CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

22.5 MW Bhilangana Hydro Power Project (BHPP)
Version 02
Date: 12th September 2006

A.2. Description of the project activity:

Swasti Power Engineering Limited (SPEL) is developing the 22.5 MW hydro electric power project on the Bhilangana River. The project is a run-of-the river hydroelectric project, which envisages harnessing the perennial waters of Bhilangana River – a major tributary of the River Bhagirathi. The purpose of the project is to generate environmentally clean electricity and contribute towards meeting the acute regional power requirements. Except for some small flourmills which harness the running water to run the mills, the water potential of the river remains un-utilized. The project will supply electricity to Northern grid.

Contribution of the project activity to Sustainable Development

As per Government of India the following indicators for sustainable development have been stipulated in the interim approval guidelines for CDM projects[1]:

- Social well being
- Economic well being
- Environmental well being
- Technological well being

The performance of the Bhilangana hydro power project across the above indicators is as follows:

Social well being:

The project activity would result in the employment of the local people during the construction and operation phases. The project activity being a run-of the river project does not result in any displacement of local people.

The irrigation facilities tend to dry up in the lean discharge months because of the lack of adequate intake diversion structures. Provision of sacrifice discharge to the tune of 0.25 m^3/s has been made in the design of the scheme to guarantee a perennial supply of water needed for the irrigation channel downstream.

Economic well being:

The northern grid is facing shortage of electrical power and thereby stunting the economic growth. The project activity will be a move towards bridging the supply and demand gap. During construction and operation of the project, employment would be generated for the local population.

Environmental well being:

The project will result in generation of clean and green power without any GHG emissions. Also, since it is a run-of-the river project there is no storage and hence no submergence. Though no deforestation is

[1] http://www.envfor.nic.in/cc/cdm/criteria.htm

required in the project activity still budget for afforestation has been provided. Fish ladder has been provided for free movement of fish on either side of the diversion weir.

Technological well being:

Highly efficient turbines and generators are being used in the project and the power transmission will be at high voltage to ensure low losses.

This demonstrates that the project activity contributes positively towards sustainable development.

A.3. Project participants:

Name of Party involved((host) indicates a host Party)	Private and/or public entity(ies) project participants (as applicable)	The Party involved wishes to be considered as project participant (Yes/No)
India (host)	Swasti Power Engineering Limited (SPEL)	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

A.4.1.1. Host Party(ies):

India

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

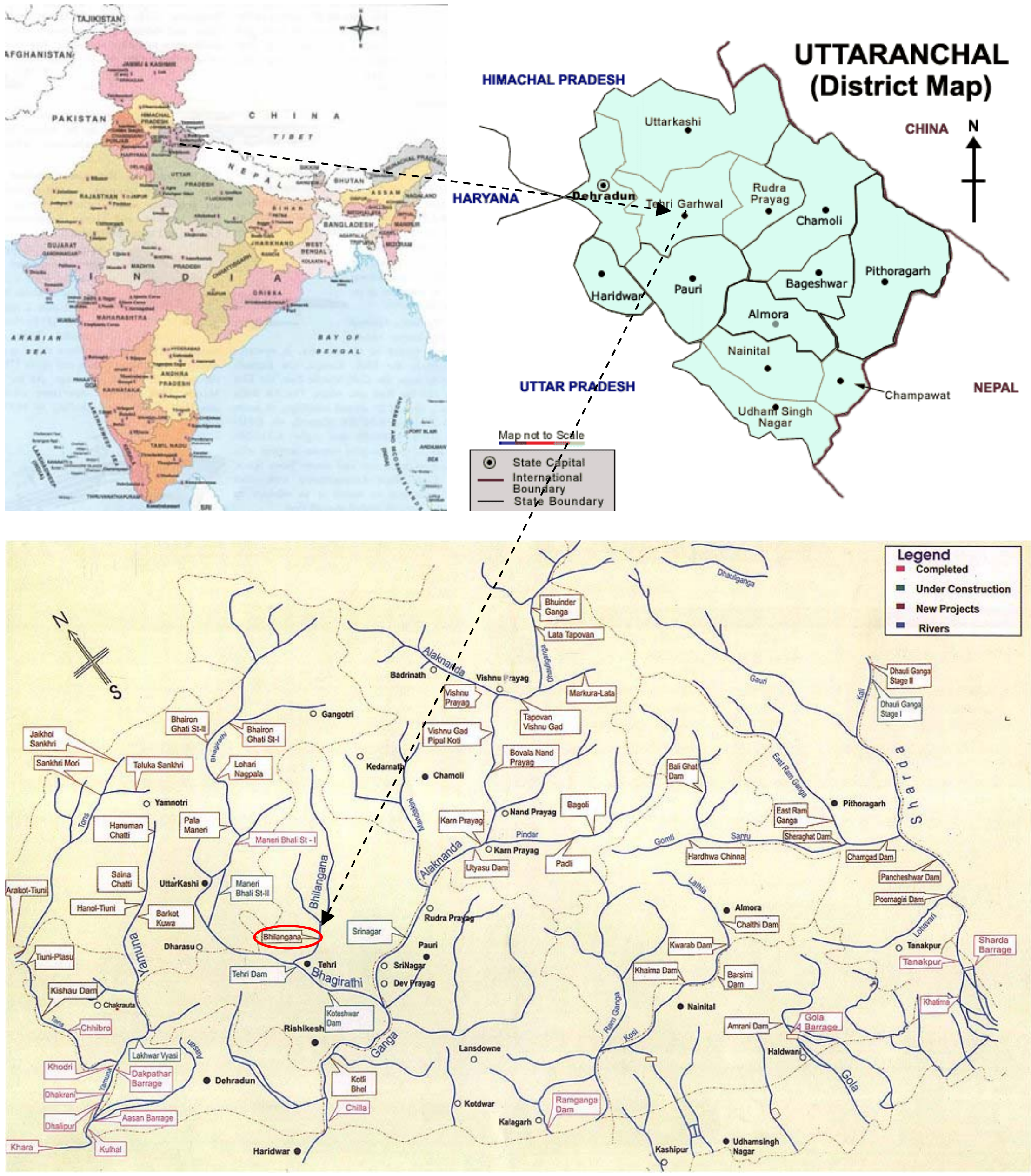
Uttaranchal

A.4.1.3. City/Town/Community etc:

Ghansali Village, Tehri Garhwal District

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

The project activity is located a few kilometres North of Ghansali township (Longitude 78^{o}34’30”, Latitude 30^{o}25’41”). The project site is about 45 kilometers from the origin of River Bhilangana. The topography of the area is rugged. The project area is within the main Himalayan belt, a tectona-litho stratigraphic belt, with the granite-gneiss of the Central Himalayan Crystallines in the northern part, and the quartzites with associated metabasics of the Garhwal group in the southern part.The access road to the project site is the Tehri-Ghansali-Koti Road.



Map of the Location (not to scale)

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

The project activity falls under Scope Number 1: Energy industries (renewable - / non-renewable sources) as per the Sectoral Scopes of the project activities enlisted in the 'List of Sectoral Scopes' (Version 4) for accreditation of operational entities.

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

The scheme comprises of Boulder Weir 44 m long and 5 m high with an intake structure to divert and regulate the waters into the 594.17 m long horse shoe shaped interconnecting tunnel, which leads the water into a 117 m long, 12.6 m wide and 16 m high D-shaped underground desilting tank. The silt free water is led to a surge shaft via a 4.0 m dia horse shoe shaped Head Race Tunnel (HRT), which is in two parts namely HRT-1 and HRT-2 with an aqueduct in between the two tunnels for crossing of the Phelenda Nala. HRT-2 terminates into the circular surge shaft of 12 m dia and 39 m high. Following the surge shaft at the exit portal emerges a single steel penstock of 3.25 m dia and 370 m long, which trifurcates into three branches of 1875 m dia just before entering the powerhouse. The powerhouse is a surface type power house, which houses three Francis type turbo generators – each of 7.5 MW capacity. The tail water emerging out from the three machines is led back to Bhilangana River via a short tailrace channel.

The project activity would be incorporating the latest / state-of-the-art technologies available in the field of hydro electric power generation as given by the Central Electricity Authority of India[2] i.e.,:

- Use of digital turbine governors for speed regulation of hydro turbines
- Computerised Control System for control of generating unit, station & units, auxiliaries, H. V. Switchgear, Intake Gates etc.
- Gas Insulated Switchgear as it involves minimum maintenance and much lesser space to install.

No import of technology is involved in the project activity.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

As the project is a run-of-the river hydro electric project, there are no GHG emissions from the project. The BHPP will be supplying power to the Northern grid which comprises mainly of coal (61.6%) and gas (11.5%) based power plants (please refer Annex 3). It displaces conventional energy equivalent of 1219.56 GWh thereby resulting in total emission reduction of 1,093,040 tons of CO_{2e} over ten years crediting period. No appreciable transmission and distribution losses will occur since the power from the project site will be evacuated at a high voltage of 220 kV for a relatively short distance. In the absence of the project activity, equivalent electrical load would have been taken up by the grid mix, which is mainly dominated by fossil fuel based power plants leading to GHG emissions. Thus the BHPP would help in reducing the anthropogenic GHG emissions as per the combined margin carbon intensity of the Northern Grid.

[2] http://www.cea.nic.in/hydro/Special_reports/best_practises/index.pdf

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

Total estimated emission reductions of **1,093,040** tonnes of CO_2 are expected by the BHPP over the fixed crediting period of ten years.

Years	**Annual estimation of emission reductions in tonnes of CO_2e**
2007 - 08	109,304
2008 – 09	109,304
2009 – 10	109,304
2010 – 11	109,304
2011 – 12	109,304
2012 – 13	109,304
2013 – 14	109,304
2014 – 15	109,304
2015 – 16	109,304
2016 – 17	109,304
Total estimated reductions (tonnes of CO_2e)	**1,093,040**
Total number of crediting years	**10**
Annual average over the crediting period of estimated reductions (tonnes of CO_2e)	**109,304**

A.4.5. Public funding of the project activity:

No public funding from parties included in Annex – I is involved in the project activity.

SECTION B. Application of a baseline methodology

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

Title: "Consolidated baseline methodology for grid-connected electricity generation from renewable sources"
Reference: UNFCCC Approved baseline methodology ACM0002 / Version 06, Sectoral Scope: 1, 19th May 2006.
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B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

The methodology applicable is the approved consolidated baseline methodology ACM0002 because it satisfies the following applicability criteria:

- It is electricity capacity addition to the grid from a *run-of-river* hydro power plant;
- The project activity does not involve switching from fossil fuels to renewable energy at the site of the project activity;
- The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available.

Grid Selection

The electrical transmission system in India is divided into five regions – Northern, Eastern, Western, Southern and North-Eastern regions. Since the project activity is coming is the northern region so Northern regional electricity grid has been taken as the baseline. The Northern Regional Electricity Board comprises of the following states namely Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh and Uttaranchal.

B.2. Description of how the methodology is applied in the context of the project activity:

In the selected approved consolidated methodology ACM0002 - version 06, the following approaches have been suggested for the identification of baseline:

- "Existing actual or historical emissions, as applicable"
  Or
- "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

And also it is suggested that the baseline scenario for project activities that do not modify or retrofit existing electricity generation facility is the electricity delivered to the grid which would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources.

The latter approach has been adopted to identify the baseline. The calculation of baseline emission (BE_y in tCO_2) is done by multiplying the electricity baseline emission factor (EF_y) and the electricity exported to the grid (EG_y). The electricity baseline emission factor (EFy) is estimated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors. The steps involved in the estimation of baseline emission factor are discussed in section D 2.1.4 and the key information and data are given in annexure 3.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

The project activity is additional compared to baseline scenario, which is discussed by using the "Tool for the demonstration and assessment of additionality - version 02 - 28 November 2005" in the following paragraphs:

Step 0. Preliminary screening based on the starting date of the project activity

SPEL wishes to have the crediting period starting after the project gets registered. The expected start of the crediting period is after 31st December 2005, since the project activity would start operating only in the year 2007, so step 0 does not apply to the BHPP activity.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity:

The alternatives available with SPEL which are realistic, credible and provide outputs comparable with the BHPP activity are:

1. The project activity not undertaken as a CDM project;
2. A diesel based power project with equivalent power output;
3. A gas based power project with equivalent power output;
4. A coal based power project with equivalent power output;
5. Continuation of the current situation in the northern grid with no project activity or alternatives undertaken.

Sub-step 1b. Enforcement of applicable laws and regulations:

The alternatives mentioned above are in compliance with the applicable legal and regulatory requirements.

Alternative 1: The project activity not undertaken as a CDM project

As the project faces various barriers discussed in step 3, this alternative cannot be undertaken without CDM consideration.

Alternative 2: A diesel based power project with equivalent power output

In this scenario, the users will draw electricity from Northern region grid with inclusive of equivalent capacity of diesel based power project. This scenario is not economically viable due to high price of diesel. Hence this option is not available with SPEL for consideration.

Alternative 3: A gas based power project with equivalent power output

Since gas availability at the project site is economically not feasible. Hence this option is not available with SPEL for consideration.

Alternative 4: A coal based power project with equivalent power output.

In this scenario, the users will draw electricity from Northern region grid with inclusive of equivalent capacity of Coal based power project. But again the feasibility of this project is questionable as the availability of fuel at viable cost at the project site is difficult. Hence this option also cannot be considered by SPEL.

Alternative 5: Continuation of the current situation in the northern grid with no project activity

In this scenario, the current grid mix will continue without any inclusion. This option is the most likely alternative in the absence of the project activity.

From the above discussions, it is clear that the realistic and credible alternative option to the project activity is:

Alternative 5 – Continuation of the current situation in the northern grid with no project activity

Step 2. Investment analysis

The additionality of the project has been demonstrated by the following step – Barrier analysis.

Step 3. Barrier analysis

For the BHPP, barrier analysis has been undertaken to indicate that the proposed project activity faces barriers that prevent the baseline scenario from occurring and therefore the project activity is additional. In this step it has been shown that the BHPP activity faces barriers that:

a) Prevent the implementation of this type of project; and
b) Do not prevent the implementation of at least one of the alternatives.

Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:

The following barriers have been identified that would prevent the implementation of the BHPP from being carried out if the project activity were not to be registered as a CDM activity:

Investment barriers

SPEL is a family promoted company; the promoters had to liquidate a large portion of their properties and assets to fund the project. The risks that prevent the financial institutions from funding the project are as follows:

(a) Hydrological risks – Bhilangana is a snow-fed as well as rain-fed river and carries discharges all year round but there was absence of long-term hydrological data initially. The BHPP being a run-of-the river project, the generation from the project varies as per the pattern of the river discharges. Therefore, to arrive at the power potential short term discharge data was recorded and long term hydrological database for the Bhilangana basin was extracted from the data of Bhagirathi. Also, the Bhilangana's catchment area is prone to severe storms occasionally resulting into cloudbursts and associated flash floods which could damage the project.

(b) Geological risks – The BHPP lies in the seismic zone IV of the Seismic Zone Map of India. The Phalenda nala lies along a fault line from where the intake tunnel passes. This plane of fault could act as a zone for the release of earth strain. Displacement of rock on either side of the tunnel is possible and this movement could damage the project activity.

(c) Environmental risks - SPEL had the option of taking water to the powerhouse via a channel or a tunnel. Although the option of channel is economically cheaper to implement as compared to that of a tunnel, but it is environmentally more degrading and results in higher emissions during construction. Therefore, SPEL has opted for the tunnel route in spite of the fact that it requires higher investments but is an environmental friendly option.

(d) Implementation risks – The promoter group is not established in hydro power generation. This could lead to time/cost overruns for the project. The BHPP being in a hilly region with the

associated hydrological and geological risks can result in time/cost over-runs due to lack of proper project management practices.

(e) Transmission risks – The evacuation of power from the BHPP to the grid would require construction of a 39 km transmission line. This transmission line has to be laid in the hilly terrain which is a difficult task and involves significant investments.

Barriers due to prevailing practice

The various small hydro power plants (1 to 25 MW) operating in the state of Uttaranchal are as follows[3]:

S.No.	Name of Scheme	Installed Capacity (MW)
1	Pathri	20.40
2	Mohammadpur	9.30
3	Galogi	3.00
4	Urgam	3.00
5	Kanchauti	2.00
6	Chhirkila	1.50
7	Kulagad	1.20
8	Sobla	6.00
9	Durgapur	1.15
	Total	**47.55**

All these plants are operated by the state authority and as per the latest available statistics there is no independent power producer in Uttaranchal. There is no private party producing power in the state of Uttaranchal as per the available statistics on hydro electric plants given by Central Electricity Authority (CEA)[4]. The BHPP activity will be the first of its kind independent power producer (IPP) of its size coming up in the state of Uttaranchal. The BHPP activity would thus be setting the precedence and thus would encourage other private investors to come up for the development of the tremendous hydro power potential existent in the state of Uttaranchal.

Other barriers

The other barriers which are associated with the BHPP hindering its implementation are:

- (a) In the downstream of the river Tehri dam has been constructed on the river Bhagirathi resulting in inundation of large area of land and displacement of the local populace. This has resulted in apprehensions in the mind of some of local populace that a hydro project essentially results in land inundation and displacements. So, some of them are against the putting up of this run-of-the river hydropower project although it does not involve any displacement. Since the project is a run-of-the river project and does not require building up a dam for water storage, so land inundation due to the BHPP is minimal which is limited to diversion of agricultural/forest land at diversion dam and also in the path of the tunnel/channel/tail end channel.

(c) The region falls under seismically sensitive and unsafe zone therefore the apprehensions of destructions caused by the boulder weir and the tunnel can not be ignored. A 2 km long tunnel is to be

[3] http://www.uttaranchaljalvidyut.com/projects/1-25mw.htm

[4] http://www.cea.nic.in/hydro/List%20of%20Hydroelectric%20Stations%20in%20the%20Country.htm

built to take the river water to the turbine using blasting method. Blasting can cause minor to major landslip in the region. Even minor adjustment of rocks can cause relocation of natural water sources to further intensify the woes of the local population.
(e) Since the BHPP is located in a remote area so SPEL is facing problems in getting skilled manpower for the project. The reluctance of skilled people to come and work in a remote location is to be tackled by devising higher compensation structure.

(f) The project is situated in the newly formed state of Uttaranchal, which was carved out from Uttar Pradesh in the year 2001. The project was allotted earlier by Uttar Pradesh and since it lies in Uttaranchal, so SPEL had to negotiate terms with the new state, i.e., Government of Uttaranchal (GoU). GoU took about 2 years to finalize its own power policy which was eventually brought out in December 2002. Owing to unclear policies of GoU, the formation of the new state and the time taken in crystallization of GoU's power policy, SPEL has faced many problems.

Sub-step 3b. Show that the Identified barriers would not prevent the implementation of at least one of the alternatives (except the proposed project activity):

As discussed in substep 3a, the BHPP has many associated barriers in its successful implementation. The barriers are arising due to the location of the project activity, which is in the hilly terrain. The above mentioned barriers though do not prevent alternatives 2 ,3 and 4 from happening. Alternative 5 wherein there is no investment involved and the status quo of the grid is maintained, i.e., Continuation of the current situation in the northern grid with no project activity is the most likely baseline scenario.

Step 4. Common practice analysis

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

The estimated potential of Small Hydro Power (SHP) i.e., less than 25 MW in India is about 15,000 MW. As of 31st December 2005 only 1,747.98 MW[5] has been developed, this corresponds to only 11.65 % of the identified potential. The database for SHP projects created by MNES in 2005-2006 includes 4404 potential sites with an aggregate capacity of 10,477 MW. In North India most of the SHP projects and capacity are located in the states of Uttaranchal, Himachal Pradesh and Jammu & Kashmir.

The statistics for these states (as on 31st December 2005) are as follows[5]:

State	Identified no. of sites	Total Capacity (MW)	Project Set-up		Projects ongoing	
			No.s	Capacity (MW)	No.s	Capacity (MW)
Uttaranchal	354	1478.24	76	75.45	37	23.01
Himachal Pradesh	323	1624.78	53	119.08	10	52.50
Jammu & Kashmir	201	1207.27	30	109.74	7	7.31
Total	**878**	**4310.29**	**159**	**304.27**	**54**	**82.82**

As can be seen from the above statistics, only 7.06% of the identified SHP potential has been developed in these states and that too the sites are of less than 5 MW size if average is taken. Moreover, the latest list[6] (as on 30-04-2006) of hydro-electric stations in India above 3 MW shows that there is no reference of any private party hydroelectric station in the state of Uttaranchal. The existing hydro-electric stations are

[5] http://mnes.nic.in/frame.htm?publications.htm

being operated by the state body – Uttaranchal Jal Vidyut Nigam (UJVNL). There clearly indicates that carrying out a project similar to the BHPP as an Independent Power Producer (IPP) is not a common practice as of date.

Also, as per the latest available statistics by the CEA of the total identified hydro-electric potential in the state of Uttaranchal is 18175 MW of which only 1802 MW has been developed representing only 9.9 % of the total potential[6].

Sub-step 4b. Discuss any similar options that are occurring:

As observed from the statistics given in the sub-step above it is very much clear that similar options as that of the BHPP is not existent as of now[7]. The average capacity of the projects already set-up comes to 1.87 MW and that of ongoing projects is 2.22 MW. Thus it indicates that there are hydro power projects coming up in these regions but the capacity of them is very small and usually in the range of 1-5 MW.

Step 5. Impact of CDM registration

The impact of CDM registration of the BHPP would be very much beneficial and multi-fold. It would help in overcoming the barriers identified as above. SPEL has taken the initiative to develop the BHPP as a CDM project and pave the way for others also to follow suit. The financial incentive due to CDM revenues would attract more parties for the development of the identified SHP existing in the region. As has been seen by the statistics presented in sub-step 4a, there is tremendous potential of generating clean power by the development of SHP potential identified. All these potential sites are usually in the hilly regions and thereby posing similar barriers as mentioned above. Thus CDM registration would give a boost towards the development of these projects and help in the reduction of anthropogenic greenhouse gas.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

As per definition project boundary shall encompass all anthropogenic emissions by sources of greenhouse gases (GHG) under the control of the project participants that are significant and reasonably attributable to the CDM project activity.

The BHPP activity boundary covers the point of water supply (Penstock entry) to the point of power generation and export to the grid, where SPEL has full control. Thus the project boundary covers the intake water structures, turbine, generator, control systems, auxiliary units, synchroniser and the power evacuation system.

According to the approved consolidated baseline methodology ACM0002 the spatial extent of the project boundary includes the project site and all power plants connected physically to the electricity system that the CDM project power plant is connected to.

For the purpose of determining the build margin (BM) and operating margin (OM) emission factor, a (regional) project electricity system is defined by the spatial extent of the power plants that can be dispatched without significant transmission constraints.

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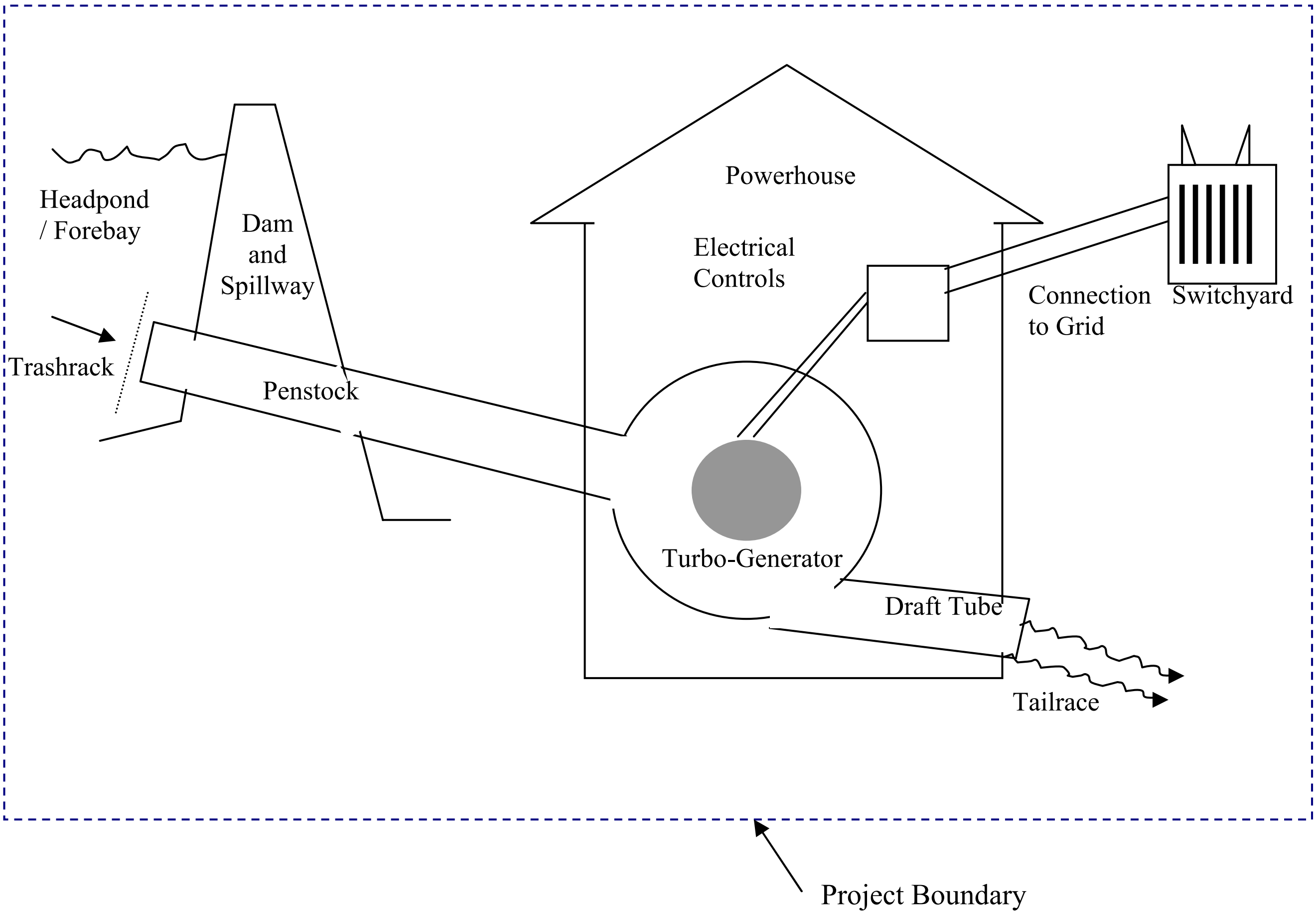
6 http://www.cea.nic.in/hydro/Status%20of%20Hydroelectric%20Potential%20Development.pdf

7 http://www.cea.nic.in/hydro/List%20of%20Hydroelectric%20Stations%20in%20the%20Country.htm

The BHPP evacuates the power to the northern grid therefore all the power plants contributing to the northern regional grid are taken for the calculation of baseline emission.



B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

Refer Annex 3, for details of baseline information

Date of completion of the baseline study - 05/09/2006

SPEL has determined the baseline for the project activity. SPEL contact details have been provided in Annex-I.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

16/10/2003

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

35 years

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

C.2.1. Renewable crediting period

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

Not Applicable

C.2.1.2. Length of the first crediting period:

Not Applicable

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

16/04/2007

C.2.2.2. Length:

10 years

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

Title: Consolidated monitoring methodology for zero-emissions grid-connected electricity generation from renewable sources

Reference: Approved consolidated monitoring methodology ACM0002/Version 06, Sectoral Scope: 1, 19th May 2006.

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

The applicability criteria of the approved consolidated monitoring methodology ACM0002 and the explanation of how the project activity will meet the criteria are discussed below:

- *Applies to electricity capacity additions from*
  - *Run-of-river hydro power plants; hydro power projects with existing reservoirs where the volume of the reservoir is not increased.*
  - *Wind sources;*
  - *Geothermal sources;*
  - *Wave and tidal sources.*

  The project activity is electricity capacity addition to the grid from a *run-of-river* hydro power plant;

- *This methodology is not applicable to project activities that involve switching from fossil fuels to renewable energy at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;*

  There is no fossil fuel switch over to renewable energy at the project site in the project activity

- *The geographic and system boundaries for the relevant electricity grid can be clearly identified and information on the characteristics of the grid is available;*

As explained in section B 1.1, Northern region grid is selected as grid boundary to estimate the baseline emission factor based on the location of the project activity. Information about the power plants located in northern region, electricity generation details are available. The details are given in Annex 3.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

There are no emissions associated with the BHPP activity. Therefore this section is not applicable.

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not Applicable

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Not applicable

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1. EG_y	Electricity supplied to the grid by the BHPP activity	BHPP records / Power Trading Corporation (PTC) records	MWh	m	hourly measure-ment and monthly recording	100%	Electronic, The data be kept during the crediting period and two years after	Used for baseline emission calculation

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

With reference to ACM0002 baseline emissions are estimated as under

Calculation of electricity baseline emission factor

The electricity baseline emission factor (EF_y) is calculated as a combined margin (CM), consisting of the combination of operating margin (OM) and build margin (BM) factors according to the following three steps. Calculations for this combined margin must be based on data from an official source (where available) and made publicly available.

STEP 1. Calculate the Operating Margin emission factor(s)

Out of the four methods mentioned in ACM0002, simple OM approach has been chosen for calculations since the low-cost/must run resources constitute less than 50% of the total grid generation in the Northern grid mix. Simple OM factor is calculated as under.

$EF_{OM, simple, y}$ is calculated as the average of the most recent three years (2003-2004, 2004-2005 and 2005-2006)

$$EF_{OM,simple,y} = \sum_{i,j} F_{i,j,y} \times COEF_{i,j} / \sum_{j} GEN_{j,y}$$

Where

$COEF_{i,j}$ - is the CO_2 emission coefficient of fuel i (t CO_2 / mass or volume unit of the fuel), calculated as given below and

$GEN_{j,y}$ - is the electricity (MWh) delivered to the grid by source j

$F_{i,j,y}$ - is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y, calculated as given below

j - refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports from the grid

The Fuel Consumption $F_{i,j,y}$ is obtained as

$$\sum_{i} F_{i,j,y} = \left(\sum_{j} GEN_{j,y} \times 860 \Big/ NCV_{i} \times E_{i,j} \right)$$

Where

$GEN_{j,y}$ - is the electricity (MWh) delivered to the grid by source j

NCV_i - is the net calorific value (energy content) per mass or volume unit of a fuel i

$E_{i,j}$ - is the efficiency (%) of the power plants by source j

The CO_2 emission coefficient $COEF_i$ is obtained as

$$COEF_{i} = NCV_{i} \times EF_{CO_2,i} \times OXID_{i}$$

Where

NCV_i -is the net calorific value (energy content) per mass or volume unit of a fuel i

$EFCO_{2,i}$ -is the CO_2 emission factor per unit of energy of the fuel i

$OXID_i$ -is the oxidation factor of the fuel

STEP 2. Calculation of the Build Margin emission factor ($EF_{BM,y}$)

It is calculated as the generation-weighted average emission factor (t CO_2/MWh) of a sample of power plants m of grid, as follows:

$$EF_{BM,y} = \sum_{i,m} F_{i,m,y} \times COEF_{i,m} / \sum_{m} GEN_{m,y}$$

Where

$F_{i,m,y}$, $COEF_{i,m}$ and $GEN_{m,y}$ - are analogous to the variables described for the simple OM method above for plants m.

Considered calculations for the Build Margin emission factor $EF_{BM,y}$ as ex ante based on the most recent information available on plants already built for sample group m of northern grid at the time of PDD submission. The sample group m consists of the 20 % of power plants supplying electricity to grid that have been built most recently, since it comprises of larger annual power generation. (Refer Annex 3)

Further, none of the power plant capacity additions in the sample group have been registered as CDM project activities.

STEP 3. Calculate the electricity baseline emission factor (EF_y)

It is calculated as the weighted average of the Operating Margin emission factor ($EF_{OM, simple, y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_y = W_{OM} \times EF_{OM,Simple,y} + W_{BM} \times EF_{BM,y}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $W_{OM} = W_{BM} = 0.5$), and $EF_{OM, Simple, y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in t CO_2/MWh.

$$BE_y = EF_y \times EG_y$$

Where

BE_y - are the baseline emissions due to displacement of electricity during the year y in tons of CO_2

EG_y- is the net quantity of electricity generated by the project activity during the year y in MWh, and

EF_y- is the CO_2 baseline emission factor for the electricity displaced due to the project activity in during the year y in tons CO_2/MWh.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

Not Applicable

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not Applicable

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

Not Applicable

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not Applicable

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Not Applicable.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Formula used for estimation of the total net emission reductions due to the project activity during a given year y is as under:

$$ER_y = BE_y - PE_y - L_y$$

Where,

ER_y - are the emissions reductions of the project activity during the year y in tons of CO_2
BE_y - are the baseline emissions due to displacement of electricity during the year y in tons of CO_2
PE_y - are the project emissions associated with the project
L_y - are the emissions sources as leakage

Since PE_y and L_y are zero therefore the equation reduces to

$ER_y = BE_y$

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1. EG_y – Electricity supplied to the grid by the project activity	Low	Electricity meters would be properly maintained with regular testing and calibration schedules developed as per the technical specification requirements to ensure accuracy

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

The BHPP activity contributes towards emission reductions by generation of electricity by harnessing the hydropower. Therefore the emission reductions would be monitored by the net electricity delivered to the grid by the project activity. The BHPP control and monitoring system will be based on programmable logic control (PLC). There are no leakages involved in the project activity. SPEL would implement an operational and management structure to monitor the emission reductions generated by the project activity.

The operational and management structure would be as follows:

Shift in-charge would be assigned with the responsibility of monitoring and recording of electricity supplied to the grid as per the monitoring plan. On a weekly basis, the monitoring reports would be checked and discussed with project manager. In case of any irregularity observed, necessary action would be taken immediately. On monthly basis, these reports would be forwarded to the management. The project manager would be a qualified engineer with 15-20 years of experience in power sector and all shift in-charges would also be qualified engineers with 8-10 years of relevant experience. The details of the same are mentioned in Annex 4: Monitoring plan.

D.5 Name of person/entity determining the monitoring methodology:

SPEL the project participant, along with guidance from the project consultants has determined the monitoring plan for the project activity.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

There are no GHG emissions arising from the project it being a hydro electric project. i.e., PE_y=0

E.2. Estimated leakage:

The main emissions potentially giving rise to leakage in the context of hydro electric sector projects are emissions arising due to activities such as power plant construction. As per the methodology ACM0002, project participants do not need to consider these emission sources as leakage in applying this methodology. Therefore no emissions related to leakage have been considered in this project.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Total project activity emissions are zero over a 10 year crediting period

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Baseline emissions (BE_y) are calculated using the formula:

$BE_y = EF_y \times EG_y$

Where,
EG_y = 121.956 GWh/annum
EF_y = 0.89626 tCO_2/GWh
The net annual baseline emissions are = 109,304 tonnes of CO_2

Year	Estimation of Net Electricity supplied to the facility, EG_y (GWh/annum)	Estimation of Emission factor, tCO_2/GWh	Estimation of baseline emissions (tonnes of CO_2e)
2007 - 08	121.956	896.26	109,304
2008 – 09	121.956	896.26	109,304
2009 – 10	121.956	896.26	109,304
2010 – 11	121.956	896.26	109,304
2011 – 12	121.956	896.26	109,304
2012 – 13	121.956	896.26	109,304
2013 – 14	121.956	896.26	109,304
2014 – 15	121.956	896.26	109,304
2015 – 16	121.956	896.26	109,304
2016 – 17	121.956	896.26	109,304
Total (tonnes of CO_2e)	**1219.56**		**1,093,040**

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

Emissions reductions (ER_y) are calculated using formula:

$ER_y = BE_y - PE_y - L_y$

Since project emissions (PE_y) and leakages (L_y) are zero, the emission reductions are equal to baseline emissions as given in table below.

E.6. Table providing values obtained when applying formulae above:

Year	Estimation of project activity emissions (tonnes of CO_2e)	Estimation of baseline emissions (tonnes of CO_2e)	Estimation of leakage (tonnes of CO_2e)	Estimation of emission reductions (tonnes of CO_2e)
2007 - 08	0	109,304	0	109,304
2008 – 09	0	109,304	0	109,304
2009 – 10	0	109,304	0	109,304
2010 – 11	0	109,304	0	109,304
2011 – 12	0	109,304	0	109,304
2012 – 13	0	109,304	0	109,304
2013 – 14	0	109,304	0	109,304
2014 – 15	0	109,304	0	109,304
2015 – 16	0	109,304	0	109,304
2016 – 17	0	109,304	0	109,304
Total (tonnes of CO_2e)	**0**	**1,093,040**	**0**	**1,093,040**

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

The environmental impacts associated with the project activity are as follows:

Impact on Flora and Fauna

As there is no storage of water involved in the project so there is no submergence of the forests, cultivable land or of the inhabited areas. The project structures to be constructed are small in size to cause an appreciable disturbance to the eco-system during the construction as well as operational phase. The construction debries are also likely to be small and measures for appropriate disposal of the same have been planned and would be carried out. No deforestation is required at the weir location. Cutting of few trees along the water conductor system is inescapable, but it has been kept to a bare minimum by suitably re-orienting the structures where possible. Fish ladder will also be provided in the project activity. The project has got the final sanction for the forest and Government land for a total of 8.9705 Hectares through 3 different orders of Government of Uttaranchal dated 4th August 2004 and 1st June 2005. Acquisition of private land will be carried out as per mutual agreements.

Socio-Economic Impact

Load survey studies have indicated that the people in the influence area are desirous of having electric power facility[8]. The construction and operational phase of the project will also give rise to employment opportunities for the local population.

Environmental Pollution

Since it is a hydro project, there is no issue regarding air pollution. The dust occurring during construction would be suppressed by sprinkling water. On the other hand power generation from the project will result in air quality improvement and emission reductions caused by burning of fossil fuels and firewood.

Impact on Irrigation

The irrigation facilities currently tend to dry up in the lean discharge months because of the lack of adequate intake diversion structures. Provision of sacrifice discharge to the tune on 0.25 cumecs has been made in the design of the scheme to guarantee a perennial supply of water needed for the irrigation channel through the scheme's intake structures.

From the above discussion it is clear that there is minimal negative impact on the environment due to the project activity.

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

The BHPP is an environmentally benign 'clean energy' and cost effective solution to meet the region's growing energy demands. Efforts have been made to enhance the existing resources and minimize the

[8] Section 12.3.3, Bhilangana H.E. Project (3x7.5 MW), Detailed Project Report, April 2004

adverse impact on the ecosystem through suitable planning. Environmental impact assessment for the project has been carried out and the environmental clearance for the project has been obtained.

SECTION G. Stakeholders' comments

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

An initial meeting with the local stakeholders was conducted on 31st August 2003 to obtain the no objection certificate (NOC) and to discuss upon the various issues related to the project. On 19th January 2004, the Sub-District Magistrate (SDM), Tehri Garhwal, held a meeting with the villagers at Ghansali and SPEL representatives explained about the project activity and clarified that BHPP being a run-of the river project will not have any significant adverse effect; there would not be any submergence due to the project activity. Subsequently a meeting on 12th April 2004 was conducted at Ghansali, chaired by the District Magistrate (DM), Tehri Garhwal, to resolve the issues raised by the local villagers. Agreements and Memorandum of Understanding (MoU) with the local villagers have been signed to address the issues raised by the local villagers.

G.2. Summary of the comments received:

The summary of the comments received from the local stakeholders are as follows:

The local people represented by the head of the village(s) raised the following issues with regards to the planned BHPP:

- Inundation of land that would occur due to the hydroelectric project
- Land acquisition required for the project activity
- Damage to crop occurring due to construction activity
- Water availability for irrigation after the project gets commissioned
- Employment generation of local people for the project activity
- Pollution arising due to the project construction
- Health impacts of the project activity
- Deforestation arising due to civil construction
- Social welfare associated with the project activity
- Criminal activities which would arise due to outsiders coming during construction phase

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

Due account has been taken for all the comments received by the local stakeholders. The issues raised by the local people have been addressed as follows:

- Since the project is a run-of-the river project and does not require building up a dam for water storage, so land inundation due to the BHPP is minimal which is limited to diversion of agricultural/forest land at diversion dam and also in the path of the tunnel/channel/tail end channel.
- Land acquisition for the BHPP would be done at the prevailing market rates or the rates provided by the revenue department or on a mutually agreeable basis.
- If any damage to the crop occurs due to the BHPP then SPEL would pay the damages as decided by the local committee
- SPEL would provide water required for irrigation through sacrificial discharge, construct tanks of requisite size and also put up hand-pumps.

- SPEL would offer employment to the local people depending upon their qualification for carrying out the required work.
- Due care will be taken such that pollution occurring during the construction phase is minimum. Water would be sprayed to suppress the dust arising during the construction.
- A doctor would be visiting for the check up of the local people, to take care of the adverse health impacts (if any) that arise to the coming up of the BHPP.
- Due diligence has been done to ensure that deforestation does not occur due to the project and is kept to a minimum. A substantial sum has been allocated for afforestation of the area.
- To improve the conditions of the local people SPEL would be constructing roads, school etc., and also provide monetary aid for the social welfare works annually.
- SPEL would ensure that no person of criminal background is involved in the project and poses a threat to the local people.

To make these issues binding SPEL has signed a deed with the local people.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Table 1.1: Project Proponent	
Organization:	Swasti Power Engineering Limited
Street/P.O.Box:	324/B, MLA & MP Colony
Building:	Road 10C, Jubilee Hills
City:	Hyderabad
State/Region:	Andhra Pradesh
Postfix/ZIP:	500033
Country:	India
Telephone:	+91-40-23556656
FAX:	+91-40-23556657
E-Mail:	swastipower@msn.com
URL:	
Represented by:	Y.S.Raveendranath Reddy
Title:	Mr.
Salutation:	Managing Director
Last Name:	Reddy
Middle Name:	Raveendranath
First Name:	+
Department:	+
Mobile:	+91-94401-85585
Direct FAX:	+91-40-23556657
Direct tel:	+91-40-23556656/57
Personal E-Mail:	raviyeduguri@hotmail.com

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No public funding from Parties included in Annex I is availed for this project activity.

Annex 3

BASELINE INFORMATION

Selection of Grid boundary

In the approved consolidated methodology ACM0002, the following guideline is given for the selection of grid. *"Where DNA guidance is not available, in large countries with layered dispatch systems (e.g. state/provincial/regional /national) the regional grid definition should be used. A state/provincial grid definition may indeed in many cases be too narrow given significant electricity trade among states/provinces that might be affected, directly or indirectly, by a CDM project activity"*.
As explained earlier in B.1.1, the electrical transmission system in India, is divided into five regions namely Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. Northern region grid comprises of Delhi, Punjab, Haryana, Chandigarh, Rajasthan, Jammu & Kashmir, Uttranchal, Uttar Pradesh and Himachal Pradesh. The location of project activity is in Uttaranchal state which is coming under northern region. Therefore northern grid region is selected as grid boundary to estimate the baseline emission factor.
Key elements to determine baseline for the project activity

The following key parameters are used to estimate the baseline emission factor of the project activity:

S No.	Key Parameters	Data Sources	Reference
1	Generation of power of all the plants for the year 2001-02, 2002-03, 2003-04, 2004-05 and 2005-06	Annual reports of Northern Region Load Dispatch Center (NRLDC) 2001-02 and 2002-03 Section 7.1, Annual reports of Northern region Electricity Board (NREB) 2003-04 – Annex-10.1.3 2004-05 – Annexure 2.7 2005-06	http://www.nrldc.org/docs/7-1.pdf http://www.nrldc.org/docs/2001-02-section5onwards.pdf http://nreb.nic.in/Reports/Index.htm
2	Coal consumption of each coal fired power plant for the year 2003-04, 2004-05 and 2005-06	Annual Performance review of Thermal power plant (CEA)	www.cea.nic.in
3	Calorific value of coal	NATCOM Report	http://www.natcomindia.org/natcomreport.htm
4	Calorific value of gas	Revised 1996 IPCC Guidelines for National Green house Gas Inventories: Reference Manual	
5	Oxidation factors	Revised 1996 IPCC Guidelines for National Green house Gas Inventories: Reference Manual	
6	Efficiency of gas based power plants supplying power to grid	MNES study titled "Baselines for Renewable Energy Projects under Clean Development Mechanism". Chapter 2,	http://mnes.nic.in/baselinepdfs/chapter2.pdf
7	Emission factor of natural gas,	Revised 1996 IPCC Guidelines for National Green house Gas Inventories: Reference Manual	Refer Note

8	Emission factor of non-coking coal	NATCOM Report, Chapter 2, page 37	http://www.natcomindia.org/pdfs/chapter2.pdf
9	Emission factor of Eastern and Western grids	MNES study titled "Baselines for Renewable Energy Projects under Clean Development Mechanism". Chapter 2, Table 2.11b, Table 2.11d	http://mnes.nic.in/baselinepdfs/chapter2.pdf

Note:
The value of emission factors given in "Revised 1996 IPCC Guidelines for national green house gas inventories: Reference Manual and Natcom report is in terms of carbon unit. It is converted in terms of CO_2 as explained below:

Fuel	Emission factor	Emission factor
	tC/TJ	tCO_2/TJ
Natural gas	15.3	56.1 (15.3 x 44/12)
Non-coking coal	26.13	95.8 (26.13 x 44/12)

Power generation Mix of Northern Region for five years

Energy Source	**2001-02**	**2002-03**	**2003-04**	**2004-05**	**2005-06**
Total Power Generation (GWh)	150935	154544	168110	172682	180854
Total Thermal Power Generation	113817	115986	122955	126342	132522
Total Low Cost Power Generation	37117	38559	45154	46339	48332
Thermal % of Total grid generation	75.41	75.05	73.14	73.16	73.28
Low Cost % of Total grid generation	**24.59**	**24.95**	**26.86**	**26.84**	**26.72**
% of Low Cost generation out of Total grid generation - Average of the five most recent years					**25.99**

Generation details

The power generation of power plants falls under Northern grid region for the past three years is given below:

Name	**Type**	**Fuel**	**Generation (2003-04) GWh**	**Generation (2004-05) GWh**	**Generation (2005-06) GWh**
Anta GPS	Thermal	Gas	2775.92	2595.77	2806.84
Auriya GPS	Thermal	Gas	4247.41	4119.47	4281.67

Badarpur TPS	Thermal	Coal	5428.96	5462.78	5380.54
Bairasiul	Hydro	Hydel	687.79	689.67	790.97
Bhakra Complex	Hydro	Hydel	6956.9	4546.01	6838.78
Chamera HPS	Hydro	Hydel	2648.32	3452.25	3833.66
Dadri GPS	Thermal	Gas	5058.66	5527.71	5399.34
Dadri NCTPS	Thermal	Coal	6181.12	6842.52	6768.09
Dehar	Hydro	Hydel	3299.29	3150.52	3122.68
Dhauliganga	Hydro	Hydel	-	-	312.46
Delhi	Thermal	Coal	1164.11	5203.8	1559.10
Delhi	Thermal	Gas	5159.77	4091.37	4046.11
Faridabad GPS	Thermal	Gas	2792.58	3172.01	2954.64
H.P.	Hydro	Hydel	3666.39	3666.39	2870.48
Haryana	Thermal	Coal	6849.26	7192.41	8352.58
Haryana	Hydro	Hydel	251.73	251.73	258.30
J&K	Hydro	Hydel	851.03	851.03	1133.41
J&K	Thermal	Gas	15.41	23.51	28.31
NAPS	Nuclear	Nuclear	2959.44	2760.01	2138.45
Pong	Hydro	Hydel	1178.93	882.57	1730.70
Punjab	Thermal	Coal	14118.96	14390.42	14848.73
Punjab	Hydro	Hydel	4420.43	4420.43	4999.36
Rajasthan	Thermal	Coal	15044.48	17330.79	19903.79
Rajasthan	Thermal	Gas	201.37	360.7	432.58
Rajasthan	Hydro	Hydel	494.07	494.07	921.33
RAPS-A	Nuclear	Nuclear	1293.37	1355.2	1267.50
RAPS-B	Nuclear	Nuclear	2904.68	2954.43	2815.73
Rihand STPS	Thermal	Coal	7949.26	7988.06	10554.73
Salal	Hydro	Hydel	3477.42	3443.29	3480.87
Singrauli STPS	Thermal	Coal	15643.4	15803.34	15502.80
SJVNL	Hydro	Hydel	1537.92	1617.45	3867.12
Tanakpur HPS	Hydro	Hydel	510.99	495.17	483.26
Tanda TPS	Thermal	Coal	2872.81	3254.67	3329.89
U.P.	Thermal	Coal	20638.05	19788.21	19326.44
U.P.	Hydro	Hydel	2063.04	2063.04	1244.92
Unchahar-I TPS	Thermal	Coal	3252.14	3342.83	3544.89
Unchahar-II TPS	Thermal	Coal	3187.93	3438.28	3501.21
Uri HPS	Hydro	Hydel	2873.54	2206.71	2724.81
Uttaranchal	Hydro	Hydel	3452.96	3452.96	3496.87
TOTAL			**168109.8**	**172681.6**	**180853.9**

Calculation of Operating Margin Emission Factor

The following table gives a step by step approach for calculating the Simple Operating Margin emission factor for Northern Regional electricity grid for the most recent 3 years at the time of PDD submission i.e.2003-2004, 2004-2005 & 2005-2006.

	2003-04	2004-05	2005-06
Generation by Coal out of Total Generation (GWh)	102704.29	106451.00	112572.8
Generation by Gas out of Total Generation (GWh)	20251.12	19890.00	19949.49
Imports from others			
Imports from WREB (GWh)	282.02	1602.84	2153.23
Imports from EREB (GWh)	2334.76	3600.58	4112.67

Fuel 1 : Coal	**2003-04**	**2004-05**	**2005-06**
Avg. Calorific Value of Coal used (kcal/kg)	4593	4593	4593
Coal consumption (tons/yr)	70,397,000	73,279,000	73,279,000
Emission Factor for Coal (tonne CO_2/TJ)	95.8	95.8	95.8
Oxidation Factor of Coal-IPCC standard value	0.98	0.98	0.98
COEF of Coal (tonneCO_2/ton of coal)	1.806	1.806	1.806
Fuel 2 : Gas			
Avg. Efficiency of power generation with gas as a fuel, %	45	45	45
Avg. Calorific Value of Gas used (kcal/kg)	10349	10349	10349
Estimated Gas consumption (tons/yr)	3,739,808	3,673,119	3684105.1
Emission Factor for Gas- IPCC standard value(tonne CO_2/TJ)	56.1	56.1	56.1
Oxidation Factor of Gas-IPCC standard value	0.995	0.995	0.995
COEF of Gas(tonneCO_2/ton of gas)	2.419	2.419	2.419
EF (WREB), tCO2/GWh	910.00	906.00	884.00
EF (EREB), tCO2/GWh	1186.00	1178.00	1158.00
EF (OM Simple), tCO_2/GWh	**1108.35**	**1116.65**	**1115.55**
Average EF (OM Simple), tCO_2/GWh			**1113.51**

List of power plants considered for calculating build margin

During 2005-06, the total power generation in northern grid region was 180,853.94 GWh. Twenty % of total generation is about 36,170.79 GWh. The recently commissioned power plant whose summation of power generation is about 37,608.63 GWh is considered for the calculation of Build margin. The list is tabulated below:

S. No.	Plant	Date of commissioning	MW	Generation of the unit in 2005-2006 (GWh)	Fuel Type
1	Dhauliganga unit-I	2005-2006	70	78.61	Hydro
2	Dhauliganga unit-II	2005-2006	70	78.61	Hydro
3	Dhauliganga unit-III	2005-2006	70	78.61	Hydro
4	Dhauliganga unit-IV	2005-2006	70	78.61	Hydro
5	Rihand Stage - II unit I	2004-2005	500	2593.70	Coal
6	Panipat # 7	2004-2005	250	921.46	Coal
7	Panipat # 8	2004-2005	250	1613.95	Coal
8	Chamera HEP-II (Unit 1)	2003-2004	100	567.67	Hydro
9	Chamera HEP-II (Unit 2)	2003-2004	100	567.67	Hydro
10	Chamera HEP-II (Unit 3)	2002-2003	100	567.67	Hydro
11	SJVPNL	2003-2004	1500	4104.25	Hydro
12	Baspa-II (Unit 3)	2003-2004	100	389.87	Hydro
13	Suratgarh-III (Unit-5)	2003-2004	250	2033.40	Coal
14	Kota TPS-IV (Unit-6)	2003-2004	195	1695.70	Coal
15	Baspa-II (Unit 1 & 2)	2002-2003	200	779.74	Hydro
16	Pragati CCGT (Unit II)	2002-2003	104.6	728.29	Gas
17	Pragati CCGT (Unit III)	2002-2003	121.2	843.86	Gas
18	Ramgarh CCGT Stage -II (GT-2)	2002-2003	37.5	146.80	Gas
19	Ramgarh CCGT Stage -II (GT-2)	2002-2003	37.8	147.97	Gas
20	Upper Sindh Extn (HPS)(1)	2001-2002	35	68.52	Hydro
21	Suratgarh stage-II (3 & 4)	2001-2002	500	3844.81	Coal
22	Upper Sindh Stage II (2)	2001-2002	35	68.52	Hydro
23	Malana-1 & 2	2001-2002	86	337.79	Hydro
24	Panipat TPS Stage 4 (Unit-6)	2000-2001	210	1688.29	Coal
25	Chenani Stage III (1,2,3)	2000-2001	7.5	3.88	Hydro
26	Ghanvi HPS (2)	2000-2001	22.5	69.71	Hydro
27	RAPP (Unit-4)	2000-2001	220	1432.17	Nuclear
28	Ranjit Sagar (Unit-1,2,3,4)	2000-2001	600	2012.84	Hydro
29	Gumma HPS	2000-2001	3	6.59	Hydro
30	Faridabad CCGT (Unit 1) (NTPC)	2000-2001	144	986.70	Gas
31	Suratgarh TPS 2	1999-2000	250	2112.17	Coal
32	RAPS-B (2)	1999-2000	220	1432.17	Nuclear
33	Uppersindh-2 HPS #1	1999-2000	35	68.52	Hydro
34	Faridabad GPS 1 & 2 (NTPC)	1999-2000	286	1959.71	Gas
35	Unchahar-II TPS #2	1999-2000	210	1732.60	Coal
36	Unchahar-II TPS #1	1998-1999	210	1767.20	Coal

Built Margin Emission Factor is calculated as per the following table:

Considering 20% of Gross Generation		
Sector		
Thermal Coal Based	20003.28	
Thermal Gas Based	4813.33	
Hydro	9927.69	
Nuclear	2864.33	
Total	37608.63	
Built Margin	-	-
Fuel 1 : Coal		
Avg. calorific value of coal used in Northern Grid, kcal/kg		4593
Coal consumption, tons/yr		12952313
Emission factor for Coal,tonne CO_2/TJ		95.8
Oxidation factor of coal (IPCC standard value)		0.98
COEF of coal (tonneCO_2/ton of coal)		1.806
Fuel 2 : Gas		
Avg. efficiency of power generation with gas as a fuel, %		45
Avg. calorific value of gas used, kcal/kg		10349
Estimated gas consumption, tons/yr		888886
Emission factor for Gas (as per standard IPCC value)		56.1
Oxidation factor of gas (IPCC standard value)		0.995
COEF of gas(tonneCO_2/ton of gas)		2.419
EF (BM), tCO_2/GWh		**679.00**

Therefore the **net baseline emission factor** as per combined margin

(OM + BM)/2 = **896.26 tCO_2/GWh**

Annex 4

MONITORING PLAN

Description of monitoring plan

The project activity would have main and backup meters to record the net power supplied to the grid. Meters would be calibrated and marked at regular intervals so that the accuracy of measurement can be ensured all the time.

Key Project Parameters affecting Emission Reductions

Net Power exported to the grid

The project revenues are based on the net units exported as measured by main metering system and/or backup metering system. The monitoring and verification system would mainly comprise of these meters as far as power export is concerned. Power Trading Corporation (PTC) would be billed by SPEL based on joint meter reading promptly following the end of each month for energy supplied.

The general monitoring principles are based on:

- Frequency
- Reliability
- Registration and reporting

Since the emission reduction from the project are determined by the net units exported to the grid (and then multiplying with appropriate emission factor) it becomes important for the project to monitor the net export of power to the grid on real time basis.

Frequency of monitoring

SPEL would carry out the hourly data recording. PTC and SPEL would jointly read the main and backup metering system on the first day of every month.

Reliability

The amount of emission reduction is proportional to the net electricity supplied to grid by the project activity. The reliability of the monitoring system is governed by the accuracy of the measurement system and the quality of the equipment to produce the result. The project proponent would also ensure quality of the equipment used for monitoring.

PTC would own, test and maintain the main metering system. The backup metering system shall be installed, tested, owned and maintained by SPEL. The main and backup metering system shall be sealed in the presence of both parties. All metering instruments would be electronic trivector meters of accuracy class 0.2 %. All the main and check meters would be tested for accuracy every calendar quarter with reference to a portable meter which shall be of an accuracy class of 0.1 %. When the main metering system and/or backup metering system and/or any component is found to be outside the acceptable limits of accuracy or otherwise not functioning properly, it would be repaired, re-calibrated or replaced, as soon as possible. All instruments would carry tag plates, which indicate the date of calibration and the date of next calibration. Any meter seal shall be broken only by PTC's representative in the presence of SPEL's

representative whenever the main or backup metering system is to be inspected, tested, adjusted, repaired or replaced.

Registration and reporting

PTC and SPEL shall jointly read the metering system and shall keep the complete and accurate records for proper administration. Hourly data recording by the Shift Incharge will be there. Weekly reports stating the generation would be prepared by the shift incharge and verified by the Plant Manager. In addition to the records maintained by SPEL, PTC would also monitor the actual power exported to the grid and certify the same.

Verification

The performance of the project would lead to CO_2 emission reductions. In other words, the higher the electricity exports to the grid the more would be the emission reductions. There are two aspects of Verification

[A] Verification of the Monitoring System which includes:

- Verification of various measurement and monitoring methods
- Verification of instrument calibration methods
- Verification of measurement accuracy

[B] Verification of Data collected which includes

- Net export of power.

The project proponent is required to provide the necessary support to enable verification of both the monitoring system and the data archived.