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Green House Gas reduction through Dry Washing of Coal – Exploring possibility

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ABSTRACT

This paper categorizes an ecofriendly approach of setting up new washery as per the directive of Ministry of Coal , Ministry of Environment, Forest & Climate change and further regulation by Central Pollution Control Board. Power plants located within a distance of 500-750 km, 750-1000 km shall be supplied with and shall use raw or blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis w.e.f. January 01, 2016. An attempt has been made for exploring the possibility of dry washery in Indian context. Washing of coal by dry based technology is a holistic way of dealing with water problem of entire region. It is strongly believed that installation & commissioning of washery at the pit head, dry washing of coal in particular would contribute to initiatives being taken to combat climate change. This study becomes very important in the light of the recently concluded climate change summit at Paris (COP 21). Setting up wet washing technology will reduce the Greenhouse gas (GHG) emission by 0.30 million tons per year and dry Washery will reduce it further by 3900 tons of GHG emission in CCL command area. It will provide community with a degree of water security as it seeks to address long-term climate adaptation risks from altered precipitation along with certain social benefits.

Key word : Coal, Dry-Washery, GHG, Carbon Footprint

1.0 INTRODUCTION

Indian coal has drift origin, resulted in intimate mixing of mineral matter with coal, giving rise to the ash content. Clean coal technology being practiced in coal washeries in India, as pre-combustion clean coal technology, mainly focus on cleaning of coal by removing ash from coal. Ash has several negative effects. It raises transportation costs per energy unit because the ash (which has no useful heating value) gets transported as part of the coal; it cuts power plant efficiency by hampering heat transmission; and it complicates plant operation and maintenance because of corrosion, fly and bottom ash removal, etc. Higher ash contents also lead to a greater variety of pollutants, while the lower coal-burning efficiency increases CO_2 emissions.

The practice of coal beneficiation in India is largely based on wet technology. Dry beneficiation is another suitable technological option. The cleaning of coal is mainly based on separation of the impurities by physicochemical methods based on the differences in the specific gravity of coal constituents and on the differences in surface properties of the coal and its mineral matter required. The wastes characteristics from coal preparation plant are highly dependent on the raw coal utilized and the final product. Washing of coal involves chemical process that separate dirt, vegetation and raw rock from coal. The process reduces the amount of ash and sulphur content of the coal, increases the heating value of the coal, improves air quality, improves transportation system. It further reduces amount of solid waste that has to be disposed of.
Ministry of Environment & Forests vide gazette notification No. GSR 560 (E) dtd. 19.09.1997, GSR 378 (E), dtd. 30.06.1998 and recent amendment G.S.R. 02 (E), dated January 02, 2014, has amended rules in respect of use of washed/blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis in Thermal Power Plants. ie. power plants located between 500-750, 750-1000 shall be supplied with and shall use raw or blended or beneficiated coal with ash content not exceeding thirty four percent on quarterly average basis w.e.f January 01, 2016 & 2015 respectively while power located beyond 1000 kms from pit head shall be supplied with and use raw or blended or beneficiated coal with ash content not exceeding thirty

four percent on quarterly average basis with immediate effect. MoEF &CC has further made follow up action vide letter no. F. No. L-11011 /2t/20t4-IA.I(T) dtd. 13.04.2015 has for Supply and use of coal with Ash Content not exceeding 34% or the Goal based Thermal Power Plants.

Thus need for using beneficiated coal further assumes importance for compliance to environmental requirement. Government of India through CIL encourages setting up washeries in India on BOO concept to be constructed on company's land.

2.0 Existing and Proposed Washery:

Table no. 1 shows different existing Washery and prosed washery. At present there are 46 existing washery in India of which 18 are coking coal and 28 are non-coking coal (Table no. 2).

Table 1 : Existing & Proposed Washery of Coal India Limited

	Existing	Capacity in MTY	Proposed	Capacity in MTY
BCCL	Dugda – I&II, Bhojudih, Patherdih Sudamdih Moonidih Mohuda Madhuband	12.63	Madhuband, Patherdih, Dahibari , Bhojudih, Patherdih-II, Dugda	18.60
CCL	Kathara, Sawang Rajrappa, Kedla, Piparwar, Kargali, Gidi	21.07	Ashok, Konar, Karo, Topa, Pundi	32.25
NCL	Bina	4.50		
WCL	Nandan	1.20		
MCL			Hingula, Basundhara, Lakhanpur, Jagannath	40.0
WCL			Kusmunda, Baroud	30.0
Total		39.4		120.85

Table 2 : Washery in India

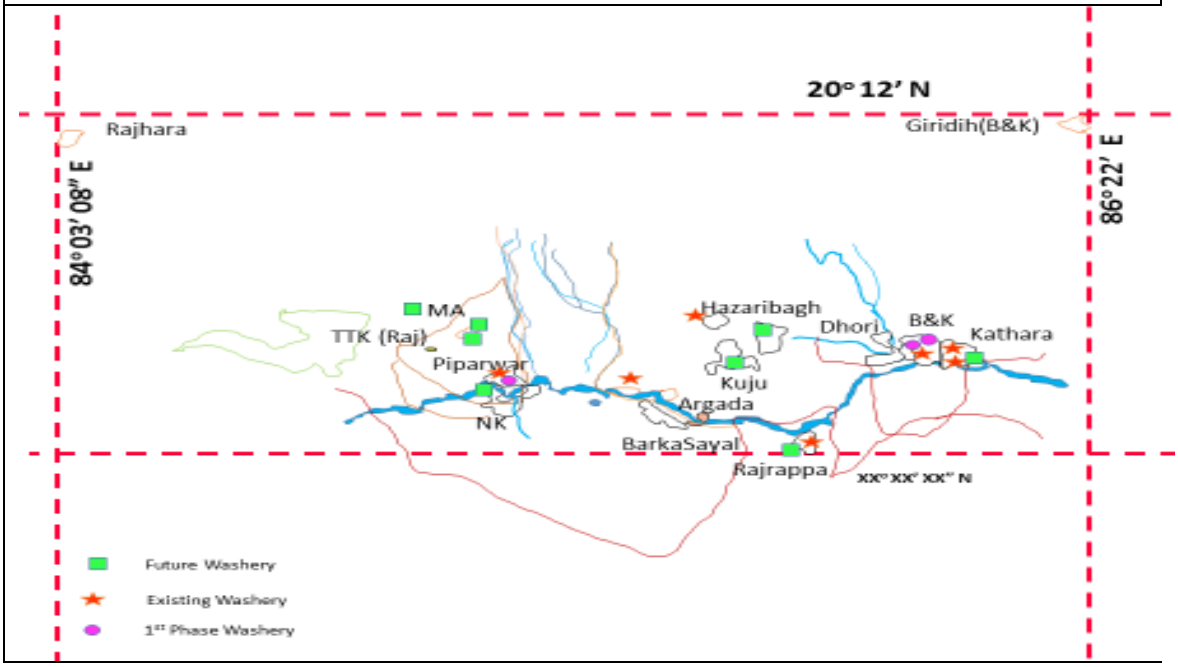
	Coking		Non Coking	
	No.	Cap in MTPA	No.	Cap in MTPA
CIL	11	15.68	7	20.20
Other PSU	3	4.85	0	0.00
Private	4	6.42	21	50.15
Total	18	30.95	28	70.35

Source : www.fossil.energy.gov

Amongst the above mentioned washeries Kathara washery (3.00 MTPA), Swang washery (0.75 MTPA), Rajrappa washery (3.00 MTPA), Kedla washery (2.60 MTPA), Kargali washery (2.72), all coking coal washery and Gidi Washery (2.5 MTPA), Piparwar Washery (6.5 MTPA), the two non-coking coal washery are situated in Central coalfields Limited. 3 more number of washery namely Ashok washery (10 MTPA), Karo washery (3.5 MTPA) & Konar washery (7 MTPA) are to be commissioned in 1st phase and are their advanced stage of

implementation. Apart from these nine more washeries are to be set up in the coming years at CCL. The location of different washeries have been shown in fig 1. The distribution of washeries are shown in fig 2.

Fig 1. : Location map of Washery at CCL



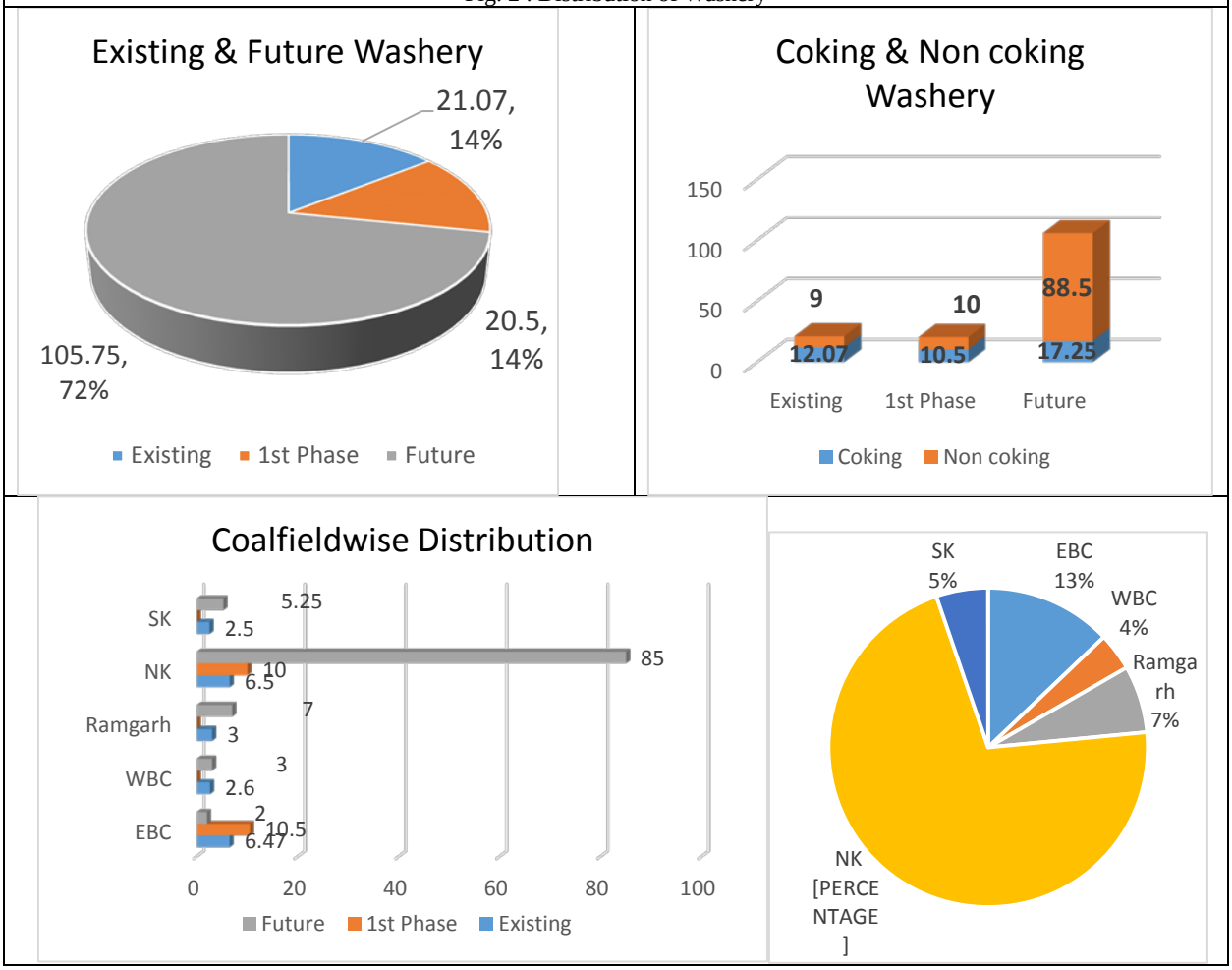
The list of washeries to be installed and constructed at CCL are shown in table 3.

Table 3 : List of future washeries at CCL

	Location	Area	Coalfield	Capacity in MTPA	Coking/non coking	Technology
FCW-1	Ramgarh	Kuju		5.25	C	Wet Washing
FCW-2	Hazaribagh	Hazaribagh	WBC	3.00	C	Wet Washing
FCW-3	Chatra	MA	NK	40.00	NC	Wet Washing
FCW-4	Chatra	MA	NK	25.00	NC	Wet Washing
FCW-5	Chatra	MA	NK	20.00	NC	Wet Washing
FCW-6	Hazaribagh	Argada	NK	2.00		Wet Washing
FCW-7	Ramgarh	Rajrappa	Ramgarh	7.00	C	Wet Washing
FCW-8	Bokaro	Kathara	EBC	3.00	C	Wet Washing
FCW-9	Chatra	Piparwar	NK	3.5	NC	Dry Washing

Note : BOM – Build, Operate & Maintain, BOO – Build, own & Operate ,
C- Coking, NC – Non coking
NK- North Karnpura Coalfields, EBC – East Bokaro Coalfields, WBC – West Bokaro Coalfields

Fig. 2 : Distribution of Washery



3.0 Water Consumption

Usually coal is cleaned using water. Billions of cum of water is used every year for cleaning coal in different washeries. The quantity of water used estimated at different existing washeries of CCL are shown in table 4. The water consumption estimates for existing, 1st phase and future washery are tabulated in table 5.

Table 4 : Water Consumption by existing Washery in 2015-16

	Washed Coal Production (15-16) in tes (Provisional)	Water consumption in thousand cum (@ 0.105 cum / ton) in 2015-16
ECW-1	139.3	14.6265
ECW-2	78.9	8.2845
ECW-3	734.2	77.091
ECW-4	368.2	38.661
ECW-5	150.4	15.792
ECW-6	177.1	18.5955
ECW-7	8477.4	890.127
Note : ECW – Existing coal washery		

Table 5 : Water Consumption by existing, 1st phase and future washery per annum		
	Capacity	Water consumption per annum
Existing Washery	21.07	2.21235
Washery in 1st Phase	20.5	2.1525
Future Washery	108.75	11.41875
Note : The Plant works on 90% washing efficiency		

It has been observed that a huge quantum of water is being used for washing of coal in wet washing technology. With water being an ever vital and precious resource, dry coal cleaning has drawn attention to all major coal producing units. Especially the state Jharkhand being situated on plateau, falls in water scarce region of the country. Dry coal washing will also reduce the GHG emission.

To cut down GHG emission and fulfill India's INDC (intended nationally determined contribution) commitment to reduce 2% of carbon emission as made in a recent Paris submit 2015. Washing whether wet or dry which comes under clean coal technology will certainly reduce the GHG emission. The degree of GHG emission is a subject of further research.

4.0 DRY COAL WASHING

Dry coal washing is an innovative and cost effective method of cleaning coal. This integrates the separation principle of an autogenous medium separator and a table concentrator. Coal particles are introduced onto vibrating deck and form a fluidized bed with the help of air provided by a blower. Density stratification is achieved in the material bed with high density particles (rock) forming the bottom layer and low density material (coal) as the top layer. Due to deck vibration and continuous influx of incoming new material, coal particles are therefore discharged along the front length of deck while high density refuse material moves upward and inward toward the discharge end of the deck where it is collected. Three product stream includes deshaled product, middlings and tailing streams are obtained through this process.

Fig 3 : Block sketch of washery

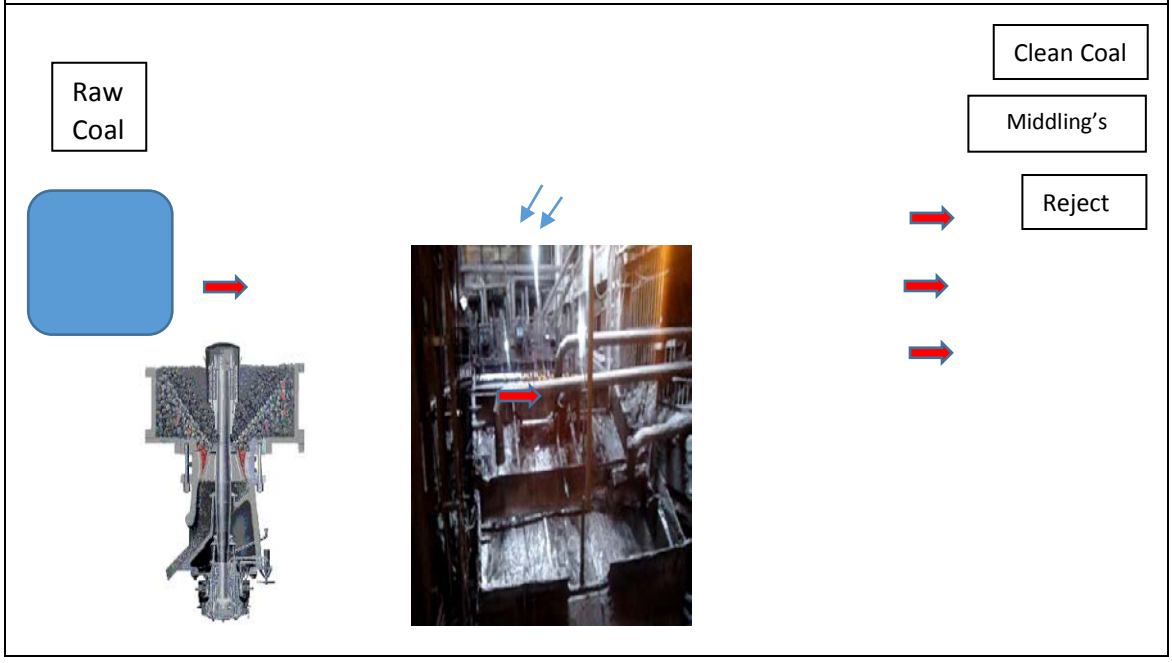
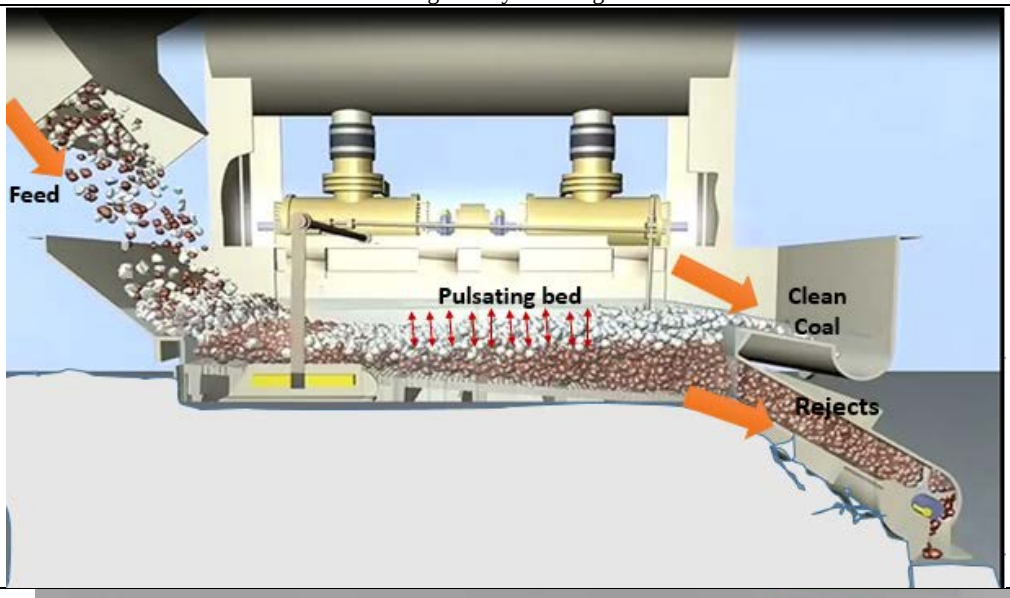
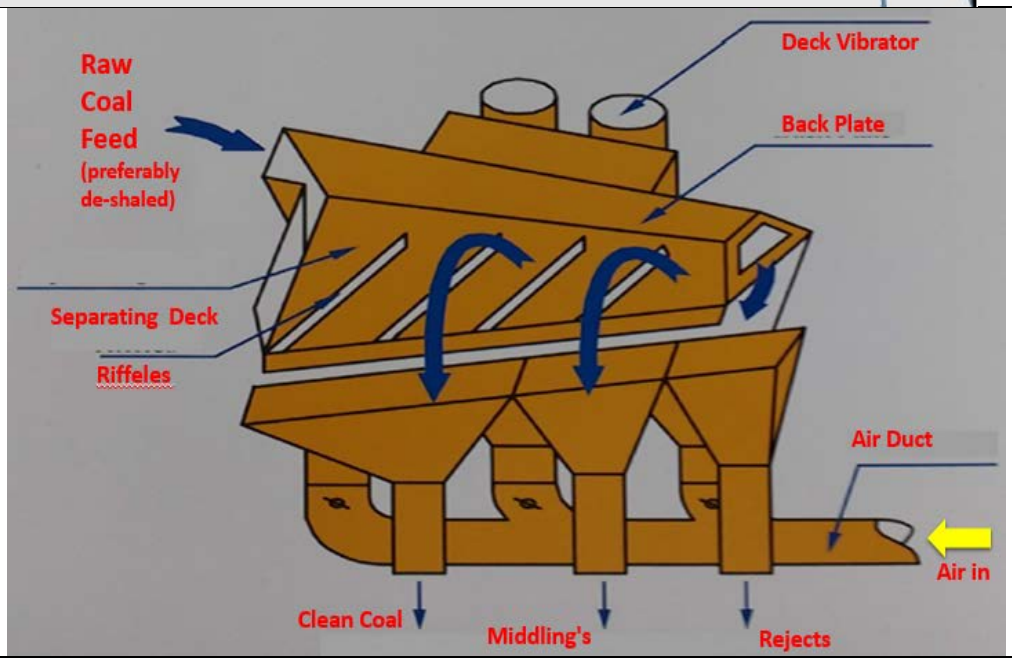


Fig 4 : Dry Washing





Applicability: It can be used at mine site – reducing transportation cost. As a completely dry process, the technology does not involve any use of water and water treatment process, which means saving the water costs. Another benefit is prep plant's productivity can be improved if de-shaled ROM coal is fed to the plant. Only drawback of this system is dust generation which has to be overcome by installation of suitable dust extraction mechanism. This will help the system environmentally ecofriendly. The deshaled coal used as feed will make the system more effective and productive.

Advantage of Dry Washing over Wet Washing

- No water – A complete dry process
- Less area
- Low cost
- Sharp separation (claims)

- Not yet proven in CCL
- High efficiency
- Environmental friendly
- Cost effective
- Low maintenance
- Large feed size range
- High capacity
- Low maintenance
- Reduced energy & investment cost
- Reliability
- Ease to operate.
- Produces comparatively clean product- lower moisture and high BTU
- Short installation and commission time.
- Near face deshaling for improved mining economics.
- Preparation of low rank coal
- Removal of pyratic sulphur coal.

5.0 GHG REDUCTION THROUGH INSTALLATION OF WASHERY

As per study made by Kumar, M. & Sangeeta (2015) , the installation of washery at pit head not only helps in reducing GHG emission at coal producing end but the process helps in reducing GHG emission at end users end. Beneficiation of Coal is a mode of implementing Clean Coal Technology CCT at Pre-combustion state. Ash content has a large impact on CO_{2e} emissions. This technology will mitigate the environmental impact of coal energy generation. Improved beneficiation will provide clean coal and is supposed to reduce GHG emission (reduction in burning of fossil fuel due to transportation, reduction in coal quantity and less water consumption for fly ash handling) and increase in power station efficiency. Low Ash means less land requirements for its disposal. Further, rejects produced as a result of washing will be well burnt where combustion takes place efficiently in fluidized bed again resulting in less emission of CO_{2e}. Assuming an ash reduction of 7 % for the upcoming washeries at the largest coal producing company of nation (table no. 6), there will be reduction of about 2900 ha of land for fly ash disposal at end users. There will be a reduction of water consumption in a tune of 131 million cubic meter at the end users not only saving the revenue but also reducing GHG emission in turn (table 7). It has been estimated that establishing a washery will help the end users of coal by reducing 287334 tons of GHG emission. Subsidiary wise contribution of reducing GHG emission has been tabulated in table 7.

Table 6 : Reduction of area for Fly ash disposal & Water consumption

	Reduction in Ash in MTY	Reduction in Land Requirement in ha (@258.75/million tes)	Reduction in water consumption for ash disposal (@11.69 million m^3/million tes flyash/ annum)
Subs-1	2.19	565.65	25.56
Subs-2	3.73	965.76	43.63
Subs-3	0.32	81.51	3.68
Subs-4	0.08	21.74	0.98
Subs-5	2.80	724.50	32.73
Subs-6	2.10	543.38	24.55
Total	11.22	2902.53	131.13
Assuming Ash reduction from 41% to 34%,			
Source : project funded by ADB by MONTAN Consulting GmBH in association with CMPDI in 2005			
Reduction in water consumption for ash disposal (@ (17.05-11.66 = 5.39)/(1.55-1.09=0.46))= 11.69 million m^3/million tes flyash/ annum)			

Table 7 : GHG Reduction due to installation of New Washery				
	Due Reduction in Ash	Due to Reduction in Land Requirement	Due to Reduction in water consumption for ash disposal	Total
Subs-1	9330.318	8795.196	29910.2	**48035.71**
Subs-2	15930.08	15013.08	51860.42	**82803.58**
Subs-3	1344.496	1266.288	0	**2610.784**
Subs-4	358.5983	337.218	0	**695.8163**
Subs-5	11950.53	11262.39	64323	**87535.92**
Subs-6	8962.977	8447.655	48242.25	**65652.88**
Total	47876.83	45121.83	194335.9	**287334.5**

If at all dry washeries are used at CCL, then there will be further reduction of GHG emission in tune of 3900 CO_{2e} [based on study made by Kumar M, & Sangeeta (2015)].

Table 8 : GHG emission from the future washeries at CCL		
	GHG reduction even due to wet washing in tons CO_{2e} per annum	GHG reduction due to dry washing tons CO_{2e} per annum
FCW-1	6890	189.6851
FCW-2	1550	108.3915
FCW-3	6610	1445.22
FCW-4	4780	903.2625
FCW-5	4998	722.61
FCW-6	4594	72.261
FCW-7	10450	252.9135
FCW-8	17460	108.3915
FCW-9	12865	126.4568
Total	**299988**	**3929.19**
Note : Conversion of wet existing washery to dry washery is combursome task and losss of revenue as such not taken under consideration while calculating reduction of GHG emission in dry washing		

At CIL level if all the proposed washeries in 1st phase are to made based on dry washing technology there will be a further reduction of 4366 tons of CO2e emission. (Table 9).

Table 9 : GHG emission reduction from the washeries to be installed in 1st phase at major coal producing company of India		
	Capacity in MTPA	GHG reduction tons co2e per annum
Subs-1	18.60	672.0273
Subs-2	32.25	1165.209
Subs-5	40.0	1445.22
Subs-6	30.0	1083.915
Total	120.85	4366.371

6.0 CONCLUSION

During the last decade dry coal processing has been growing exponentially due to continued technical improvements and increasing environmental concerns. Dry coal processing will help coal operators significantly improve operational efficiency , profitability and reduction in GHG emission as well.

7.0 ACKNOWLEDGEMENT

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