Reply on Review Requested on **AARTI CDM CPP" (1649)**

1. Further clarification is required on how the DOE has validated that the economic comparison, between a 10 MW coals based power plant (with 95% PLF) and the 4.5 MW project activity (with 66% PLF) is appropriate given the different levels of production from these two options.	1. While validating the unit cost of power from the 4.5 MW project activity a number of Manpower cost has been attributed on the 5.5 MW AFBC portion, thus the unit cost of power from WHRB became lower than what would have otherwise been there if calculated for stand alone WHRB. 2. The correct level of comparison is to compare the UNIT cost of power from the 4.5 MW added portion in AFBC. Logically the unit cost of power from the 4.5 MW added portion would be much less; than the average unit cost of power from the entire 10 MW AFBC power plant. Hence even considering unit cost of power from the entire 10 MW AFBC capacity is conservative. 3. The decision to set up a captive power plant is in accordance to the assessed load requirement by us, in this case it is assessed to be 10 MW. To meet the assessed demand a reliable & consistent source of Power is required which could have been easily met by Coal based AFBC as it can easily provide 95% & above PLF, at the same time economically most attractive. Therefore any alternate system capable to give equivalent power at, at-least the equivalent economic cost level, only can replace the AFBC. WHRB are known for their power fluctuation & unpredictable system shut downs etc, thus at their best they can give about 66% PLF on annualized basis, therefore to operate the captive load, a grid system back up is essential to provide this 29% gap in generation. Thus while comparing the average unit cost of power for the equal qty of power per annum; the cost of power further goes high; as the grid power unit charges are costlier than the WHRB or AFBC

	power. Thus as a conservative approach the unit cost of Power was calculated only on the 66% PLF of WHRB. Therefore the considered PLF level for WHRB also is most conservative and appropriate. 4. This may be argued that in absence of the project activity what is the need of increasing the AFBC capacity by 4.5 MW when the equal quantum of energy can be generated only by adding (4.5X.66/.95) =3.12 MW. This argument is practically not valid for the simple reasons that the assessed annual demand of 10 MW captive loads cannot be met from any system of lower capacity (i.e.=5.5MW+ 3.12MW= 8.62MW). More over having invested on every other components of 10 MW power generating system, except boiler; why we would not increase the AFBC boiler capacity to 10 MW which can be done at much less cost than putting up a WHRB. Thus such scenario is not practical. Even if for the sake of an academic exercise it is done; then also the unit cost of power from the added portion of 3.12MW capacity will be much less than the entire 10 MW AFBC power. Hence the 10 MW level for considering the Unit cost of power is appropriate. 5. Another argument can be made why not a lower capacity of WHRB equal to 4.5X0.66= 3.12 MW is set up & operated at 95% level? This option is not exercisable because at the optimum level of sponge iron production the available waste heat would be capable to generate up-to 4.5 MW. A lower capacity WHRB will require emitting into atmosphere the useable waste heat; which will be against the purpose of the project activity. More over even by doing so the annualized PLF would not improve from 66% to any better level. Because even by doing so the plant availability of sponge iron plants will

	neither improve from estimated 300 days; nor any other technical barrier will ease out by doing so. Hence this option also is not exercisable. In view of the above the comparison made is most conservative & appropriate. The different level of production does not make any impact on the additionality of the Project activity. **For greater clarity the following are submitted additionally:** The project activity is to produce 4.5 MW WHRB based power, to replace coal based power generation to the extent of 4.5 MW WHRB power generation from its proposed 10 MW CPP. For comparison of investment on levelized unit cost of power, we have the following alternatives which can be compared:

1	Baseline Scenario i.e. Unit cost of power from the added 4.5 MW portion to 5.5 MW coal based AFBC. But as a conservative approach considered 10 MW Coal based AFBC captive power generation
2	Project Activity i.e. 4.5 MW WHRB power project as stand alone, but considered the unit cost of Power generation by sharing a number of cost with 5.5 MW AFBC as a conservative approach .
3	Combination of 4.5 MW WHRB and 5.5 MW Coal based AFBC only
4	Combination of 4.5 MW WHRB and 5.5 MW Coal based AFBC along with grid imported energy(energy import cost from Grid) to levelize the generation up to 95% level
5	Generation cost of grid

On comparing the above scenario by attributing the costs as explained above during the validation process, we had found the most conservative comparison is to compare the 4.5 MW WHRB power generation on basis of 66% PLF with Baseline Scenario i.e. 10 MW Coal based AFBC. We are also providing “Chartered Accountants certificate” **(Annex-VII)** for the comparison made by us. A summary of the comparison is as follows:

S.No.	Scenario	Per MWh unit cost of power
1	Baseline Scenario i.e. 10 MW Coal based AFBC power generation	1361.22 Rs./MWh
2	Project Activity i.e. 4.5 MW WHRB power project.	1439.18 Rs./MWh
3	Combination of 4.5 MW WHRB and 5.5 MW Coal based AFBC	1498.71 Rs./MWh
4	Combination of 4.5 MW WHRB and 5.5 MW Coal based AFBC along with grid imported energy to levelize the generation up to 95% level	1849.52 Rs./MWh
5	Energy Import from grid (Tariff – **Annex-V**)	2650.00 Rs./MWh
6	Power Generation Cost at Grid (refer tariff order **Annex-VI**)	1040.00 Rs/MWh

By above comparison the unit cost of power for Baseline Scenario i.e. 10 MW Coal based AFBC is found to be most economically attractive and reliable. As per requirement of Methodology we had compared the project scenario (4.5 MW WHRB power generation) with the baseline scenario (i.e.10 MW Coal based power generation). Because the comparison between 10 MW Coal based power plant (Baseline Scenario)

	and 4.5 MW WHRB power plant (Project Scenario) is also found to be most conservative, hence used, and DOE has validated the conservativeness and appropriateness of the same. the appropriateness of the above comparison can be understood with the simple logic which is as follows: 1) Cost of Baseline Scenario i.e. 10 MW Coal based Captive power plant is found to be lowest,. 2) Cost of any power generated at lower capacity than the 10 MW in this coal based power plant will always be (a) greater than; or (b) at the most equal to the unit cost of power of baseline scenario i.e 10 MW. 3) Unit Cost of power from WHRB stand alone in comparison to Single Boiler based AFBC is also higher, because (a) higher investment per MW project cost in WHRB, (b) higher interest burden on per MW cost of project in WHRB, (c) higher depreciation in per MW cost of project in WHRB, (d) lower PLF because of various technology barriers which also includes higher manpower requirement because of more number of boiler, and more operation and maintenance cost due to technology barriers in WHRB. 4) The combination of 2 and 3 (4.5 MW WHRB + 5.5 MW Coal based AFBC) will always be higher than 1 (baseline Scenario i.e. 10 MW Coal based Power generation), because;

Unit cost of power by 5.5 MW Coal based AFBC is always higher than the unit cost of power from Baseline Scenario (i.e. increased portion of 4.5 MW or even 10 MW) or at least equal to the same.

5) Combination of levelized energy production needs import from Grid which is also costlier than WHRB and AFBC based power generation.

Thus if the energy level is required to be leveled for Calculations then deficit in power generation to extent of 29% in WHRB based power generation has to be imported from Grid which result higher unit cost of power

Hence, the comparison between Project Activity 4.5 MW WHRB power generation with 10 MW Coal based power generation is justified.

This is to be noted that 4.5 MW WHRB based power generation (Project Activity) and 10 MW Coal based power generation (Baseline Scenario) can not give the levelized energy production, hence we had chosen the cost of per MWh power generation to compare the scenario, which is also justified.

Regarding difference in level of production, it will be noted that WHRB power plant faces enormous technology barriers. These technology barriers also impact capacity utilization of power plant resulting into poor capacity utilization. The technology employed in proposed project activity is to utilize the waste heat from Sponge Kiln to generate power. Sponge Iron manufacturing process also faces lot of barrier, which results in poor PLF i.e. 50 to 60%, and which is also evident with SIPB's (a Govt. of Chhattisgarh undertaking- **Annex-I & Annex-II**) official data, in which average PLF

	(based on 300 days) of Sponge Iron manufacturing units were found 50.57% average PLF for the period of 2006-07 and 54% average PLF for 2007-08. This PLF will further get reduced to 43.35% for 2006-07 and 46.29% for 2007-08 if calculated based on 350 days working as considered in levelized cost comparison. Against which coal based AFBC boiler can be operated for 350 days in a year at 95% PLF and above. Please refer to **Annex- III**, where the coal based power generation PLF is achieved even 104%, and also please refer to **Annex-IV**, where the coal based power generation PLF is achieved 95%. The PLF of WHRB power plant is mainly based on Sponge Iron Kiln's performance, where in coal based AFBC faces no barriers. The Coal based AFBC power plant for captive use is the common practice in the region because of abundant availability of Coal. It will also be evident with list of captive power plant being installed in regions from Ministry of Environment and Forest **(Annex-V)** web site sanctioning environment clearance.

2. Further clarification is required how the DOE has validated that the range of variation of PLF in the sensitivity analysis is reasonable.	PLF for WHRB based power plant is mainly based on Sponge Iron Kiln's performance, in addition; it is also influenced by many technology barriers associated with the operation of WHRB. Because the average capacity utilization for Sponge Iron Kiln is also found around 50 to 60%. Therefore waste heat generation with Sponge Iron Kiln is also reduced to 50 to 60% levels, this will also be evident with company past performance of Sponge Iron Kilns and is also evident with SIPB's (Govt. of Chhattisgarh undertaking) official data which is also available on the internet on web-link : http://www.chhattisgarh.nic.in/departments/sipb/Allocation%20of%20Iron%20Ore%202007-08.pdf to demonstrate Sponge Iron Units PLF for the period 2006-07 http://www.chhattisgarh.nic.in/departments/sipb/Iron%20Ore%20Recommended%20for%202008-09.pdf demonstrate Sponge Iron Units PLF for the period 2007-08.With this it will be evident that average PLF is 50.54% for 2006-07 (Based on 300 days) and average PLF is 54% for 2007-08 (Based on 300 days), hence the average PLF for WHRB can not be more than this in any condition. We had already considered the 66% PLF which is already higher by 10% from the average PLF which can be normally achieved in Sponge Iron Kiln based waste heat recovery power plant of this size. Hence the PLF variation used for sensitivity analysis can be treated as 10% higher than the normally achievable PLF, as already considered. The 5% variation in PLF is considered only in case of project activity by keeping the Baseline PLF for AFBC as constant at 95%. Therefore we feel that the sensitivity analysis done by increasing 5% percentage level over the already considered higher PLF for WHRB while comparing it with the same baseline PLF of 95% is quite conservative & appropriate.

<table>
<tr><td></td><td>Hence the sensitivity analysis done by us is appropriate and justifiable, hence validated by DOE.</td></tr>
<tr><td>3. Further clarification is required how the DOE has validated the emission factor, in particular, CO_2 emissions factor of coal used in captive power generation.</td><td>For emission factor calculations the following data’s are used:
<table>
<tr><td>1</td><td colspan="2">Manufacturers Specification for Power Plant</td><td></td></tr>
<tr><td></td><td>a.</td><td>Capacity of Turbine</td><td>10 MW</td></tr>
<tr><td></td><td>b.</td><td>Steam required for designed capacity</td><td>42930 Kgs/hr</td></tr>
<tr><td></td><td>c.</td><td>Steam required for each MWh</td><td>4293 Kgs</td></tr>
<tr><td>2.</td><td colspan="2">Enthalpy required for per MW generation is calculated based on Total capacity and total Enthalpy required.</td><td></td></tr>
<tr><td>3</td><td colspan="2">Enthalpy of Steam to be provided</td><td>3393.8 kj/KG</td></tr>
<tr><td></td><td>a.</td><td>Temperature of Steam</td><td>$490^{0}C$</td></tr>
<tr><td></td><td>b.</td><td>Pressure of steam</td><td>65 Kg/cm^2</td></tr>
<tr><td>4</td><td colspan="2">Afterwards we had calculated the enthalpy added for per MW Generation (in TJ) by multiplying the steam required per MW to Enthalpy of Steam provided.</td><td>0.014569583 TJ</td></tr>
<tr><td>5</td><td colspan="2">Heat equivalent to 1 MW power generation (IPCC value)</td><td>0.36</td></tr>
<tr><td>6</td><td colspan="2">Efficient of CPP was determined by using 100% boiler efficiency (as per methodology and conservative approach) and dividing the energy equivalent to 1 MW power generation by enthalpy added for 1 MW power by baseline turbine.</td><td>24.709011%</td></tr>
<tr><td>7</td><td colspan="2">Thereafter we had used the formulae provided by methodology which is
EF captive,y = EF CO2,I/Eff captive x 44/12 x 3.6/1000</td><td></td></tr>
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	Where EF_{CO2} = emission factor for fuel i.e. coal in captive power generation in t C/TJ to be conservative, hence we had used the IPCC value as conservative approach.	26.2 tC/TJ
	$Eff_{Captive}$ = Calculated value as per methodology using 100% boiler efficiency as per conservative approach was used to determined the same.	24.709011%
	Other figures are constant in formulae.	
	This formulae gives the result **1.399651312 but for the conservativeness we have used only 1.39 tCO_2/MWh.**	Result : 1.399651312 tCO_2/MWh **We had used :** **1.39 tCO_2/MWh**

The above clarification justify the CO_2 emission factor of captive power plant, which is worked out as per the methodology , while keeping a conservative approach by using the boiler efficiency as 100% and by adopting to IPCC values only and hence the basis of the above DOE had validated the same.

The above $EFCO_2$ calculations have been done as per the methodology by adopting the conservative approach, by keeping the boiler efficiency as 100%. Whereas in actual the boiler efficiency is designed at best with 84% efficiency. If we take the boiler efficiency at 84% as per

	the design specification of the manufacturer then the $EFCO_2$ will go even higher than estimated by us. However an argument can be raised that why the $EFCO_2$ for the similar capacity of 4.5 MW power plants for WHRB is found lower than this. The simple answer to this that if only 4.5 MW WHRB would have been setup as a standalone power plant then the efficiency of the boiler and turbine might have been yet lower than this. The efficiency of the boiler and turbine goes down with the decreasing capacity. Thus when compared with higher rating of turbine and boiler natural the efficiency of the lower rating of turbine and boiler will be lesser. Since the project activity is part of 10 MW CPP therefore the efficiency of the same may be lower than the other captive power projects of higher rating. We have calculated the $EFCO_2$ exactly in accordance to the approved methodology and by considering the IPCC value applicable for the purpose and by using the turbine manufacturers specification and by adopting a conservative approach by keeping the boiler efficiency 100%. Therefore request the Executive Board to kindly accept the calculations considered in PDD.