

Emission Reduction			Bulb wattage (W)				Total					
n	Quantity of ICL Replaced / CFLs Installed	nos.	-	186,422	361,878		548,300					
PI, BL	Rated power of the baseline lighting devices of the group of "i" lighting devices	Watts	40	60	100							
PI, PJ	Rated power of the project lighting devices of the group of "i" lighting devices	Watts	11	11	20		69.46					
Oi	Average daily operating hours of the lighting devices replaced by the group of "i" lighting devices, use 3.5 hours per 24 hrs period or the measured value determined from the representative sample	hours	3.5									
ESI	Estimated annual electricity savings for equipment of type i, for the relevant technology	kWh	0.00	62.60	102.20		88.74					
ESI = (PI, BL- PI, PJ) x Oi x 365/1000												
Calculation of Lamp Failure Rate (LFRi)												
Li	Rated average life for equipment type i (hours)		10000	7.82778865	7	0.82778865	8					
Ri	% of lamps of type i operating at the rated lifetime (use a value of 50)		50									
y	Counter for year		1	2	3	4	5	6	7	8	9	10
Xi	Number of operating hours per year for equipment type i (hours)		1277.5	1277.5	1277.5	1277.5	1277.5	1277.5	1277.5	1277.5	1277.5	1277.5
LFRi,y	Lamp Failure Rate for equipment type i in year y		6%	13%	19%	26%	32%	38%	45%	100%	100%	100%

$$\text{If } y * X_i < L_i, LFR_{i,y} = y * X_i * (100 - R_i) / (100 * L_i) \quad \text{If } y * X_i > or = L_i, LFR_{i,y} = 1$$

Correction Factor to take into account CFL replaced under CPA (field failures, breakages, replacements to households in CPA defined warranty period etc)			10%		0	0							
TDy	Average annual technical grid losses (transmission and distribution) during year y A default value of 10% shall be used for average annual technical grid losses.		0.1851										
NTG	NTG = Net-to-gross adjustment factor, a default value of 0.95 to be used unless a more appropriate value based on a lighting use survey from the same		0.95										
EFCO2,elec,y	Emissions Factor tCO2/MWh		0.856										
NES,y	$NES_y = \sum_i QP_{i,j} * (1 - LFR_{i,y}) * ESI * [1 / (1 - TDy)] * NTG$		53,097	49,474	45,851	42,228	38,605	34,982	31,359	23,476	23,476	23,476	
NES,y	$NES_y = \sum_i QP_{i,j} * (1 - LFR_{i,y}) * ESI * [1 / (1 - TDy)] * NTG - MWh$	319,070	53,097	49,474	45,851	42,228	38,605	34,982	31,359	23,476	-	-	
Ery	Emission Reductions (tCO2e)	273,124	45,451	42,349	39,248	36,147	33,046	29,944	26,843	20,095	-	-	

Carbon Transaction Assumptions

PDD Validation				INR	0
Verification Costs				INR	200,000
Monitoring Database Infrastructure and Software				INR	258,500
Monitoring Survey Costs				INR	705,000
Others				INR	23,500
Total				INR	1,163,500

Carbon Emission Reduction - CER

Exchange Rate USD to INR		INR	47		
Revenue from one CER		INR	600		
Project NPV - WITHOUT CER		INR	(66,461,784)	USD	(1,414,081)
Project NPV - WITH CER		INR	53,325,783	USD	1,134,591

Distribution costs	Estimated Assumptions
Total Lamps to be Distributed	100,000.0
Time Period (Months)	4.0
Total Lamps to be Distributed per month	25,000.0
Lamps to be distributed per household	2.5
No. of H/H to be covered in 1 month assuming 2.5 Lamps per H/H	10,000.0
No. of H/Hs covered per person per day	7.0
Man days required to cover the Target No. of H/Hs in 1 month	1,428.6
Total Manpower Required based on 25 working days per month	57

Cost Estimation

Salary Cost	
Salary per person per month (Rs.)	5,000.0
Total Salary per month for the entire manpower (Rs.)	285,714.3
Total Salary for Distribution of CFLs over 4 months	1,142,857.1

Distribution Cost per CFL	11.43
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Storage Cost	
Bulbs Units Per Pallet	4,000
Per Pallet Space (Including pathways)	2.75
Area Required	413
Area in Sft	4,452
Operations Area for Bulb Repacking +Office	442
Total Area Required	4,894
Cost per sft	20
Total Storage cost - 6 months	587,297

Storage costs per ICLs	5.87
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Storage Costs of fused CFLs during project life	0.5
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Database entry costs

Salary per person per month (Rs.)	8,000
No of households and ledgers	219,320
No. of data entries per day assuming 8 hours per day and 2 min per ledger	240
No. of people	33
No of days	28
Laptops (5 laptops)	250,000
Cost for data entry	471,535
Laptops	

Data entry costs per CFL	4.72
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	23
Contingency (boxes for storage etc)	2

Total	25
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A4.4.4

Estimated Amount of Emission Reductions (tonnes of CO2 e)	
Year	Estimation of annual emission reductions(tonnes of CO ₂ e)
1	45,451
2	42,349
3	39,248
4	36,147
5	33,046
6	29,944
7	26,843
8	20,095
9	0
10	0
Total Estimated reductions	273,124
Total number of crediting years	7.83
Annual average	34,892

B.3

NPV without CDM consideration	Negative	INR	(66,461,784)	USD	(1,414,081)
NPV with CDM consideration		INR	53,325,783	USD	1,134,591

Revenue from 1 CER		INR	600.0
		USD	12.8

B.5.2

Year	Yearly LFR and NES									
	1	2	3	4	5	6	7	8	9	10
Till date cumulative CFL operating	1,278	2,555	3,833	5,110	6,388	7,665	8,943	10,000	0	0
Lamp Failure Rate(LFR%)	6%	13%	19%	26%	32%	38%	45%	100%	0%	0%
Net Energy Saved(NES,MWh)	53,097	49,474	45,851	42,228	38,605	34,982	31,359	23,476	0	0

Emission Reduction (Ery) ex-ante calculations

Emission Reductions(ER, tonnes of CO ₂ e)	1	2	3	4	5	6	7	8	9	10
	45,451	42,349	39,248	36,147	33,046	29,944	26,843	20,095	0	0

B.5.3

Summary of ex-ante estimation of emission reductions	
Year	Estimation of overall emission reductions (tonnes of CO ₂ e)
1	45,451
2	42,349
3	39,248
4	36,147
5	33,046
6	29,944
7	26,843
8	20,095
9	0
10	0
Total(tonnes of CO₂e)	273,124

B6.1

Ex-post Monitoring Year over crediting period										
Year	1	2	3	4	5	6	7	8	9	10
p	0.064	0.128	0.192	0.256	0.32	0.384	0.448	0.5	0	0
Sample Size(n)	4353	2028	1253	865	633	478	367	298	0	0
Actual House	2177	1014	626	433	316	239	183	149	0	0

Calculations of Baseline Electricity Emission from Grid

The combined margin is calculated according to the procedure as described in the "Tool to calculate the emission factor for an electricity system" (Version 1.1) and the following six steps are applied. The data used in the calculation is obtained from the latest published study by CEA (version 4.0) and is available in the CEA website as below: <http://www.cea.nic.in/planning/c%20and%20e/Government%20of%20India%20website.htm>

STEP 1. Identify the relevant electric power system

The project activity is located at <state> and the electricity supply is obtained from <North / Southern> Grid. As per the applied tool, electricity exports are not subtracted.

STEP 2. Select an operating margin (OM) method

$$EF_{\text{grid,OMsimple},y} = \frac{\sum_{i,m} FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO_2,i,y}}{\sum_m EG_{m,y}}$$

$EF_{\text{grid,OMsimple},y}$	Simple operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$FC_{i,m,y}$	Amount of fossil fuel type i consumed by power plant / unit m in year y (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fossil fuel type i in year y (GJ / mass or volume unit)
$EF_{CO_2,i,y}$	CO ₂ emission factor of fossil fuel type i in year y (tCO ₂ /GJ)
$EG_{m,y}$	Net electricity generated and delivered to the grid by power plant / unit m in year y (MWh)
m	All power plants / units serving the grid in year y except low-cost / must-run power plants / units
i	All fossil fuel types combusted in power plant / unit m in year y
y	Either the three most recent years for which data is available

The calculation of the operating margin emission factor ($EF_{\text{grid,OM},y}$) is based on **Simple OM method** because the low-cost/must-run resources constitute less than 50% of Southern Grid generation in the average of the five most recent years. In India, hydro and nuclear stations qualify as low-cost / must-run sources.

Table 1: Share of Must-Run (Hydro/Nuclear) (% of Net Generation)

Year	2003-04	2004-05	2005-06	2006-07	2007-08
Southern Grid	16.20%	21.60%	27.00%	28.30%	27.10%

STEP 3. Calculate the operating margin emission factor according to the selected method

The simple OM is calculated using **ex ante option 1** based on 3-year generation-weighted average. The energy data values are inclusive of electricity imports as required under the tool.

Note: In the CEA database, the combined margin is calculated using the ex-post option 2. This option is not chosen by the CPA implementer.

Table 2: Simple Operating Margin for Southern grid

Year	2005-06	2006-07	2007-08	3 Year Average
Simple OM (tCO₂/MWh)	1.00567	0.99912	0.99062	0.99847

STEP 4. Identify the cohort of power units to be included in the build margin (BM)

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

$EF_{grid,BM,y}$	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh)
m	Power units included in the build margin
y	Most recent historical year for which power generation data is available

The sample group of power units m used to calculate the build margin consists of the set of power capacity additions in the electricity system that comprise **20% of the system generation** and that have been built most recently.

Using the available data from CEA, the total output of the 20% of the system generation built most recently in Southern Grid is as below:
As per applied tool this represents choice (b).

Table 3: Net Generation in Build Margin (GWh)

Year	2007-08
Southern Grid	31,613

Table 4: Absolute Emissions BM (tCO2)

Year	2007-08
Southern C	22,550,310

STEP 5. Calculate the build margin emission factor

The calculation of Build Margin is performed based on the net generation of the 20% most recent capacity additions in the grid.

Table 5: Build Margin for Southern Grid

Year	2007-08	
Net generation in BM (MWh)	31,613,000	31,613,274
Absolute Emissions BM (tCO2)	22,550,310	22,550,310
BM (tCO2/MWh)	0.71332	0.71332

STEP 6. Calculate the combined margin (CM) emissions 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:

$EF_{grid,CM,y}$	Combined margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,OM,y}$	Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,BM,y}$	Build margin CO ₂ emission factor in year y (tCO ₂ /MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

Parameter	Value	Unit
$EF_{grid,OM,y}$	0.99847	tCO ₂ /MWh
$EF_{grid,BM,y}$	0.71332	tCO ₂ /MWh
w_{OM}	0.50000	- (recommended default value by the tool)
w_{BM}	0.50000	- (recommended default value by the tool)
$EF_{grid,CM,y}$	0.856	tCO₂/MWh