

## Calculation of weighted average emission in Current generation mix

(Sources : CSEB Tariff Petition 05/2005)

(i)	Size of Project activity	:	14 MW (69.854 Million KWh net)	
			2004-05 (Million KWh)	Emission Co-efficient in Kg CO <sub>2</sub> /KWh Or tCO <sub>2</sub> /MWh
(ii)	<b>Total Generation from CSEB</b>	:		
	(a)	<b>Thermal (Coal based)</b>		
		Korba (E)-II	1254	
		Korba (E) –III	761	
		Korba (W)	4781	
		<b>Sub Total</b>	<b>6796</b>	<b>1.187933594</b>
	(b)	<b>Hydel Power</b>		
		Hasdeo Bango	409	
		Mini micro HPS Korba (W)	5	
		<b>Sub Total</b>	<b>414</b>	<b>0</b>
(iii)	<b>Drawn from Central Share</b>			
	(a)	<b>Thermal Coal</b>		
		NTPC Korba	2011	
		NTPC Vindhyachal-I	210	
		NTPC Vindhyacha-II	139	
		<b>Sub Total</b>	<b>2360</b>	<b>0.977398334</b>
	(b)	<b>Gas</b>		<b>0</b>
		NTPC Kawas	-	
		NTPC Gandhar	-	
	(c)	<b>Nuclear</b>		
		NPC Kappa	71.7	<b>0</b>
(iv)	<b>Other Sources</b>			
	(a)	J.S.P.L 132	262	
	(b)	J.S.P.L. 221	648	
	(c)	BALCO	39	
	(d)	Prakash Industries	4	
	(e)	Jaiswal NECO	55	
	(f)	Chhattisgarh Electric Co.	1	
	(g)	NTPC Vidyut	35	
			1044	<b>0.977398334</b>
(v)	<b>Others -1 (wind and CPP)</b>			
(vi)	<b>Others -2 (Power Trading Corp. and Thermal Trading Corp.)</b>			
		<b>Thermal Coal</b>	599.55	<b>0.977398334</b>
		Gas	101.87	<b>0.464740535</b>
		Nuclear	76.31	<b>0</b>
		Hydel	142.28	<b>0</b>
		<b>Sub Total ::</b>	<b>920</b>	
	<b>Grand Total ::</b>		<b>11605.7</b>	

The Weighted Average Emission Factor of current generation Mix (EF y)

1.0369

(Calculation for PDD Page No. 35)

**Calculation of Net Electricity Generated ( EG y)**

Installed generation capacity	=	14 MW
Assumed PLF	=	70%
No. of Working Days in Year	=	330 Days
No. of Working Hours in a Day	=	24 Hours
Generated power / Annum	=	77616 MWh
Auxiliary Consumption @ 10%	=	7761.6
Net Electricity Generation	<b>(EG y)</b> =	69854.4 MWh
	Or Say =	<b>69854</b> MWh

**BASELINE EMISSION REDUCTION FROM GRID**

$ER_{ELECTRICITY\ y}$	=	$EG\ y \times EF\ y$
EG y	=	69854
EF y	=	1.036900
$ER_{ELECTRICITY\ y}$	=	$EG\ y \times EF\ y$
<b><math>ER_{ELECTRICITY\ y}</math></b>	=	<b>72431.61</b>
<b>Or Say <math>ER_{ELECTRICITY\ y}</math></b>	=	<b>72431</b>

(Calculation for PDD Page No. 36)

**Calculation of Emision due to Project Activity**

$$PEFFy = Qi NCVi EF_{CO2} OXIDi$$

Where

$$PEFFy = \text{Emision arising out of combustion of fossil fuel (coal) due to co-firing. tCO2e./ Annum}$$

$$Qi = 9800 \text{ Quantity of Coal used for Co-Fired 10\% of total Rice Huse Requirement / Annur}$$

$$NCVi = 14.166 \times 10^{-3} \text{ Tj/t (Net Calorific Value)}$$
$$= 0.014 \text{ Tj/t (Net Calorific Value)}$$

$$OXIDi = 0.98$$

$$EF_{CO2} = 94 \text{ tCO2/Tj}$$

$$PEFFy = Qi NCVi EF_{CO2} OXIDi$$

$$PEFFy = 12788.92 \text{ tCO2e/Annum}$$

$$\text{Or Say} = 12789 \text{ tCO2e/Annum}$$

(Calculation for PDD Page No. 50)

**Emission Reduction due to Project Activity**

$$ER_y = ER_{Electricity_y} - PEFF_y - L_y$$

Where

ER <sub>y</sub>	=	Emission Reduction of the Project Activity	=	
ER <sub>Electricity_y</sub>	=	Baseline Emission Reduction	=	72431.61 tCO <sub>2</sub> e/Annum
PEFF <sub>y</sub>	=	Proejct Activity Emission	=	12789 tCO <sub>2</sub> e/Annum
L <sub>y</sub>	=	Leakage	=	0 tCO <sub>2</sub> e/Annum

Therefore,

$$ER_y = ER_{Electricity_y} - PEFF_y - L_y$$

$$ER_y = 59642.6126 \text{ tCO}_2\text{e/Annum}$$

$$\text{Or Say } ER_y = \mathbf{59642 \text{ tCO}_2\text{e/Annum}}$$

(Calculation for PDD Page No. 52)

**Year wise Emission Reduction estimated'**

Year	Estimation of Project activity emission reduction tonnes of CO <sub>2</sub> e	Estimation of baseline emission reduction tonnes of CO <sub>2</sub> e	Estimation of leakage tonnes of CO <sub>2</sub> e	Estimation of emission reduction tonnes of CO <sub>2</sub> (tCO <sub>2</sub> e/ Annum)
2006	12789	72431	0	59642
2007	12789	72431	0	59642
2008	12789	72431	0	59642
2009	12789	72431	0	59642
2010	12789	72431	0	59642
2011	12789	72431	0	59642
2012	12789	72431	0	59642
2013	12789	72431	0	59642
2014	12789	72431	0	59642
2015	12789	72431	0	59642
				596420

( Calculation For PDD Page - 12, 52)

**Step -1 Calculation of EF<sub>OM</sub>, Simple Y,**

**Composition of Grid Electricity (Coal Based)**

	<b>FY 03</b>	<b>FY04</b>	<b>FY 05</b>	<b>FY 06 (Projected)</b>
CSEB	6858.22	6869	6796	7974
Central	2855.93	2737	2360	1843
Others	410.89	612	1044	360.2
Others-2	0	474.4276837	599.551468	1372.972863
<b>Total</b>	<b>10125.04</b>	<b>10692.42768</b>	<b>10799.5515</b>	<b>11550.17286</b>

(Calculation for PDD Page No. 31)

**Calculation of Weighted Average of NCV of Coal for CSEB generation  
(Source : CSEB Petion 5/2005)**

	<b>FY 03</b>	<b>FY04</b>	<b>FY 05</b>	<b>FY 06 (Projected)</b>
NCV for Coal (K Cal/Kg)				
1 Power Plant (Korba East)		3296	3335	3316
2 Power Plant (Korba West)		3447	3404	3443
Electricity Generated (Million KWh)				
3 Power Plant (Korba East)		1791	2015	2780
4 Power Plant (Korba West)		5078	4781	5194
5 Total Power		6869	6796	7974
<b>6 Weighted Average NCVi</b>	<b>3383.5416</b>	<b>3407.628767</b>	<b>3383.54164</b>	<b>3398.723602</b>

(Calculation for PDD Page No. 32)

## Step 1.1 Calculation of Efom, Simple OM for CSEB Generated Electricity Coal.

based on CSEB Tariff Petition 5/2005

	FY 03	FY04	FY 05	FY 06 (Projected)
1 Electricity Generated (Million KWh)	6858.220	6869.000	6796.000	7974.000
2 Net Calarofic Value				
2.1.1 For Coal - CEA sources				
K Cal/ Kg	3383.54	3407.63	3383.54	3398.72
Tj/t ( $10^{-3}$ )	14.166	14.267	14.166	14.230
2.2 Net Calarofic Value for Aux Fuel from IPCC Guidelines				
Tj/t	0.04333	0.04333	0.04333	0.04333
3 Fuel Consumption - CSEB Tariff Petition 05/2005				
3.1.1 Qty. of Coal (Million MT)				
CSEB (CSEB Source)	6.214	6.250	6.158	7.134
3.2 Quantity of Auxilliary Fuel in KL				
3.2.1 CSEB	13179.569	12818.000	13060.000	12506.000
4 Oxidation Factor OXID - IPCC guidelines				
4.1 Coal	0.980	0.980	0.980	0.980
4.2 Auxilliary Fuel	0.990	0.990	0.990	0.990
5 CO2 emission factor $EF_{CO_2j}$ (tCO <sub>2</sub> /Tj)				
5.1 Coal $EF_{CO_2j/Tj}$ (IPCC Guidelines )	94.000	94.000	94.000	94.000
5.2 Auxilliary Fuled $IEF_{CO_2j/Tj}$ tCO <sub>2</sub> /Tj IPCC Guideliens	73.500	73.500	73.500	73.500
6 COEF i, j tCO <sub>2</sub> /t				
6.1 Coal	1.3050	1.3143	1.3050	1.3108
6.2 Auxiliary Fuel	3.1529	3.1529	3.1529	3.1529
7 $EF_{OM}$ simple y tCO <sub>2</sub> eq./MWh				
COAL	1.1879	1.2011	1.1879	1.1772
Auxilliary Fuel	0.00545	0.00530	0.00545	0.00445

(Calculation for PDD Page No. 32)

Step 1.2 Calculation of  $EF_{OM}$  Simple OM for Central Generation for Coal based Power

based on CEA General Review 2005 (for year 2003-04)

	FY 03	FY04	FY 05	FY 06 (Projected)
1 Electricity Generated (Million KWh)	3266.820	3823.428	4003.551	3576.173
2 Net Calarofic Value				
2.1.1 For Coal - CEA Sources				
K Cal/ Kg	3820.00	3820.00	3820.00	3820.00
Tj/t ( $10^{-3}$ )	15.994	15.994	15.994	15.994
2.2 Net Calarofic Value for Aux Fuel from IPCC Guidelines				
Tj/t	0.04333	0.04333	0.04333	0.04333
3 Fuel Consumption - CSEB Tariff Petition 05/2005				
3.1.1 Qty. of Coal (Million MT)				
CSEB (CSEB Source)	2.166	2.535	2.654	2.371
3.2 Quantity of Auxilliary Fuel in KL				
3.2.1 CSEB	639.791	748.800	784.076	700.376
4 Oxidation Factor OXID - IPCC guidelines				
4.1 Coal	0.98000	0.98000	0.98000	0.98000
4.2 Auxilliary Fuel	0.99000	0.99000	0.99000	0.99000
5 CO2 emission factor $EF_{CO_2j}$ (tCO <sub>2</sub> /Tj)				
5.1 Coal $EF_{CO_2j/Tj}$ (IPCC Guidelines )	94.00000	94.00000	94.00000	94.00000
5.2 Auxilliary Fuled $EF_{CO_2j/Tj}$ tCO <sub>2</sub> /Tj IPCC Guideliens	73.50000	73.50000	73.50000	73.50000
6 COEF i, j tCO <sub>2</sub> /t				
6.1 Coal	1.4733	1.4733	1.4733	1.4733
6.2 Auxilliary Fuel	3.1529	3.1529	3.1529	3.1529
7 $EF_{OM}$ simple y tCO <sub>2</sub> eq./MWh				
COAL	0.9774	0.9774	0.9774	0.9774
Auxilliary Fuel	0.00056	0.00056	0.00056	0.00056

(Calculation for PDD Page No. 33)



**Calculation of EF<sub>OM</sub>, Simple y for Gas based Power**

based on CEA General Review 2005 (for year 2003-04)					
	Parameters	Unit	Gas	Naptha	Auxilliary Fuel (HSD)
1	IPCC Sources Guidelines	Tj/t	0.0433	0.0450	0.0433
2	OXID I IPCC Sources Guidelines		0.9950	0.9900	0.9900
3	EFCO2 IPCC Sources Guideline (tCO2/Tj)		56.0000	73.0000	73.5000
4	COEFi	tCO2/t	2.4143	3.2529	3.1529
5	Power Generated CEA Source for 2003-04	MWh/Year	4296838.899	2812071.101	7108910.000
6	Fuel Quantity	Tonnes	726822.0000	475669.4840	540.9000
7	Emission Factor EFOM Simple y	tCO2/MWh	0.4084	0.5502	0.0002
8	Average Emisison Facto of Naptha & Gas and addition Emission due to Auxilliary	tCO2/MWh	0.464740535		

(Calculation for PDD Page No. 34)

**Rice Husk requirement**

Requirement of steam turbo generator to produce 14 MW Power	:	62000.00	Kgs/Hr
		At 64.8 Kg/cm <sup>2</sup> g and 490 <sup>0</sup> C.	
Steam generated in Boiler	=	62000.00	Kgs/Hr
		At 66.0 Kg/cm <sup>2</sup> g and 495 <sup>0</sup> C	
Enthalpy of Steam at 66 Kg/cm <sup>2</sup> g and 495 <sup>0</sup> C temperature = enthalpy of steam at 66 KG/cm <sup>2</sup> & 495 <sup>0</sup> C – Enthalpy of boiler feed water as 66 KG/cm <sup>2</sup> & 150 <sup>0</sup> C	=	2770.00	KJ/Kg ( from Steam Table)
	=	661.60	K Cal/Kg.
Boiler efficiency	=	84%	
Calorific Value of Rice Husk	=	3150.00	K Cal/Kg.
Rice Husk required to be burnt per Kg of steam generation.	=	0.25	Kg/Kg
Steam generated	=	62000.00	KGs/hr.
Rice Husk required	=	15502.42	KGs/Hr.
	Or Say	= 15.50	Tonnes/Hr.
No. of Working Days in Year	=	330.00	Days
No. of Working Hours in a Day	=	24.00	Hourse
Rice Husk required per Annum to produce 14 MW power) at PLF @ 100%	=	122779.14	Tonnes/Year
Rice Husk required per Annum PLF @ 70%	=	85945.40	Tonnes/Year
Rice Husk required per Annum PLF @ 80%	=	98223.31	Tonnes/Year
Available Rice Husk	=	<b>572880.00</b>	Tonnes/Annum
Qi = Calculation of 10% of 80% PLF Rice Husk Requirement	10% =	9800	for consideration of Coal cofiring

(Calculation for PDD Page No. 19)

## Figures from Guidelines which are used for Calculations

### IPCC GUIDELINES figure which are used for calculation

Fuel	NCV (Tj/t)	OXID	EF <sub>CO2</sub> (tCO2/Tj)
Coal		0.98	94
HSD (Aux. Fuel)	0.04333	0.99	73.5
Naptha	0.04501	0.99	73
Gas	0.04333	0.995	56

(Source CEA General Review 2005 (for year 2003-04))

Ref : General Review 2005

Average Calorific Value of Coal 3820 K Cal/Kg

### Consumption of Fossil Fuel for electricity generation in Thermal Power Plant using Coal in Central Sector WR

(Source CEA General Review 2005 (for year 2003-04))

Coal	21683000 MT
Furnace Diesel	6115 KL
Light Oil	289 KL
Power Generated	32685.7 GWh
or Say	32685700 MWh

### Consumption of Fossil Fuel for electricity generation in Thermal Power Plant using Natural gas and Naptha in Central Sector WR

(Source CEA General Review 2005 (for year 2003-04))

Natural Gas	894 Million M <sup>3</sup>	726.822 Million Kgs	726822 Tonnes
Naptha	676628 KL		475669.48 Tonnes
	TOTAL ::		1202491.5
HSD (Aux. Fuel)	601 KL		540.9 Tonnes

Power Generation	7108.91 GWh
=	7108910 MWh

Power Generation by Gas 4296838.899 MWh

Power Generation by Naptha 2812071.101 MWh

**Composition of Electricity generated from  
Central Sector Western Regions Installed capacity from CEA Sources**

Hydel Power	6172 MW	15.47%
Coal Power	26007.5 MW	65.17%
Gas	4418.99 MW	11.07%
Neuclear	3310 MW	8.29%
<b>Grand Total ::</b>	<b>39908.49 MW</b>	<b>100.00%</b>
<b>or Say</b>	<b>= 39908 MW</b>	

(Calculation for PDD Page No. 31)

**CURRENT GENERATION MIX FOR CSEB GRID ELECTRICITY GEN**

(i)	<b>Size of Project activity</b>	:	14 MW (69854 Million KWh net) Less than (<)1% of the system electricity.
			<b>2004-05</b> <b>(Million KWh)</b> <b>(Actual)</b>
(ii)	<b>Total Generation from CSEB</b>	:	
	(a)	<b>Thermal (Coal based)</b>	
		Korba (E)-II	1254
		Korba (E) –III	761
		Korba (W)	4781
	(b)	<b>Hydel Power</b>	
		Hasdeo Bango	409
		Mini micro HPS Korba (W)	5
(iii)	<b>Drawn from Central Share</b>		
	(a)	<b>Thermal</b>	
		NTPC Korba	2011
		NTPC Vindhyachal-I	210
		NTPC Vindhyacha-II	139
	(b)	<b>Gas</b>	
		NTPC Kawas	-
		NTPC Gandhar	-
	(c)	<b>Nuclear</b>	
		NPC Kappa	71.7
(iv)	<b>Other Sources</b>		
	(a)	J.S.P.L 132	262
	(b)	J.S.P.L. 221	648
	(c)	BALCO	39
	(d)	Prakash Industries	4
	(e)	Jaiswal NECO	55
	(f)	Chhattisgarh Electric Co.	1
	(g)	NTPC Vidyut	35
(v)	<b>Others -1 (wind and CPP)</b>	:	-
(vi)	<b>Others -2 (Power Trading Corp. and</b>	:	920
	<b>TOTAL</b>	::	<b>11605.7</b>

(Calculation for PDD Page No. 20 & 30)

SOURCE: CSEB Tariff Petition- 5/2005 FOR 2004-05 ( IN TABLE F4)

**Grid Electricity Source**

	2002-03	2003-04	2004-05	2005-06
<b>CSEB(Own Generation)</b>				
Coal	6858.22	6869	6796	7974
Hydel	276.48	298	414	432
<b>Sub -Total ::</b>	<b>7134.7</b>	<b>7167</b>	<b>7210</b>	<b>8406</b>
<b>CENTRAL</b>				
Coal	2855.93	2737	2360	1843
Gas	267.57	-	-	-
Nuclear	290	147	71.7	27
Renewable/ WHRB	0	-	-	-
<b>Sub Total ::</b>	<b>3413.5</b>	<b>2884</b>	<b>2431.7</b>	<b>1870</b>
Other Coal	410.89	612	1044	360.2
Others (1) (Wind/ CPP)	255.36	2	-	-
Other (2)	0	728	920	2106.8
<b>Sub-Total ::</b>	<b>666.25</b>	<b>1342</b>	<b>1964</b>	<b>2467</b>
<b>Grand Total ::</b>	<b>11214.45</b>	<b>11393</b>	<b>11605.7</b>	<b>12743</b>

(Calculationf or PDD Page No. 29)