on the fact that one company has obtained the rights to all emissions reduction credits for the two projects and there is substantial savings in transactions costs in obtaining the approval for the group as opposed to preparing separate project documents for each plant.

The two hydro power plants, with a capacity of 1 MW & 3.5 MW, have a combined capacity of 4.5 MW and the estimated annual energy export to grid is 19740 MWh. The electricity from each of the plants will be sold to the government-owned utility Karnataka Power Transmission Corporation Limited (KPTCL).

**Shahapur-D9 Project**

The Project is canal based Mini Hydel scheme on the distributary-9 of Shahapur Branch canal (SBC). The length of the canal is 36 km. The project site is in the District of Gulbarga near the village Banathal Shahapur –D9 envisages the utilization of seven drops accounting for 11 m head and a chute structure of 10 m, totalling to 21 m gross head and the flow in the distributary's to generate 1 MW with single installed unit of capacity 1000 kW. The Annual generation of electricity by Shahpura-D9 Project is 4310 MWh, out of which it exports 4260 MWh of energy to the KPTCL substation at Gugi which is 8 km far way from the Project site.

**Mandagere Project:**

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

The Project is located at the downstream of Mandagere anicut near Mandagere Village, Mandya district of Karnataka state. The scheme utilizes the flows which are spilling over the anicut from the regulated releases from Gorur dam in Hemavathi river and a gross head of 8 m available in the river due to the presence of Mandagere anicut and rapids on downstream for power generation with two units of each 1750 kW installed capacity totalling to 3.5 MW. The annual generation of energy by the Mandagere Project activity is 15800 MWh and it exports 15480 MWh of energy to the KPTCL substation at Kikkere which is located at a distance of 5 km from the Project site.

Since the grouped Project activity generates electricity through sustainable means to meet the demand for electricity in the state of Karnataka, electricity generated from these small hydro projects, which is a renewable source of energy, supports reduction of green house gases leading to sustainable development.

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

**Table 2:** Geographical & Physical information of the grouped activity

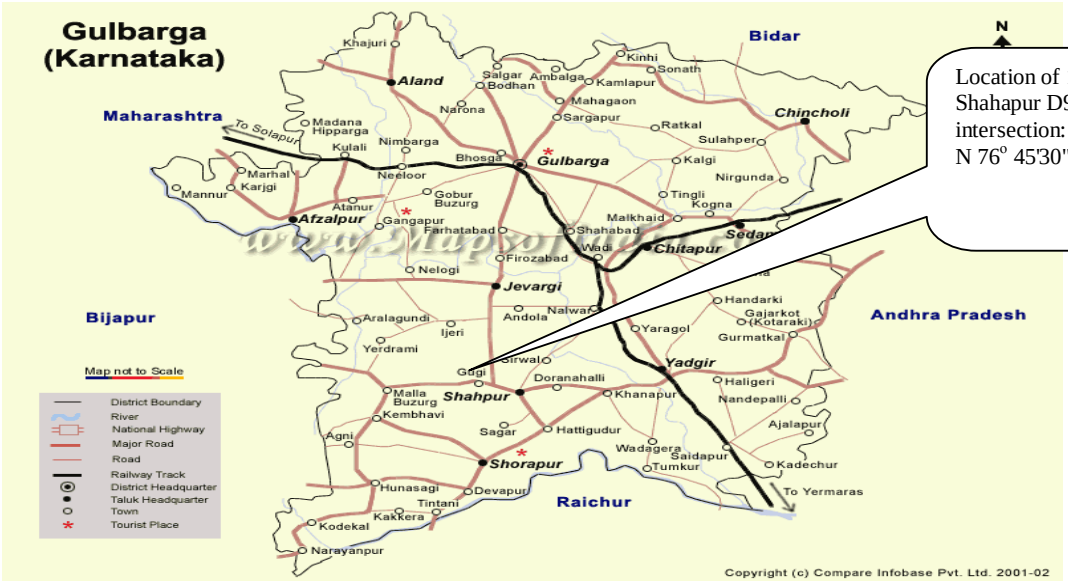
| Details | Shahapur-D9 Project | Mandagere Project |
|---|---|---|
| Village | Banathihal | Mandagere |
| Mandal | Shahpur | Krishnarajpet |
| District | Gulbarga | Mandya |
| State | Karnataka | Karnataka |
| Latitude | 16° 41'30"**N** | 12° 44’0” **N** |
| Longitude | 76°45’30”**E** | 76° 22'30"**E** |
| Land survey No | 22/4,5,6,23,42,44/1,2 3,4,46/1,47 | 93,94,95,96/1,96/2, 96/3,91/1,23,4,92,102 |

Project boundary encompasses the physical, geographical site of the renewable energy generation source. For the Grouped project under consideration, the project boundary considered encompasses the physical location of the power project which includes diversion and intake structure, Power house (consisting of Turbine, generators, switch yard, etc.) and all power plants connected physically to the electricity system grid that the project activity is connected to. The power generated in the project is evacuated into the KPTCL grid, which is a part of Southern regional grid. Power generating units under Southern regional grid of India are also included in the project boundary.

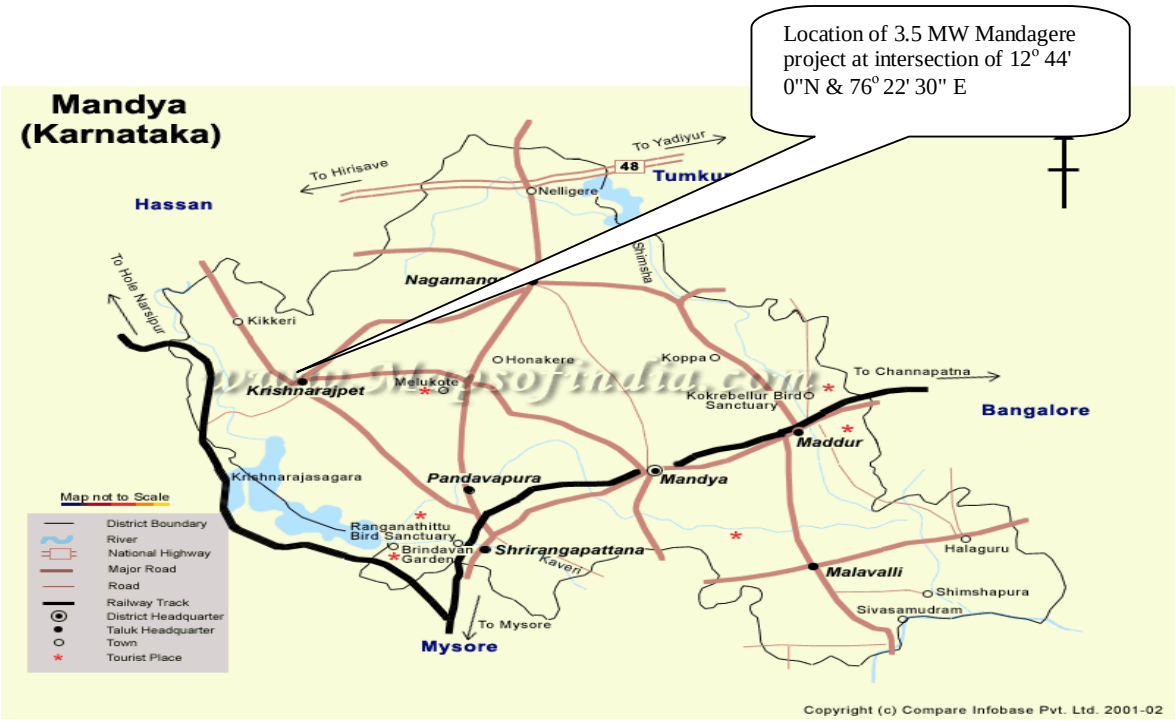


**Map1: Location of Karnataka in India**

**Map2: Location of Gulbarga & Mandya Districts in Karnataka.**




**Map 3: Location of 1 MW Shahapur-D9 Project in Gulbarga District of Karnataka**




**Map 4: Location of 3.5 MW Mandagere Project in Mandya District of Karnataka**

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

*Project Start date:*

- 29 August 2003 for Shahapur-D9 project
- 16 September 2004 for Mandagere project

(Commencement of Commercial operation/Synchronization with state grid i.e. the day project activity began reducing GHG emissions)

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

The credit period start date is considered from 1 April 2006 for each of the grouped project activity. The crediting period chosen is of 10 years (i.e. from 1 Apr 2006 to 31 Mar 2016).

## 1.7 Conditions prior to project initiation:

The project activities were newly implemented and these activities were not constructed to

- increase in the reservoir capacities and the power density of the project activity,
- new reservoir for power generation.
- modify/retrofit of any existing grid-connected renewable power plant/unit,

The conditions prior to initiation of the project are

Electricity has a universal role in the economic development. It has a dual function as a "factor of production" and as a "consumer good" that increases the quality of life. Energy needs of the country are growing in tune with the needs of the liberalised economy. With an installed capacity around 83000 MW, Indian power sector is facing huge demand & supply gap. The current energy and peaking shortages are 8% and 19% respectively.

The forecast for the year 2001-2002 as per 15th electricity power survey by CEA and the Power supply position during 2007-08 are shown below:

| **Description** | **Unit** | **Year 2001-02 At time of implementation** | **Year 2007-08[2] At time of VCS PD submission** |
|---|---|---|---|
| Peak Availability | MW | 3072 | 5567 |
| Peak Demand | MW | 5422 | 6583 |
| Deficit | MW | -2350 | -1016 |
| Energy Availability | GWh | 20178 | 39230 |
| Energy Requirement | GWh | 31208 | 40320 |
| Deficit | GWh | -11030 | -1090 |

In the absence/prior to the project activity, the power would continue to be imported from the grid which has mainly connected by fossil fuels generation in the state of Karnataka. The details are presented below:

[2] CEA Annul Report 2007-08 page no.146

| Description | Unit | Year 2001-02[3] At time of implementation | Year 2007-08[4] At time of VCS PD submission | % of addition |
|---|---|---|---|---|
| Total Installed Capacity | MW | 5487.07 | 8876.92 | |
| Thermal | MW | 2437.12 | 3757.09 | +54.2% |
| Nuclear | MW | 130.0 | 190.90 | |
| Hydro | MW | 2865.55 | 3288.20 | +14.7% |
| RES | MW | 54.40 [x] | 1640.73 [y] | |

[x] *Wind*
[y] *RES includes the Small hydro projects, wind, biomass, biogasifier, wind & solar etc.*

It is evident that the percentage of power generation addition during 2001 to 2008 by fossil fuels (thermal) is 54.2% which reveals that in the absence of project activity the power imports from grid which is mainly dominated by fossil fuel plants.

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

Emission reductions due to the project activity depend on the energy fed to the regional grid and the content of fossil fuel based generation in the grid system. Hence, power fed to the regional grid and the generation mix in the baseline becomes the basis for estimating emissions reductions. The installed capacity of the Grouped Project activity is 4.5 MW, which is expected to export 19740 MWh. Since the commissioning of the Shapura-D9 project in 2003, the actual plant load factor and generation have been substantially lower than the estimated at the time of detailed project report (DPR) stage due to unusually low monsoon rains and the actual energy generation details are furnished below:

Project Activity: **Shahpura-D9**

| | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 |
|---|---|---|---|---|---|---|
| Actual Generation, GWh | 2.86 | 3.74 | 3.51 | 4.11 | 3.14 | 3.08 |
| PLF Achieved,% | 32.6% | 42.7% | 40.1% | 46.9% | 35.8% | 35.2% |
| Estimated at the time of DPR stage | 49.2% Estimated based on the Hydrology study carried out | | | | | |

Project Activity: **Mandegere**

| | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 |
|---|---|---|---|---|---|
| Actual Generation, GWh | 1.72 | 6.13 | 5.72 | 9.14 | 7.15 |
| PLF Achieved,% | 5.61% | 19.99% | 18.66% | 29.81% | 23.32% |

[3] Ministry of power annual report 2001-02 page no:129

[4] CEA Annul Report 2007-08 page no.146

| | |
|---|---|
| Estimated at the time of DPR stage | 51.53%<br>Estimated based on the Hydrology study carried out |

In the absence of the project activity, the power would continue to be imported from the grid already overwhelmed by fossil fuel generation. The emission reductions from the project are projected using the Combined Margin factor for the Southern Regional Grid as 0.8545 $tCO_2$/MWh. The baseline emission factor is considered as fixed ex-ante for the first crediting period.

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

The technology of power generation process using hydro resources is by conversion of the energy available in the water flow into mechanical energy using hydro turbines and then to electrical energy using alternators. The generated power will be transformed to match the voltage of nearest grid sub-station for proper interconnection and smooth evacuation of power.

Each Project activity consists of diversion structure/Over flow weir, fore bay, intake structure, penstock, power house, and tailrace-pond and tailrace canal.

The total capacities of the turbine generators are 4.5 MW, which generates electricity at 3.3 kV level and evacuated at 33 kV for Shahpura-D9 and 66 kV for Mandagere. It is anticipated that the plants can attain Plant Load Factor (PLF) of 51 % on an average. The annual export to the regional grid is 19740MWh from grouped Projects, after accounting for auxiliary consumption of 370 MWh from the gross electricity generation of 20110 MWh.

**Table 3**: Technical & equipment Details of the grouped Project

| **Parameter/ Name of the project** | **Shahapur-D9 Project** | **Mandagere Project** |
|---|---|---|
| **HYDROLOGY** | | |
| *Rated discharge* | 6 | 30.86 |
| *Design Head* | 21 | 6.8 |
| **ENERGY** | | |
| *Gross energy generation (MWh)* | 4310 | 15800 |
| *Auxiliary Consumption, transform & Transmission losses (MWh)* | 50<br>(1.16% on gross generation) | 320<br>(2% on gross generation) |
| *Net electricity generated(MWh)* | 4260 | 15480 |
| *Plant Load Factor (%)* | 49.2 | 51.53 |
| **PLANT EQUIPMENT DETAILS** | | |
| *Type of hydro turbine & make* | Horizontal Francis-Jyoti Ltd | Horizontal Kaplan |
| *Type of generator & make* | Squiralcage induction & Jyoti Ltd. | Synchronous-Crompton & greaves |
| *No. of generating units* | 1 | 2 |

| | | |
|---|---|---|
| *Capacity of each generating unit (kW)* | 1000 | 1750 |
| *Generation voltage(kV)* | 3.3 | 3.3 |
| *Frequency(Hz)* | 50 | 50 |
| **SUB-STATION** | | |
| *KPTCL substation* | Gugi | Kikkeri |
| *Voltage level (kV)* | 33/11 | 66/11 |
| *Distance(in km)* | 8 | 5 |

*In this process there would be no greenhouse gas emissions or burning of any fossil fuels. Thus, electricity would be generated through sustainable means without causing any negative impact on the environment. No technology transfer from any other country is involved in the project.*

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

| Stakeholder Name | Function of Stakeholder | Description of Involvement |
|---|---|---|
| *Karnataka Renewable Energy Development Ltd. (KREDL)* www.kredl.kar.nic.in | Policy implementation body in respect of renewable energy projects in Karnataka. KREDL reviews the project documentation and accords clearance for utilizing renewable energy sources in the state | Issues clearance for setting up the project in Karnataka utilizing hydro potential available at the proposed site. |
| *Karnataka Power Transmission Corporation Limited (KPTCL)* www.kptcl.com | The state owned electricity utility company that manages the electricity transmission and distribution in Karnataka state. Any electricity generation project proposed in Karnataka shall approach KPTCL for power evacuation arrangements. Both KPTCL and the project proponent shall sign a Power Purchase Agreement, before implementing the project. | Purchases power from the project proponent by executing Power Purchase Agreement to determine the tariff and other terms. |
| *Karnataka State Pollution Control Board(KSPCB)* www.kspcb.kar.nic.in | A statutory local body that oversees the pollution control aspects in the state. Any project activity shall obtain clearance from the KSPCB for implementation. | Issues clearance for setting up of the project and for continued operation. |
| *Irrigation Department* | Is part of Government and oversees utilization of water | Accords clearance for utilizing water resources in irrigation canals in Karnataka state. |
| *Local Village Panchayat* | Elected statutory body of the local populace | Accords permission for setting up of the project under the jurisdiction of the village |

The project has sought and obtained all the requisite legal and regulatory clearances for establishment of these project activities.

The list of Compliance has been elaborated in Section 6 below. The copies of consents/approvals are provided to the DOE for validation/Verification.

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

The grouped activity is highly dependent on the level of water discharged in the canal and water available in the river where the project activities are located. The water discharges are regulated by the Government of Karnataka on a year-by-year basis. They are thus beyond the control of the project participants and also very difficult to anticipate. The factors which influence the discharge level include the following:

- Available water resources (rainfall)
- Area under irrigation and crop types

The uncertainty relating to water discharges was in fact one of the key risk factors affecting the project's GHG emission reductions and/or removal enhancements.

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

The main purpose of the project activity is to generate electricity by utilising the irrigation discharges at Shahpura-D9 project and river flows at Mandagere project. As explained in section 1.9 of the VCS PD, the project activity produces clean electric energy by making use of the energy available in the flowing discharge from the Shahpura & Mandagere Projects. There are no GHG emissions in the whole power generation process of the project activity. The project promoters hereby confirm that the project is not implemented to create GHG emissions for the purpose of its subsequent removal or destruction.

**1.13 Demonstration that the project has not created another form of environmental credit (for example renewable energy certificate):**

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

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

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

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

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

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

Project Proponent (PP): **Bhoruka Power Corporation Limited (BPCL)**

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

| | |
|---|---|
| Organization: | **Bhoruka Power Corporation Limited** |
| Street/P.O.Box: | No.48, Lavelle Road, |
| Building: | Hitananda Complex |
| City: | Bangalore- |
| State/Region: | Karnataka |
| Postfix/ZIP: | 560 001 |
| Country: | India |
| Telephone: | +91-80-2227 2271 |
| FAX: | +91-80-2224 5246 |
| E-Mail: | bhoruka@bhorukapower.com |
| URL | www.bhorukapower.com |
| Represented by | |
| Title: | Managing Director |
| Salutation: | Mr |
| Last Name: | S. |
| Middle Name: | -- |
| First Name: | Chandrasekhar |
| Mobile: | -- |
| Direct FAX: | -- |
| Direct tel: | +91-80-2229 1259 |
| E-mail | sekhar@bhorukapower.com |

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

***Legislative***

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

***Technological well-being:***

The project utilizes environmentally safe, reliable, mature and proven technology in small-scale hydro-electric power sector. The project demonstrates harnessing hydro potential from seasonal flow, and encourages setting up such new projects in future. Hence, the project leads to the technological well being.

Some of the socio-economic benefits that are expected due to implementation of the project are

***(a) Improves standard of life***

The project activity will lead to creation of infrastructure in & around the proposed project area, which improves the quality of life of the local communities.

***(b) Employment generation***

The project leads to alleviation of poverty by generating direct and indirect employment during construction as well as operational lifetime of the project to the local population.

***(c) Prevents migration***

Since the project activity generates local employment, it reduces the migration of rural people to urban areas.

***(d) Grid stabilization***

With rising hydropower generation and improving efficiencies in distribution of electricity this project hopes to offer energy at stable prices for other industrial development in the Mandya & Gulbarga Districts of respective project activity. This increases the economic prospects for the population.

The expected environmental impacts of the project are

***(a) Reducing GHG impact***

Since the project activity utilizes discharge available in the Shahpura canal & Mandagere anicut for a power generation and not any other fossil fuels, the project does not lead to any GHG emissions. So, the project doesn't have its influence on the microclimate of the region by non-polluting, entails no wastes or production of toxic gases; environmentally benign and reduce global warming impacts.

***(b) Non-utilization of forest area:***

Since the construction of roads and project components will neither involve felling of trees on a large scale nor lead to deposition of excavated material in the Mandagere River anicut and shahpura canal, there are no adverse environmental impacts.

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

Further the project would demonstrate the feasibility of generation of electricity by harnessing water discharges in the river/canal under medium/low head and encourage setting of similar projects in future, and can play a critical role in improving the overall energy scenario of the country, particularly of the remote and inaccessible areas.

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

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

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

# 2 VCS Methodology:

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

As per Voluntary Carbon Standard-the project activity falls under Renewable energy [wind, PV, solar thermal, biomass, liquid bio fuels, geothermal, run-of river hydro] and the project activity uses the approved AMS I.D - Grid Connected Renewable Electricity Generation, version-13, EB-36 Sectoral scope: 1

For calculation of the combined margin baseline emission factor, the approved consolidated baseline Methodological tool (Version 01.1) **"Tool to calculate the emission factor for an electricity system"**.

Monitoring Methodology – "**Grid Connected Renewable Electricity Generation**" version-13, EB-36. It has been referred from the list of approved methodologies for CDM project activities in the UNFCCC CDM.
http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html).

It is further demonstrated that the Project is additional based on the project, as defined in the VCS 2007.1 in the subsequent sessions.

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

Grouped Project activity is 4.5 MW small hydro power projects established as a canal based project. Grouped Project activity is eligible to use the methodology indicated above, since project activity generates and exports renewable electricity to a grid system, dominated by thermal energy sources. The capacity of the project activity is well below the qualifying limit for project activities under small scale methodology AMS.I.D Ver.13, i.e., 15 MW. Hence, AMS.I.D **"Grid connected renewable electricity generation"** methodology is applied for the project activity.

1. Since, the grouped project activity is a grid connected hydro power project, therefore this methodology is applicable.

2. Project activity proposes to generate 4.5 MW electricity using renewable hydel power which is less than 15 MW. Hence, it is a small scale project activity.

3. Project activity is only for renewable electricity generation and not co-generation type.

4. Project activity is a new unit, green field project activity and the project activity does not seek to retrofit or modify any existing facility.

5. The project activity only has a renewable component of less than 15 MW.

Hence the choice of project category and applicable methodology is correct. Based on the water and power studies carried out for grouped project and by keeping main parameters in view, such as, head and discharge available in the canal, the project participants declare that the project would be within the limits of the small scale project activity throughout the crediting period. In addition, the design parameters of turbine and generator reveal that the project would be within the small scale limit throughout the crediting period.

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

**GHG Sources**

The major anthropogenic (man-made) sources of GHG i.e. $CO_2$ by burning of fossil fuels like coal, petroleum, natural gas for industrial, commercial, transportation, residential and other uses. Small amounts of methane ($CH_4$) are emitted during coal mining and the venting of natural gas.

The production and use of CFCs and other halocarbons during industrial processes also emits GHGs. The Montreal Protocol concerns issues related to these substances.

Changes in land use patterns Deforestation, biomass burning (including fuel wood) and other changes in land-use practice release carbon dioxide, methane and nitrous oxide into the atmosphere.

The grouped activity emissions ($CO_2$ emissions is from the combustion of Diesel) acts as a source of GHG.

The spatial extent of the project boundary includes the project site and all power plants connected physically to the baseline grid. In the calculation of project emissions/removals, only $CO_2$ emissions from fossil fuel combustion at the project plant are considered.

**Sinks of GHGs**

Sinks refer to 'storehouses' of the gases - places where they can be sequestered.

The project activity is generation of electricity by using the harnessable resource (water) and export the same to the grid which is overwhelmed by fossil fuel sources and though the project is not a direct sink but contributes as a sink($CO_2$removals) for GHG.

**Overview of emissions sources included in or excluded from the project boundary**

| | Source | Gas | Included | Justification / Explanation |
|---|---|---|---|---|
| **Baseline** | Power Generation in baseline | **$CO_2$** | Yes | Main Emission Source |
| | | **$CH_4$** | No | Excluded for simplification. This is conservative |
| | | **$NO_2$** | No | Excluded for simplification. This is conservative |
| **Project** | Onsite fuel consumption due to | **$CO_2$** | Yes | Main Emission Source |
| | | **$CH_4$** | No | Excluded for simplification. This is conservative |
| | | **$NO_2$** | No | Excluded for simplification. |

| | | | | |
|---|---|---|---|---|
| | the project activity | | | This is conservative |

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

The baseline scenario of the project is the continued operation of the existing power plants in the grid system and the addition of new generation sources to meet increased electricity demand. The project activity is generation of electricity using renewable energy resources and exporting the same to the grid system, which is also fed by other fuel sources such as fossil and non-fossil types. Emission reductions due to the project activities are the difference between baseline emissions and project emissions and leakage.

In accordance with the small scale methodology AMS-I.D, baseline emissions are equal to power generated by the project activity and delivered to the grid, multiplied by the baseline emission factor. According to the small scale methodology AMS-I.D clause 9, there are two options for baseline emission factor calculation: the baseline emission factor is calculated as either the "average of the approximate operating margin and the build margin" (Option I), or the "weighted average emissions (in tCO2e/MWh of the current generation mix)" (Option II). For the grouped project, Option I was chosen to calculate the baseline emissions factor as shown in section 4.1 of this document.

**Baseline Emissions ($BE_y$):**

The baseline emissions are calculated based on the net energy provided to the grid (in MWh/year), and an emission factor for the displaced grid electricity (in $tCO_2$ /MWh). The baseline scenario is electricity delivered to the grid by the project that would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources.

$$BE_y = EG_y \times EF_y$$

| Key Parameter | Value | Data Source | Website |
|---|---|---|---|
| $EF_y$ | Baseline emission factor for the southern region grid | CEA published baseline emission factor for southern region grid. | www.cea.nic.in |
| $EG_y$ | Net electricity exported to the grid per annum | From Plant and KPTCL Records. Ex post determination. | ` |

The baseline emission factor has been considered from the Central Electricity Authority (CEA) (which is an official source of Ministry of Power, Government of India) have worked out baseline emission factor for various grids in India and made them publicly available i.e. "**$CO_2$ Baseline Database version 3.0 dated 15th December 2007**"
http://www.cea.nic.in/planning/c%20and%20e/Govertment%20of%20India%20website.htm

Actual emission reductions will be calculated based on the actual monitored monthly net electricity export to grid. These are based on the readings recorded in Form B and the same is being duly certified by KPTCL and respective plant personnel.

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

The project activity meets the VCS program approved Methodology as explained in the above sections of the VCS PD.

In addition to demonstrating that the project activity meets the VCS methodology, the project additionality is demonstrated below:

**Test 1- The project test:**

**Step 1: Regulatory Surplus**

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

There is no national legislation that requires the production of power generation through water resources. Additionally, the Government regulation has not imposed any target for small hydel power generation.

The project activities are not a downstream energy efficiency project in a jurisdiction with a mandatory GHG emissions cap.

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

**Step 2: Implementation barriers**

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

In the Indian power sector, the common practice is investing mostly in medium or large scale fossil fuel fired power projects, which is evident from a host of planned projects that comprises mostly large-scale fossil fuel based power generation projects. This is mainly due to the assured return on investment, economies of scale and easy availability of finances.

The project location is underdeveloped, hence basic infrastructures such as roads, communication, transportation and civic amenities etc. are expected to come under the investment of project proponent. Since project site is in remote area it is very difficult to access skilled technical experts and unskilled persons involved in construction and operational phase of the plant. Project participant has to invest on building of residences and providing all basic amenities to workers involved in plant construction.

The project activities are located at distance of 5 to 8 km from sub-stations. This involves construction of long transmission system for which PP had spent considerable huge amount towards construction of Transmission line & Evacuation of power. Further the grid

connectivity voltages are 33 KV and 66 KV, which are very high for the small capacity of the project.

The difficult terrain, working conditions, and poor infrastructure make it extremely difficult to implement these projects at respective places, repair and maintenance net works and this adversely affects reliability and performance of installed services.

***Investment barrier***

The project faces capital or investment return constraints that can be overcome by the additional revenues associated with the generation of VCU.

The project participants have invested around Rs 72.03 millions for Shahpura-D9 Project and for Mandagere Project Rs 199 Millions. The investment cost per MW is high compared to investment in conventional power projects.

**Typical capital costs for Convention Power projects in India**[5]

| Type of Power Project | Capital Cost (Corers /MW) |
|---|---|
| Coal Based | 4.0 |
| Lignite | 4.2 |
| Gas Based | 2.7 |
| Diesel | 2.7 |
| Naphtha | 2.7 |
| LNG | 2.7 |
| Shahapur –D9 | 7.2 |
| Mandagere | 5.6 |

Unlike fossil fuel based plants which have assured source of fuel, small hydel power project faces uncertainties with regard to the availability of water.

**Appropriateness of choosing benchmark:**

In case where a benchmark approach is used the applied benchmark shall be appropriate to the type of IRR calculated. Local commercial lending rates or weighted average cost of capital (WACC) are appropriate benchmarks for a project IRR". Based on this the PP has taken into account the Weighted Average Cost of capital as the Benchmark Return. Project IRR is used to demonstrate the additionally of the project.

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

[5] http://cdm.unfccc.int/UserManagement/FileStorage/ZBEFC58QMKTB9WHAKCPOOQGCZAXZT7 Page no.11

**Calculation of Benchmark WACC:**

The WACC is the weighted average of the cost of equity and cost of debt used for financing. Standard parameters (and not project specific ones) are required to be used for arriving at the benchmark rate. In India, a debt to equity ratio of 70:30 is considered as the norm for financing power sector projects[6]. Accordingly the WACC has been calculated based on a 70:30 debt to equity ratio.

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

WACC = Debt x Cost of Debt + Equity x Return on Equity

Lowest return on equity (conservatively) is considered based on the return (Published data) earned by Central sector undertakings (CSUs) as estimated by CAS (A division of CRISIL) http://cercind.gov.in/rep1304.pdf

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

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

| **Input Parameters** | **Shahapura-D9 Project (1 MW)** | **Mandagere Project (3.5 MW)** |
|---|---|---|
| Installed Capacity ( MW) | 1.00 | 3.50 |
| Expected Generation (Gwh) | 4.31 | 15.80 |
| Plant Load factor | 49.2% | 51.53% |
| Auxiliary consumption, Transform & Transmission losses (KWh) | 50 | 320 |
| Net gen. Available for Sale (GWh) | 4.26 | 15.48 |
| Tariff (Rs/kWh) | 3.39 | 2.90 |
| Simple Escalation on Tariff (Rs/kWh) | 0.066 | 0.058 |
| O &M charges (on Project Cost) | 1.5% | 1.5% |
| Admn. Cost on Project Cost (Rs, millions) | 2.50 | 6.50 |
| Yearly Escalation in O & M | 6% | 6% |

6 http://www.cercind.gov.in

| | | |
|---|---|---|
| Financial Parameters : | | |
| Means of Finance: Equity | 42.93 | 69.00 |
| Rs, millions) Term Loan | 29.10 | 130.00 |
| Interest on Term Loan | 13.5% | 12.25% |
| Loan repayment Period/Years | 7 | 8 |
| Moratorium/ Years | 2 | 1 |
| Income Tax ( MAT) | 7.65%* | 7.88%# |
| Income Tax ( REGULAR) | 36.70* | 36.75%# |
| IRR | 6.36% | 11.62% |

* *Indian I.T Act 2001-02;* # *Indian I.T Act 2002-03*

**Analysis for Shahapur- D9**

The project IRR in baseline scenario is working out to 6.36%. The investment estimated to be incurred on the project activity along with assumptions made for estimation of IRR are furnished as soft copy for validation of the DOE. The IRR is less compared with prevailing bench mark which is considered at 14.56% at the time of investment decision i.e. Feb 2002.

**Analysis for Mandagere**

The project IRR in baseline scenario is working out to 11.62%. The investment estimated to be incurred on the project activity along with assumptions made for estimation of IRR are furnished as soft copy for validation of the DOE. The IRR is less compared with prevailing bench mark which is considered at 14.53% at the time of investment decision i.e. Apr 2003.

***Sensitivity analysis***

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

PP has identified the critical factors are power generation, Tariff, project cost, and O& M expenses. Accordingly, the critical assumptions have been subjected to a +/-10% variation. The outcome of the sensitivity analysis is given below for each project of the grouped activity.

| **Shahapur-D9** | | | |
|---|---|---|---|
| **Factor** | **-10%** | **0%** | **+10%** |
| Generation | - | 6.36% | 10.03% |
| Tariff | 0.28% | 6.36% | 10.11% |
| Project cost | 9.17% | 6.36% | 3.84% |
| O & M Cost | 6.92% | 6.36% | 5.75% |
| Bench Mark | 14.56 | | |

| Mandagere | | | |
|---|---|---|---|
| **Factor** | **-10%** | **0%** | **+10%** |
| Generation | 8.73% | 11.62% | 14.13% |
| Tariff | 8.73% | 11.62% | 14.13% |
| Project cost | 13.75% | 11.62% | 9.77% |
| O & M Cost | 11.86% | 11.62% | 11.37% |
| Bench Mark | 14.53% | | |

As this is a grouped project, the lower of the two benchmarks may be considered as the common benchmark and it is established that the project IRR does not cross the benchmark, even under the best circumstances. The foregoing analysis proves that the project is additional and would continue to remain additional, thus the project justifies the need of VCS benefits for the project activity.

**Step 3: Common Practice**

According to the MNES annual report (2001-02), India has an estimated small hydro potential of about 15,000 MW[7]. The total installed capacity (1423 MW) of small hydro projects is only 9.48% of the total potential, which indicates that there exists some barrier due to which the potential couldn't be fully exploited.

In the State of Karnataka, the small hydro power projects were implemented an aggregate capacity of 89.25 MW before the implementing the project activity and 348.57 MW as on 2007-08. The status of the Commissioned Small Hydro Projects in the Karnataka up to 2007-08 is listed below.

**Table 5: Details of Small Hydro Projects [8]**

| Sl No. | Financial Year | Capacity allotted in MW | No of Companies | Capacity Commissioned in MW | No of companies |
|---|---|---|---|---|---|
| 1 | Up to 96 | 191.750 | 26 | 18.000 | 1 |
| 2 | 96-97 | 85.000 | 10 | 5.200 | 4 |
| 3 | 97-98 | 30.900 | 5 | 22.300 | 3 |
| 4 | 98-99 | 21.300 | 3 | 4.750 | 3 |
| 5 | 99-2000 | 83.600 | 8 | 27.000 | 5 |
| 6 | 2000-01 | 105.000 | 10 | 12.000 | 1 |
| | **Sub-Total up to 2000-01** | **517.550** | **62.000** | **89.250** | **17.000** |
| 7 | 2001-2002 | 92.600 | 22 | 36.500 | 5 |
| 8 | 2002-2003 | 266.800 | 32 | 13.250 | 6 |
| 9 | 2003-2004 | 231.925 | 41 | 34.500 | 4 |
| 10 | 2004-2005 | 142.475 | 48 | 33.150 | 6 |
| 11 | 2005-2006 | 249.700 | 33 | 76.550 | 8 |

[7] http://www.mnes.nic.in/annualreport/2001_2002_English/ch5_pg20.htm

[8] http://kredl.kar.nic.in/Docs/Year%20wise%20details.xls

| | | | | | |
|---|---|---|---|---|---|
| 12 | 2006-2007 | 291.500 | 54 | 12.120 | 2 |
| 13 | 2007-2008 | 74.000 | 5 | 53.250 | 4 |
| | Total up to 2007-08 | **1866.550** | **297.000** | **348.570** | **52** |

However the total installed capacity of power from all sources in the state of Karnataka as on July 2008 is 8876.92 MW[9], which comprises of about 3288.20 MW from Hydro resources incl. small/medium, hydel units. The contribution of small/ medium hydel power generation is about 10.6% on total hydro resources. Further the total capacity of small hydro projects commissioned as on 2007-08 is only 348.57 MW as against the capacity allotted i.e. 1866.55 MW Therefore the project activity is not a common practice in the State of Karnataka.

In regard of the project activity the generation of electricity is dependent upon the availability of water in the river/canal, which is controlled by the Department of Irrigation, Govt. of Karnataka. The project proponent would be dependent upon the irrigation department for the generation of electricity throughout the life of the project. The firm shall make all payments on account of any royalties, taxes, cess, levies etc. imposed by government or consequent statutory authority for utilisation of water for generation of power. But, it cannot be assured that the required quantum of water for power generation would become continuously available, since the river/ canal/ may not receive sufficient flows in times of demand, for water in the ayacut may be less/nil. This indicates that investing in projects of this nature is risky and hence is not a common practice.

Thus at the time of taking investment decision, the project activities were not a common practice and therefore is additional.

The knowledge of carbon credit benefits helped the project promoters to make the decision of setting up this renewable energy project.

In view of the above barriers it can be concluded that the project activity is additional and not the same as the baseline scenario. VCU revenues will help the project proponent to compensate some of the hardships caused by the various barriers indicated above.

[9] CEA Annual Report 2007-08 Page no: 205

# 3 Monitoring:

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

The project is applicable to use the AMS ID methodology:

**Sectoral Scope** **:** I – Renewable Energy Projects
**Project Category** : D – Grid connected renewable electricity generation
**Reference** **: AMS I.D, Version 13, EB 36**

Methodology AMS I.D also refers to:-
***"Tool to calculate the emission factor for an electricity system[10]"*** (Version 01.1)

Reference: Appendix B of the simplified modalities and procedures for small-scale CDM project activities i.e. 'indicative simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories', Version 12.

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

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

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

**Data and Information for reporting.**

- Gross electricity generated (kWh/MWh)by the project activity
- Net quantity of Electricity generated (exported) by the project activity (kWh/MWh)
- Electricity Import from the grid system(kWh/MWh)
- Periodical calibration of monitoring equipments
- Diesel consumption due to usage of DG set for lighting & emergency purpose (Ltrs)

**Monitoring Equipments:**

- External Metering system
  - Main Meter, for metering the exported electricity to the grid & Imported electricity from grid system
  - Check Meter, for metering the exported electricity to the grid & Imported electricity from the grid system
- Internal Metering system
  -Gross electricity Generation meter

[10] http://cdm.unfccc.int/methodologies/Tools/EB35_repan12_Tool_grid_emission.pdf

**Monitoring Roles & Responsibilities**

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

| | | |
|---|---|---|
| 1 | Shift in-charge/ Supervisor | Shift in-charge will monitor the plant parameters including the monitoring parameters as described in the VCS PD. He will collect the data recorded in log sheets and prepare the consolidated report on electricity generation, export to grid, fuel consumption, plant shut down time, etc. for every shift. These reports would be submitted to the Plant Manager for review. |
| 2 | Plant Manager | Review of the monitored parameters for correctness, corrective measures in case of minor errors in the monitored data and preparation of a daily summary on project operation and electricity generation to the General Manager on daily basis. |
| 3 | General Manager | Summarization of data and preparation of report. Report will be sent to Board of Directors.<br>The responsibility of storage and archiving of information in good condition also lies with the General Manager. He would also co-ordinate to obtain audit reports as per the monitoring plan from Internal auditors. |
| 5 | Board of Directors | Review Data report and to take necessary corrective actions. The authority and responsibility for registration, monitoring, measurement, reporting and reviewing of the data rests with the Board of Directors. |
| 4 | KPTCL Personnel | Metering the exported electricity to the grid and import of electricity from Grid. |

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

**Managing Data Quality**

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

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

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

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

independently with reference to the power exported and imported with respect of grid. The reports would be submitted periodically to the designated.

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

Methodology proposed to be adopted for determining base line emission factor is the combined margin in the Southern grid system, which represent the intensity of carbon emissions of the grid system. The baseline emission factor would be adopted from the "$CO_2$ Baseline Database, Ver.03, 15 Dec 2007" published by CEA for the latest available year for the southern grid and the same would be used for the future projection

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

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

| **Data / Parameter:** | $EG_{grossy}$ |
|---|---|
| Data unit: | kWh(or MWh) |
| Description: | Total electricity generated by the project during the year y |
| Source of data to be used: | On-site measurements |
| Value of data applied for the purpose of calculating expected emission reductions | 4310 from Shahpur-D9<br>15800 from Mandagere<br>20110 by the Grouped activity (anticipated) |
| Description of measurement methods and procedures to be applied: | Measured monthly using calibrated meters and aggregated annually. |
| QA/QC procedures to be applied: | Meters will be calibrated as per industry standards. |
| Any comment: | Data archived: Crediting period + two years.<br>Instruments : kWh meter |

| **Data / Parameter:** | **$EG_{export,y}$** |
|---|---|
| Data unit: | kWh(or MWh) |
| Description: | Quantity of Electricity exported to the grid by the grouped project during the year y |
| Source of data to be used: | On-site measurements |
| Value of data applied for the purpose of calculating expected emission reductions | 4260 from Shahpur-D9<br>15480 from Mandagere<br>19740 by the Grouped activity (anticipated) |
| Description of measurement methods and procedures to be applied: | Electric power exported to grid will be measured monthly using calibrated meters by both project proponent and KPTCL as specified in the PPA and records maintained. The PP will consider the export figures from FORM-B for emission reduction estimations |
| QA/QC procedures to be applied: | Meters will be calibrated as per industry standards/PPA. Sales records to the grid and other records are used to ensure consistency. |
| Any comment: | Data archived: Crediting period + two years.<br>Instruments : Trivector energy meter |

| **Data / Parameter:** | $EG_{import,y}$ |
|---|---|
| Data unit: | kWh(or MWh) |

| | |
|---|---|
| Description: | Grid electricity import to the project activity during the year y |
| Source of data to be used: | On-site measurements |
| Value of data applied for the purpose of calculating expected emission reductions | 0 from Shahpur-D9<br>0 from Mandagere<br>0 by the Grouped activity<br>(Projected) |
| Description of measurement methods and procedures to be applied: | Electric power imported from grid will be measured monthly using calibrated meters by both project proponent and KPTCL as specified in the PPA and records maintained. The PP will consider the import figures from FORM-B for emission reduction estimations, |
| QA/QC procedures to be applied: | Meters will be calibrated as per industry standards/PPA. Sales records to the grid and other records are used to ensure consistency. |
| Any comment: | Data archived: Crediting period + two years.<br>Instruments : Trivector energy meter |

| | |
|---|---|
| **Data / Parameter:** | $EG_y$ |
| Data unit: | kWh(or MWh) |
| Description: | Net Electricity export to the grid by the project during the year y |
| Source of data to be used: | From the certified joint meter readings |
| Value of data applied for the purpose of calculating expected emission reductions | 4260 from Shahpur-D9<br>15480 from Mandagere<br>19740 by the Grouped activity<br>(anticipated) |
| Description of measurement methods and procedures to be applied: | Calculated as the difference of the electricity export to grid and electricity import from grid by the project activities |
| QA/QC procedures to be applied: | -- |
| Any comment: | Electricity exported and Imported to the grid will be measured by Main Meter and Check Meter by both project proponent and KPTCL as specified in the PPA and records maintained. To be cross-checked with monthly invoices or receipts of payments.<br>Data archived: Crediting period + two years.<br>Instruments : Trivector energy meter |

| | |
|---|---|
| **Data / Parameter:** | $F_{d,y}$ |
| Data unit: | Liters |
| Description: | Quantity of diesel used in DG set during the year, y |
| Source of data to be used: | On-site measurements/store issues |
| Value of data applied for the purpose of calculating expected emission reductions | 0 from Shahpur-D9<br>0 from Mandagere<br>0 by the Grouped activity<br>(Projected) |
| Description of measurement methods and procedures to be applied: | The total quantity of HSD consumed will be measured on regular basis using dip stick/ level gauge or store issues. Hence, the total quantity of HSD procured and quantity of HSD consumed is considered for estimation of project emissions. |
| QA/QC procedures to be applied: | The data recorded can be cross checked against the fuel purchase receipts. |
| Any comment: | The data on quantity of HSD procured would be collected separately.<br>Instruments : Level gauge |

| | |
|---|---|
| **Data / Parameter:** | $NCV_{Diesel}$ |

| | |
|---|---|
| Data unit: | TJ/Gg |
| Description: | Net calorific value of diesel |
| Source of data to be used: | IPCC default value |
| Value of data applied for the purpose of calculating expected emission reductions | 43 (Source IPCC 2006) |
| Description of measurement methods and procedures to be applied: | IPCC values have been used for diesel since no country specific data is available. |
| QA/QC procedures to be applied: | Project participants have no control on the parameter. Hence, No QA/QC procedures are applicable |
| Any comment: | -- |

| **Data / Parameter:** | $EF_{CO2}$ |
|---|---|
| Data unit: | $tCO_2/TJ$ |
| Description: | $CO_2$ emission factor of diesel |
| Source of data to be used: | IPCC default values |
| Value of data applied for the purpose of calculating expected emission reductions | 74.1 |
| Description of measurement methods and procedures to be applied: | The Indian specific emission factor value is used for data parameter. The emission factor is conservative since it specific to the country and the applied value is high from IPCC emission factor. |
| QA/QC procedures to be applied: | -- |
| Any comment: | -- |

| **Data / Parameter:** | OXID |
|---|---|
| Data unit: | Not applicable (constant) |
| Description: | Oxidation Factor of Diesel |
| Source of data to be used: | IPCC 2006 default values |
| Value of data applied for the purpose of calculating expected emission reductions | 1 |
| Description of measurement methods and procedures to be applied: | IPCC value have been used for the fuel type since no country specific oxidation factor is available |
| QA/QC procedures to be applied: | -- |
| Any comment: | -- |

| **Data / Parameter:** | Density |
|---|---|
| Data unit: | Kg/lit |
| Description: | Density of diesel |
| Source of data to be used: | Society of Indian Automobile Manufacturers(SIAM) |
| Value of data applied for the purpose of calculating expected emission reductions | 0.82 |
| Description of measurement methods and procedures to be applied: | SIAM data has been used for estimations http://www.siamindia.com/scripts/Diesel.aspx |
| QA/QC procedures to be applied: | -- |
| Any comment: | -- |

## 3.4 Description of the monitoring plan

### Data and Information for reporting.

The project would maintain standard log sheets and formats to record the monitoring parameters. The persons would be given proper training to maintain the plant records. The Plant Manager would be the designated person to verify, compile and archive all the monitored data. The parameters to be monitored during the crediting period would be provided in a tabular format to the designated person. The person would be provided necessary training with respect to maintenance of the relevant monitoring records to enable him/her to deal the monitoring independently. The training would be provided to the monitoring personnel for monitoring of the following parameters:

- Gross electricity generation by the project (kWh or MWh)
- Net Electricity supplied (export) to the grid by the project (kWh or MWh)
- Electricity Import from grid system kWh or MWh)
- Periodical calibration of monitoring equipments
- Diesel consumption due to usage of DG set for lighting & emergency purpose (Ltrs)

Both Main meter and Check meter shall be identical in make, technical standards of 0.2% accuracy class and the permissible limit of error i.e. 0.5%. These energy meters will be calibrated once in a year, so that the accuracy of measurement is ensured all the time. Both Main meter and Check meter will be calibrated by KPTCL according to the standard procedures. Calibration of meter will be done whenever any fault occurs to the metering systems.

Meter details:

1. **Mandagere project**:

Both meters are of L&T make, 3 Ph-4w, 11 kv/110 V, 300/1a, Cl 0.2 s, MF=1, LINE 1 Main meter number 03157703; Check meter number: 03157704; LINE 2 Main meter number 03157705; Check meter number: 03157706

2. **Shahpur Project**:

Both meters are of SECURE make, 0.2 Accuracy class, Main meter number KAB 01428 and Check meter number KAB 01429.

The in house metering system will be calibrated by reputed third party agency according to the standard procedures for calibration and supplier's schedule

***Uncertainties****:*

Any uncertainty like inconsistency/discrepancy of data parameters will be dealt with various corrective actions. These will be reported along with its time of occurrence, possible reasons and duration.

Uncertainty with metering (if any difference between recording of main meter and check meter) will be dealt jointly both by Bhoruka Power Corporation Limited (BPCL) & KPTCL representatives. Corrective actions will be undertaken after identification of reason for such uncertainty.

# 4 GHG Emission Reductions:

## 4.1 Explanation of methodological choice:

The project activity is generation of electricity using hydro potential and exporting the same to the grid system, which is also fed by other fuel sources such as fossil and non-fossil types. Emission reductions due to the project activity are considered to be equivalent to the emissions avoided in the baseline scenario by displacing the grid electricity. Emission reductions are

related to the electricity exported by the project and the actual generation mix in the grid system

**Grid Emission Factor ($EF_Y$)**

As per paragraph 9 of AMS I.D, the combined margin of the regional grid calculated in accordance with the "Tool to calculate emission factor for an electricity system". The combined margin for the Southern Grid are derived from the Central Electricity Authority (CEA) database available at http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm

| Parameter | Unit | Description |
|---|---|---|
| $EF_{grid\ CM,y}$ | $tCO_2/MWh$ | Combined margin $CO_2$ emission factor for grid connected power generation in year *y* |
| $EF_{grid\ BM,y}$ | $tCO_2/MWh$ | Build margin $CO_2$ emission factor for grid connected power generation in year *y* |
| $EF_{grid\ OM,y}$ | $tCO_2/MWh$ | Operating margin CO2 emission factor for grid connected power generation in year y |

**The Simple Operating Margin ($EF_{grid\ OM,y}$) (incl. Imports) for Southern Grid is derived from CEA data as follows:**

| Most recent three years | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|
| Operating Margin* (OM) in t $CO_2$ /MWh | 1.001 | 1.008 | 1.003 |
| Average of 3 years | **1.004 $tCO_2$/MWH** | | |
| * including imports | | | |

**Build Margin ($EF_{grid\ BM,y}$) for Southern Region Grid (FY 2006-07):**

| | | |
|---|---|---|
| Build Margin (BM) for the year 2006-07<br>**(incl. Imports)** | **0.705** | $tCO_2$ / MWh |

***Combined margin ($EF_{grid\ CM,y}$) emission factor.***

The combined margin emissions factor is calculated as follows:

$$EF_{grid,\ CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

Where:

$EF_{grid,BM,y}$ = Build margin $CO_2$ emission factor in year y ($tCO_2/MWh$)

$EF_{grid,OM,y}$ = Operating margin CO2 emission factor in year y ($tCO_2/MWh$)

$w_{OM}$ = Weighting of operating margin emissions factor (%)
$w_{BM}$ = Weighting of build margin emissions factor (%)

The default values used for the project (hydro) activity are

$w_{OM}$ = 0.5; $w_{BM}$ = 0.5;

There by the Baseline Emission factor arrived is of

$$EF_{grid,CM,y} or EF_y = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

$$= 1.004 \times 0.5 + 0.705 \times 0.5$$

$$= 0.8545 \text{ tCO}_2/\text{MWh}$$

The calculated value has been fixed ex-ante for the crediting period.

**Project Emissions ($PE_y$)**

No project emissions are applicable to the small scale hydro electric power projects, since the electricity generation is based on hydro resources, which does not involve combustion or generation of emissions from fossil fuels. However, the project activity installs DG set to meet the emergency requirements of power house etc., emissions out of usage of fossil fuel (Diesel) will be accounted as project emissions based on the following equation as provided in the "Tool to calculate project or leakage $CO_2$ emissions from fossil fuel combustion"

$PE_y = PE_{diesel,y}$

**Project emissions due to the combustion of fossil fuels (DG set):**

$PE_{diesel,y} = F_{d,y} \times Density \times NCV_{Diesel} \times EF_{CO2} \times OXID / 10\text{^}6$

Where

$PE_{diesel,y}$ = Project Emissions due to usage of diesel during thé year y ($tCO_2$)

$F_{d,y}$ = Quantity of diesel used during the year (Ltrs)

Density of diesel 0.82 kg/Ltr. as per Society of Indian Automobile Manufacturers (SIAM)

$NCV_{Diesel}$ = The calorific value of diesel (43 TJ/Gg as per IPCC 2006 default value)

$EF_{CO2}$ = The $CO_2$ emission factor of Diesel (74.1 $tCO_2$/TJ as Per IPCC 2006 default Value)

OXID = The oxidation factor of the Diesel (1 as per IPCC 2006 default value)

**Leakage($L_y$):**

No leakage emissions are considered from the grouped project activity since no energy generating equipment is transferred from another activity and/or the existing equipment is transferred to another activity.

**Emission Reductions:**

Since the leakage is zero, the emission reductions are equal to the baseline emissions minus the project emissions. These are calculated based on the monitored net amount of electricity supplied to the grid, and the baseline emission factor.

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

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

**Baseline emissions**
Baseline emissions calculated as explained in section 4.1 above are summarized as below.

**Emission Reduction calculations for the Year 2006**

| Parameter | Description | Shahpura-D9 Project | Mandagere Project | Total | Unit |
|---|---|---|---|---|---|
| $EG_y$ | Net Electricity Exported to grid | 2606.1 | 5449.8 | 8855.9 | MWh |
| $EF_{grid, CM, y}$ or $EF_y$ | Baseline grid emission factor | 0.8545 | 0.8545 | 0.8545 | $tCO_2$ /MWh |
| $F_{dy}$ | Diesel consumption | 104.5 | 360 | 464.5 | Ltrs. |
| $BE_y$ | Baseline Emissions | 2226 | 4656 | 6882 | $tCO_2e$ |
| $PE_{diesel,y}$(=$PE_y$) | Project emissions due to use of diesel | 1 | 1 | 2 | $tCO_2e$ |
| $L_{,y}$ | Leakage Emissions | 0 | 0 | 0 | $tCO_2e$ |
| $ER_{,y}$ | Emission reductions | 2225 | 4655 | 6880 | $tCO_2e$ |

Net Electricity Exported to grid by the grouped activity

$EG_y$ = 2606.1 + 5449.8 = 8855.9 MWh

$EF_y$ = 0.8545 $tCO_2$/MWh

Base Line emissions $BE_y = EG_y \times EF_y$

= 8855.9 × 0.8545
= 6882 $tCO_2e$

Project emissions ($PE_y$):

The project emissions due to the combustion of diesel are considered as for estimation emission reductions. As DG set is used in case of plant emergency for the lighting purpose.

$PE_{diesel,y}$ = (104.5×0.82×74.1×43×1/10^6)+(360×0.82×74.1×43×1/10^6)
= 0.3 + 0.9
= 1 + 1 = 2 $tCO_2e$

Total Project emissions PEy = 2 $tCO_2e$

**Leakage**

No leakage is applicable as $L_y$ = 0 $tCO_2e$

$ER_y$ = $BE_y$ - $PE_y$ - $L_y$

$ER_y$ = 6882 - 2 - 0

$ER_y$ = 6880 $tCO_2e$

## Emission Reduction calculationsfor the Year 2008 (prospective)

### Baseline Emissions ($BE_y$)

| Description | Shahpura-D9 Project | Mandagere Project | Total | Unit |
|---|---|---|---|---|
| *Plant Capacity* | 1 | 3.5 | 4.5 | MW |
| *Plant load factor* | 49.2 | 51.533 | | % |
| *Annual Gross energy generation (MWh)* ***(A)*** | 4310 (=1*24*365 *49.2%) | 15800 (=1.75*2*24*3 65*51.53%) | 20110 | MWh |
| *Auxiliary Consumption, transform & Transmission losses (MWh)* ***(B)*** | 50 | 320 | 370 | MWh |
| *Net Electricity Exported to grid(C) =(A)-(B)* | 4260 | 15480 | 19740 | MWh |

Net Electricity Exported to grid by the grouped activity

$EG_y$ = 4260 +15480 = 19740 MWh

$EF_y$ = 0.8545 $tCO_2$/MWh

Base Line emissions $BE_y = EG_y \times EF_y$
= 19740 × 0.8545
= 16867 $tCO_2e$

### Project emissions ($PE_y$)

The project emissions due to the combustion of diesel are considered as zero for estimation of *ex-ante* calculations of emission reductions because DG set would be operated emergency situations only. However the quantity of diesel combusted in the project activity will be monitored during each year of crediting period and deducted from baseline emissions as mentioned formula below.

$PE_{diesel,y}$ = (0×0.82×74.1×43×1/10^6) + (0×0.82×74.1×43×1/10^6)

= 0+0 = 0 $tCO_2e$

Total Project emissions PEy = 0 $tCO_2e$

**Leakage**

No leakage is applicable
$L_y$ = 0 $tCO_2e$

$ER_y$ = $BE_y$ - $PE_y$ - $L_y$

$ER_y$ = 16867 - 0 - 0

$ER_y$ = 16867 tCO2e

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

The GHG emissions and/ or removals from the project activity are the project emissions due to combustion of fossil fuel (Diesel) for the DG set which are accounted as shown in the section 4.2 above.

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

Summery of the quantifying GHG emission reductions and removal enhancements for the grouped activity are furnished 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 ($tCO_2e$) |
|---|---|---|---|---|
| **Retrospective Emission Reductions** | | | | |
| Apr 2006 to Dec 2006 | 2 | 6682 | 0 | 6680 |
| 2007 | 3 | 9862 | 0 | 9859 |
| **Prospective Emission Reductions** | | | | |
| 2008 | 0 | 16867 | 0 | 16867 |
| 2009 | 0 | 16867 | 0 | 16867 |
| 2010 | 0 | 16867 | 0 | 16867 |
| 2011 | 0 | 16867 | 0 | 16867 |
| 2012 | 0 | 16867 | 0 | 16867 |
| 2013 | 0 | 16867 | 0 | 16867 |
| 2014 | 0 | 16867 | 0 | 16867 |
| 2015 | 0 | 16867 | 0 | 16867 |
| Till Mar 2016 | 0 | 4216 | 0 | 4216 |
| **Total (tonnes of** | **5** | **155896** | **0** | **155891** |

| | | | | |
|---|---|---|---|---|
| **$CO_2e$)** | | | | |

## 5 Environmental Impact:

For the size of the project activity Environmental Impact Assessment (EIA) studies are not required[11]. However prior to implementation, the project proponent is required to notify to the Karnataka State Pollution Control Board for necessary evaluation and approval. The project Proponent had already received Consent for Establishment and the Consent for Operation from Karnataka State Pollution Control Board for the grouped activity.

No significant environmental impacts are likely to occur due to the implemented Grouped project activity. Hence, no references or procedures are specified here.

## 6 Stakeholders comments:

No specific public consultation / participation requirements are specified in Indian statutes for setting up of small-scale industries.

Before implementing any project, project investors / developers need to identify the stakeholders, prepare necessary documents, approach the identified stakeholders directly and obtain required clearances / approvals. The stakeholders after review of documents and investment profile, will accord approvals / licences or send comments in writing to project investors for further clarifications / corrections. In case they are not satisfied with the project design or they feel that the project impacts any of the local environment / social / economical environments, they will not issue clearances / approvals and stop the implementation of the project.

***Identification of Stakeholders***

| **Name of the Stakeholder** | **Description** | **Responsibility** |
|---|---|---|
| Karnataka Renewable Energy Development Ltd. (KREDL) www.kredl.kar.nic.in | Karnataka Renewable Energy Development Ltd. (KREDL) is an organization devoted entirely to the promotion of non-conventional energy sources in Karnataka. | Issues clearance for setting up the project in the state of Karnataka. |

11 Environment Impact Assessment Notification S.O. 60 (E), dated 27/01/1994
http://envfor.nic.in/legis/eia/so-60(e).pdf

| | | |
|---|---|---|
| Karnataka Power Transmission Corporation Limited (KPTCL) www.kptcl.com | Karnataka Power Transmission Corporation Limited is mainly vested with the function of Transmission and Distribution of Power in the state of Karnataka. Electricity generation project proposed in Karnataka shall approach KPTCL for power evacuation arrangements. Both KPTCL and the Project Proponent have sign a Power Purchase Agreement, Before implementing the Project. | Both KPTCL and the project proponent shall sign a Power Purchase Agreement, before implementing the project Power Purchase Agreement to determine the tariff and other terms. |
| Karnataka State Pollution Control Board(KSPCB) www.kspcb.kar.nic.in | A statutory local body that oversees the pollution control aspects in the state. Any project activity shall obtain clearance from the KSPCB before implementation. | Issues consent for establishment and consent for operation of the project. |
| Local Village Panchayat | Project proponents approach Elected administrative of the village Panchayat where the project is being implemented to obtain clearance. | Accords permission for setting up of the project under the jurisdiction of the village. |
| Chief Inspector of Factories | Is part of Govt. of Karnataka looks after all industrial activities through out the state of Karnataka. | Accords approval for establishing the power plant |

The process of obtaining stakeholder comments is either through public announcements or by directly approaching the stakeholders as required.

The project participants prepared necessary documentation before implementation of the project activity and approached the above stakeholders individually for clearances and approvals. All stakeholders have issued their approvals/consents/licenses for setting up the project and no adverse comments were received on the project.

## 7 Schedule:

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

**Chronology of Events of Shahpura-D9 Project:-**

| | |
|---|---|
| 1 Investment decision | : Feb 2002 |
| 2 Financial Closure (Sanction letter from IREDA) | : Feb 2002 |
| 3 Permission from the Irrigation Authorities | : Feb 2002 |
| 4 Power Purchase Agreement [PPA] with KPTCL | : Apr 2002 |
| 5 Agreement/P.O.s for plant equipment | : May 2002 |
| 6 Plant synchronization | : Aug 2003 |
| 7 Appointment of DOE | : July 2008 |

| | |
|---|---|
| 8. Project period | : 25Years |
| 9. Crediting period | : 10Years |
| 10. Monitoring Frequency (Preferable) | : Annually |

**Chronology of Events of Mandagere Project:-**

| | | |
|---|---|---|
| 1 | Investment decision | : Apr 2003 |
| 2 | Power Purchase Agreement [PPA] with KPTCL | : Jan 2004 |
| 3 | Financial Closure (Sanction letter from SBI) | : May 2004 |
| 4 | Permission from the Irrigation Authorities | : May 2004 |
| 5 | Plant synchronization - Unit-I | : Sep 2004 |
| | Unit-II | : Mar 2005 |
| 6 | Appointment of DOE | : July 2008 |
| 7. | Project period | : 25Years |
| 8. | Crediting period | : 10Years |
| 9. | Monitoring Frequency (Preferable) | : Annually |

# 8 Ownership:

## 8.1 Proof of Title:

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

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

The synchronization certificates are considered as the evidence for the proof of title of the project activities. Copies of synchronization certificates are provided to DOE .

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

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

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

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

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

Not applicable for the activity

## Annex -1

## BASE LINE INFORMATION

From Carbon Dioxide Baseline Data base, Version 03, 15 December 2007 published by Government of India, Ministry of Power Central Electricity Authority, Government of India.

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

## Appendix A Assumptions for $CO_2$ Emission Calculations

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

| | Unit | Coal | Lignite | Gas | Oil | Diesel | Naphta | Corex |
|---|---|---|---|---|---|---|---|---|
| EF based on NCV | gCO2 /MJ | 95.8 | 106.2 | 56.1 | 77.4 | 74.1 | 73.3 | 0.0 |
| Delta GCV NCV | % | 3.6% | 3.6% | 10% | 5% | 5% | 5% | n/a |
| EF based on GCV | gCO2 /MJ | 92.5 | 102.5 | 51.0 | 73.7 | 70.6 | 69.8 | 0.0 |
| Oxidation Factor | - | 0.98 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | n/a |
| Fuel Emission Factor | gCO2 /MJ | 90.6 | 100.5 | 51.0 | 73.7 | 70.6 | 69.8 | 0.0 |

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

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

| | Unit | Coal | Lignite | Gas-CC | Gas-OC | Oil | Diesel-Eng | Diesel-OC | Naphta | Hydro | Nuclear |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Auxiliary Power Consumption | % | 8.0 | 10.0 | 3.0 | 1.0 | 3.5 | 3.5 | 1.0 | 3.5 | 0.5 | 10.5 |
| Gross Heat Rate | kcal /kWh (gross) | 2,500 | 2,713 | 0 | 3150 | 0 | 1,975 | 3,213 | 0 | n/a | n/a |
| Net Heat Rate | kcal /kWh (net) | 2,717 | 3,014 | 0 | 3,182 | 0 | 2,047 | 3,330 | 0 | n/a | n/a |
| Specific Oil Consumption | ml /kWh (gross) | 2.0 | 3.0 | n/a | n/a | n/a | n/a | n/a | n/a | n/a | n/a |
| GCV | kcal /kg (or m3) | 3,755 | n/a | 8,800 | n/a | 10,100 | 10,500 | 10,500 | 11,300 | n/a | n/a |
| Density | t /1,000 lt | n/a | n/a | n/a | n/a | 0.95 | 0.83 | 0.83 | 0.70 | n/a | n/a |
| Specific CO2 emissions | tCO2 /MWh | 1.04 | 1.28 | 0.00 | 0.68 | 0.00 | 0.60 | 0.98 | 0.64 | n/a | n/a |

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

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

| **Coal** | Unit | 67.5 MW | 120 MW | 0-250 MW | 500 MW |
|---|---|---|---|---|---|
| Gross Heat Rate | kcal /kWh | 2,750 | 2,500 | 2,500 | 2,425 |
| Auxiliary Power Consumption | % | 12.0 | 9.0 | 9.0 | 7.5 |
| Net Heat Rate | kcal /kWh | 3,125 | 2,747 | 2,747 | 2,622 |
| Net Efficiency | % | 28% | 31% | 31% | 33% |
| Specific Oil Consumption | ml /kWh | 2.0 | 2.0 | 2.0 | 2.0 |
| Specific CO2 Emissions | tCO2 /MWh | 1.19 | 1.05 | 1.05 | 1.00 |

| **Lignite** | Unit | 75 MW | 125 MW | 0/250 MW |
|---|---|---|---|---|
| Gross Heat Rate | kcal /kWh | 2,750 | 2,560 | 2,713 |
| Auxiliary Power Consumption | % | 12.0 | 12.0 | 10.0 |
| Net Heat Rate | kcal /kWh | 3,125 | 2,909 | 3,014 |
| Net Efficiency | % | 28% | 30% | 29% |
| Specific Oil Consumption | ml /kWh | 3.0 | 3.0 | 3.0 |
| Specific CO2 Emissions | tCO2 /MWh | 1.32 | 1.23 | 1.28 |

| **Gas** | Unit | 0-49.9 MW | 0-99.9 MW | >100 MW |
|---|---|---|---|---|
| Gross Heat Rate | kcal /kWh | 1,950 | 1,910 | 1,970 |
| Auxiliary Power Consumption | % | 3.0 | 3.0 | 3.0 |
| Net Heat Rate | kcal /kWh | 2,010 | 1,969 | 2,031 |
| Net Efficiency | % | 43% | 44% | 42% |
| Specific CO2 Emissions | tCO2 /MWh | 0.43 | 0.42 | 0.43 |

| **Diesel** | Unit | 0.1-1 MW | 1-3 MW | 3-10 MW | >10 MW |
|---|---|---|---|---|---|
| Gross Heat Rate | kcal /kWh | 2,350 | 2,250 | 2,100 | 1,975 |
| Auxiliary Power Consumption | % | 3.5 | 3.5 | 3.5 | 3.5 |
| Net Heat Rate | kcal /kWh | 2,435 | 2,332 | 2,176 | 2,047 |
| Specific CO2 Emissions | tCO2 /MWh | 0.72 | 0.69 | 0.64 | 0.60 |

| **Naphta** | Unit | All sizes |
|---|---|---|
| Increment to Gas Heat Rate | % | 2% |
| Gross Heat Rate | kcal /kWh | 0 |
| Auxiliary Power Consumption | % | 3.5 |
| Net Heat Rate | kcal /kWh | 0 |
| Specific CO2 Emissions | tCO2 /MWh | 0.00 |

| **Combined Margin** | Unit | |
|---|---|---|
| Weight OM | % | 50% |
| Weight BM | % | 50% |

| **Conversion Factors** | Unit | |
|---|---|---|
| Energy | kJ /kcal | 4.1868 |
| | MJ /kWh | 3.6 |

| **Oil** | | |
|---|---|---|
| Specific Emission | gCO2 /ml | 2.96 |

# Appendix B Grid Emission Factors

***Table A: Values for all regional grids for FY 2000-01 until FY 2006-07, excluding Inter regional and cross-border electricity transfers.***

***Note: Values are rounded off to two decimals See the web link given Above for additional decimal places(Database –Excel worksheet)***

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

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.72 | 0.73 | 0.74 | 0.71 | 0.71 | 0.71 | 0.72 |
| East | 1.09 | 1.06 | 1.11 | 1.10 | 1.08 | 1.08 | 1.03 |
| South | 0.73 | 0.75 | 0.82 | 0.84 | 0.78 | 0.74 | 0.72 |
| West | 0.90 | 0.92 | 0.90 | 0.90 | 0.92 | 0.87 | 0.85 |
| North-East | 0.42 | 0.41 | 0.40 | 0.43 | 0.32 | 0.33 | 0.39 |
| India | 0.82 | 0.83 | 0.85 | 0.85 | 0.84 | 0.82 | 0.80 |

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

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.98 | 0.98 | 1.00 | 0.99 | 0.97 | 0.99 | 0.99 |
| East | 1.22 | 1.22 | 1.20 | 1.23 | 1.20 | 1.16 | 1.13 |
| South | 1.02 | 1.00 | 1.01 | 1.00 | 1.00 | 1.01 | 1.00 |
| West | 0.98 | 1.01 | 0.98 | 0.99 | 1.01 | 0.99 | 0.99 |
| North-East | 0.74 | 0.71 | 0.74 | 0.74 | 0.71 | 0.70 | 0.69 |
| India | 1.02 | 1.02 | 1.02 | 1.03 | 1.03 | 1.02 | 1.01 |

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

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | | | | | 0.53 | 0.60 | 0.63 |
| East | | | | | 0.90 | 0.97 | 0.93 |
| South | | | | | 0.70 | 0.71 | 0.71 |
| West | | | | | 0.77 | 0.63 | 0.59 |
| North-East | | | | | 0.15 | 0.15 | 0.23 |
| India | | | | | 0.69 | 0.68 | 0.68 |

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

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.76 | 0.76 | 0.77 | 0.76 | 0.75 | 0.80 | 0.81 |
| East | 1.06 | 1.06 | 1.05 | 1.07 | 1.05 | 1.06 | 1.03 |
| South | 0.86 | 0.85 | 0.86 | 0.85 | 0.85 | 0.86 | 0.85 |
| West | 0.87 | 0.89 | 0.88 | 0.88 | 0.89 | 0.81 | 0.79 |
| North-East | 0.44 | 0.43 | 0.44 | 0.44 | 0.43 | 0.42 | 0.46 |
| India | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.85 | 0.85 |

***Table B: Values for all regional grids for FY 2000-01 until FY 2006-07, including inter-regional and cross-border electricity transfers.***

**Weighted Average Emission Rate (tCO2/MWh) (incl. Imports)**

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.72 | 0.73 | 0.74 | 0.71 | 0.72 | 0.73 | 0.74 |
| East | 1.06 | 1.03 | 1.09 | 1.08 | 1.05 | 1.05 | 1.00 |
| South | 0.74 | 0.75 | 0.82 | 0.84 | 0.79 | 0.74 | 0.72 |
| West | 0.90 | 0.92 | 0.90 | 0.90 | 0.92 | 0.89 | 0.86 |
| North-East | 0.42 | 0.41 | 0.40 | 0.43 | 0.52 | 0.33 | 0.40 |
| India | 0.82 | 0.83 | 0.85 | 0.85 | 0.84 | 0.81 | 0.80 |

**Simple Operating Margin (tCO2/MWh) (incl. Imports)**

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.98 | 0.98 | 1.00 | 0.99 | 0.98 | 1.00 | 1.00 |
| East | 1.22 | 1.19 | 1.17 | 1.20 | 1.17 | 1.13 | 1.09 |
| South | 1.02 | 1.00 | 1.01 | 1.00 | 1.001 | 1.008 | 1.003 |
| West | 0.98 | 1.01 | 0.99 | 0.99 | 1.01 | 1.00 | 0.99 |
| North-East | 0.74 | 0.71 | 0.74 | 0.74 | 0.90 | 0.70 | 0.70 |
| India | 1.01 | 1.02 | 1.02 | 1.02 | 1.02 | 1.02 | 1.01 |

**Build Margin (tCO2/MWh) (not adjusted for imports)**

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | | | | | 0.53 | 0.60 | 0.63 |
| East | | | | | 0.90 | 0.97 | 0.93 |
| South | | | | | 0.71 | 0.71 | 0.705 |
| West | | | | | 0.77 | 0.63 | 0.59 |
| North-East | | | | | 0.15 | 0.15 | 0.23 |
| India | | | | | 0.69 | 0.68 | 0.68 |

**Combined Margin in tCO2/MWh (incl. Imports)**

| | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 |
|---|---|---|---|---|---|---|---|
| North | 0.76 | 0.76 | 0.77 | 0.76 | 0.76 | 0.80 | 0.81 |
| East | 1.06 | 1.05 | 1.04 | 1.05 | 1.04 | 1.05 | 1.01 |
| South | 0.86 | 0.85 | 0.86 | 0.85 | 0.85 | 0.86 | 0.85 |
| West | 0.87 | 0.89 | 0.88 | 0.88 | 0.89 | 0.82 | 0.79 |
| North-East | 0.44 | 0.43 | 0.44 | 0.44 | 0.52 | 0.42 | 0.46 |
| India | 0.85 | 0.86 | 0.86 | 0.86 | 0.86 | 0.85 | 0.84 |