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CPSI wishes its members, industry leaders and energy professionals a safe, healthy, prosperous and fullfilling New Year 2021

Washing of coal is vital for introduction of clean coal technologies in India in tune with Hon'ble Prime Minister Shri Narendra Modi's exhortation towards ***Atamnirbhar Bharat*** *and* ***Atamnirbhar*** *coal industry.*

CPSI has dedicatedly been promoting washing of domestic COAL to reduce its ash content and enhance the heat value for its efficient combustion in power plant boilers with significantly lower emissions. CPSI's efforts are to enable India to reduce the GHG emission intensity of its GDP by 33-35% below 2005 levels by 2030 as committed at the Paris Climate Treaty.

Washing of thermal coal is vital for successful implementation of clean coal technologies.

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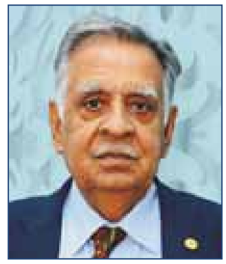
From the President



At the outset, on behalf of the entire CPSI family as well as on my own behalf, I wish a very happy, bright and fulfilling New Year 2021 to all energy professionals.

The year 2020 has been a very testing and tormenting period for humanity across the globe. The covid-19 pandemic started in February/March, spread like wildfire causing enormous damage both on health as well as economic front. Global cases of COVID-19 have exceeded 82 million with nearly two million loss of lives. Fortunately, with the successful development of a number of vaccines, 49 countries have already started vaccinating their population, albeit gradually. India has also started vaccination from 16th January. With the daily count having come down to below 14K, let us hope the pandemic wanes out completely in the coming months and the life becomes normal.

India's energy sector, both coal and power, has displayed its prowess by maintaining coal production and electricity generation fully meeting the demand of services which were working albeit at reduced capacity during the lockdowns. With the industrial production badly interrupted, the economy suffered a big blow. The lockdown period saw pseudo environmentalists rejoicing the 'Neela Aakash' due to lowering of air pollution levels in the big cities. The blue sky was the feature that appeared because most vehicles were off the roads, but coal-fired plants were still operating. Therefore, coal alone is not to be blamed for high levels of air pollution. This has led to the government pushing the introduction of EVs at an accelerated pace. Renewable energy projects also got shot in the arm.

While on one hand the government has been working on coal sector reforms, MoEFCC issued a notification on 21st may 2020, doing away with the use of washed coal with ash content < 34% by power plants located more than 500 KM from the coal supply sources. This was a retrograde step by the government. There has been heavy criticism of this notification from many renowned energy experts and various others who are in the know of the high ash content of Indian coal and the quality of coal supplied to the power plants in general.

In order to get the factual position about the benefits accruing to the thermal power plants by using washed coal, CPSI constituted an Expert Group comprising highly experienced and knowledgeable subject experts. The report of the Expert Group which explicitly brought out the benefits accruing to the power plants in quantified terms was submitted to the Hon'ble Prime Minister and other concerned ministries.

While, officially there has been no response to our submission to the Hon'ble Prime Minister, this seemingly has led to the PMO taking a call on the compelling factors that had led the MoEFCC to issue the subject notification. As per reliable sources, the government was given an impression that by a certain power company that by using washing coal, that generation cost electricity increases by 30 to 35 per Kwh. Unfortunately, the government, without consulting the experts and the stakeholders, issued the notification doing away the requirement of use of washed coal in power plants. As per latest information, the Ministry of Power (MoP) has directed the Central Electricity Authority (CEA) to undertake a 'field level analysis' of the impact of the decision of doing away with the requirement of use of washed coal by the power plants. The committee constituted by CEA to undertake the study is reported to have completed its task and submitted its report. Since the findings of the 'field level analysis' carried out by the committee are reported to be positively in favour of use of washed coal, as per reliable sources, the concerned ministries are probably looking for some alibi or face-saving textual excuses to back down from the stand taken and representations made to the MoEFCC that led to the issuance of the 21st May, 2020 notification.

Government has recently taken a very positive step and set up a 'Single Window' portal for expediting the process of various clearances for making the mines operational in the shortest possible time. As per NITI Aayog's projections, coal will continue as the dominant fuel in India contributing 65% to the total energy basket in 2035 and the share of coal fired electricity is projected to be 56% in 2030 and 42% in 2040. Therefore, for its responsible usage and sustainability, washing of coal is an imperative for India. In the overall economic interest Government must enforce washing of coal irrespective of distance from the supplying mines.

R K Sachdev

CPSI Journal welcomes readers' comments, letters to the editors, and articles on the topical issues. Interesting events, photographs and news are also welcome. Please post your comments at E-mail : cpsidelhi.india@gmail.com

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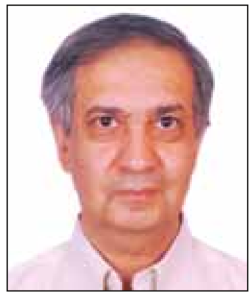
Chairman's Note

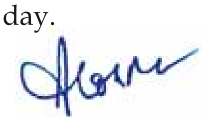


CPSI completed 20 years of existence last year. To commemorate this an International webinar was organized which was very well attended. The subject of the Webinar was: Coal to dominate India's Energy Mix: Preparing it for responsible usage is an imperative'. The webinar was inaugurated by former chairman of National Green Tribunal. The speakers were from various organizations who are involved in some way with the usage of coal either for power generation, metallurgical application or coal conversion to gas or liquid. The most noticeable feature of the deliberations was that without exception very one supported washing of coal indicating the several benefits use of uniform and better-quality coal can render. The Guest of Honour, Dr. V K Saraswat of Member of NITI Aayog also mentioned that use of washed coal is beneficial. It is a matter of concern that despite wide scale acceptance of the fact that washing of coal has many benefits from environment and economic angle the government without consultation with a large number of stakeholders decided to do away with mandatory washing of coal which was to move more than 500 Kms from the supplying mine. Even at this stage if a process of consultation with power producers who are using washed coal is done it is likely that most of them would support washing indicating a highly beneficial experience they have had with washed coal.

Following this anniversary webinar CPSI had another webinar on an equally important subject. This was related to quality issues and in particular to methods of sampling and analysis. The deliberations of this webinar clearly pointed out the vast deficiencies existing in the present systems deployed in our country. Even the standards are more than half a century old which is a matter of concern when scientific advancements take place so rapidly. The commitment to update the BIS standards is a welcome step. While the investments required for modernizing the coal handling methods which will enable proper sampling and testing is not beyond the reach of the coal companies but there is ample reluctance to lay emphasis on this is unfortunate. We understand that now there is a move to invest huge sums for this purpose. The problem lies in process and here the past experience in evaluating tenders etc. is unfortunately not encouraging.

In the anniversary webinar a reference was made to the International Energy Agency's proposed plan to achieve zero emissions by 2070. Many countries are working out on how this goal can be achieved. Every country is expected to create a vision in which the method for achieving zero emissions will be attained. This vision would then have to be converted into plans which would include extensive research and development efforts. It may also require some estimation of fund requirement. India is yet to initiate work on this matter. China, we believe has declared that they would reach this goal by 2060. This exercise would set the prospects of the coal mining industry and therefore the earlier it is done the better it would be. It is quite clear that traditional coal usage is going to decline and the future is uncertain.

The government's initiative to introduce commercial mining was a welcome step but the response being weak is also understandable from the coal miners prospective. While one accepts the fact that at present the requirement of coal for power generation is going to increase but the growth rate would be much lower than that witnessed in the last decade. The government's attempt to ensure that mines acquired for commercial mining do not in practice become captive mines is not likely to be successful as is evident from the first round of auctions. We feel that while this initiative is laudable it is perhaps too late in the day.



Alok Perti, IAS (Retd.)

Dry Beneficiation of High Ash Indian Thermal Coals Using Air Fluidized Vibrating Deck Separator

– Durga Prasad G*, P R Varma**
& K K Mishra***

Abstract

In India, the current practice of coal processing is by wet method, which calls for huge infrastructure and maintenance cost, requirement of process water and media. Now, a day's water is a scarce commodity in many regions. NML and CMPDI has taken initiative to explore development in the field of dry beneficiation for thermal coal using Air Fluidized Vibrating Deck Separator (AFVDS). Non-coking coal samples from the Hingula mine of Talcher coalfield and Lakhanpur mine of Ib valley coalfields of MCL has been identified for testing purposes. The separation performance of AFVDS for coarse size fraction (-50+6mm) of Hingula coal is much higher compared to Lakhanpur coal. The Error Probable (Ep) value of AFVDS for Hingula coal is 0.14 and that of Lakhanpur coal is 0.28 because of poor washability characteristics and higher amount of a Near Gravity Material present in the Lakhanpur coal.

Keywords : *Dry Beneficiation, High ash non-coking coals, AFVDS, Near Gravity Material.*

1.0 Introduction

Coal is the predominant source of energy in India. About 72% of energy is produced from coal. There has been an increasing demand for non-coking coal for the power sector leading to the mining of higher tonnage of coal. Indian coal deposits are generally of high ash content varying from 36-50% and they have poor washability characteristics. However, most of the coals supplied for power generation are raw coals containing 40-42% ash thereby causing low thermal efficiencies, high operating and maintenance costs, erosion problems, difficulty in pulverization and an excessive amount of fly ash generation with a large amount of unburnt carbon. High ash non-coking coals need to be beneficiated through deshaling to reduce 5-6% ash for the supply of consistent quality to the consumers.

Conventionally, wet beneficiation is carried out to reduce the ash content in coals to meet the requirement of ash as per customer. The wet beneficiation process adds surface moisture to the washed coal requiring dewatering systems and leads to the generation of slime water which causes environmental pollution. Water is a scarce commodity and is not available in many regions. Dry beneficiation has several advantages over wet beneficiation of coal like prevention of coal slime water as no water is used in the process. Dry coal separators are compact which requires a small floor area compared to the wet processing equipment. Keeping in view the benefits of dry beneficiation of coal, a joint work by the National Metallurgical Laboratory (NML), Jamshedpur and CMPDI, Ranchi has been carried out through dry beneficiation using Air Fluidized Vibrating Deck Separator.

2.0 Coal Sampling and its Characterization

Two RoM coal samples from Talcher and Ib valley coalfield of Mahanadi Coalfields Limited (MCL),one coal sample from Seams VIII and IX of Hingula mine, Talcher coalfield and another coal sample from Seam V of Lakhanpur mine of Ib valley coalfield were collected by channel sampling. The proximate, ultimate, petrography, Gross Calorific Value (GCV) of Hingula and Lakhanpur coal sample is mentioned in Table 1 and that of screen & washability analysis is mentioned in Table 2 :

*Manager (Coal Preparation), CMPDI, Ranchi.
**General Manager (Coal & Mineral Preparation), CMPDI, Ranchi.
***Director (T/ES), CMPDI, Ranchi.

Table 1: Proximate, Ultimate & Petrographic Analysis

Analysis	Parameter (%)	Hingula coal	Lakhanpur coal
Proximate	Ash	40.91	44.25
	Moisture	3.57	1.65
	Volatile Matter	16.30	30.66
	Fixed carbon	39.22	23.44
Ultimate	Carbon	45.15	39.22
	Hydrogen	3.29	2.98
	Nitrogen	1.09	0.99
	Sulphur	0.51	0.52
Petrography	Vitrinite	26.13	34.03
	Inertinite	17.97	19.11
	Liptinite	8.11	-
	Mineral matter	47.79	46.86
	Random Reflectance of vitrinite	0.62	0.42
Calorific value	GCV, Kcal/kg	3620	3363

Table 2 : Screen and Washability Analysis

	Size fraction	Wt%	Ash%
Hingula Coal	-50+6mm	89.1	42.09
	-6mm	10.9	31.11
	Total	**100.0**	**40.90**
Washability	Cleans (-50+6mm)	73.0	34.0
	Rejects (-50+6mm)	16.1	78.8
	natural -6mm	10.9	31.11
	Total	**100.0**	**40.90**
Lakhanpur Coal	-50+6mm	78.5	45.89
	-6mm	21.5	39.52
	Total	**100.0**	**44.52**
Washability	Cleans (-50+6mm)	45.53	34.0
	Rejects (-50+6mm)	32.97	62.31
	natural -6mm	21.5	39.52
	Total	**100.0**	**44.52**
Lakhanpur Coal	-50+3mm	82.3	45.55
	-3mm	17.7	39.69
	Total	**100.0**	**44.52**
Washability	Cleans (-50+3mm)	49.38	34.0
	Rejects (-50+3mm)	32.92	62.9
	natural -3mm	17.7	39.69
	Total	**100.0**	**44.52**

3.0 Experimental Setup

The experimental setup consists of a hopper for raw coal storage, air compressor/blowerfor the supply of air at the bottom of the panel, motor for panel vibration, perforated panel assembly, product chutes (3 nos) for discharge, cyclone and bag filter for fines collection, control panel, etc. The experimental setup is shown in Figure-1 having the capacity to handle the coal up to 10 tonnes/hour.

Figure 1 : Air Fluidized Vibrating Deck Separator setup

4.0 Experimental Procedure

Hingula Coal : The received coal sample was crushed to -50mm. The detailed washability studies were carried out for the size fraction -50-6mm. The -50+6mm fraction in crushed coal is 89.1% with 42.09% ash and the -6mm fines is 10.9% with 31.11% ash. From the washability study of -50+6mm coal sample, it was found that the theoretical yield is 82% which is 73% w.r.t feed at 34% ash level.

The dry beneficiation of -50+6mm was carried out using Air Fluidized Vibrating Deck Separator (AFVDS) under different operating conditions such as longitudinal angle, transverse angle of vibrating deck separator, airflow rate, feed rate, deck frequency.

Lakhanpur Coal : The received coal sample was crushed to -50mm and the two feed samples were prepared by screening at -6mm and -3mm aperture. The ash content of -50+6mm and -50+3mm is around 45.89% and 45.55% ash respectively. The washability studies of -50+6mm and -50+3mm were carried out and it was found that theoretical yield at 34% ash level for -50+6mm and -50+3mm is 58% and 60% respectively. The near gravity material (NGM) between the density range of 1.6 to 1.9 gm/cc is about 28% which indicates that coal is very difficult to beneficiate.

The dry beneficiation of -50+6mm and -50+3mm was carried out separately using AFVDS under different operating conditions such as longitudinal angle, transverse angle of vibrating deck separator, air flow rate, feed rate, deck frequency.

5.0 Results and Discussions

Hingula Coal : The pilot-scale campaigns (3 nos) were conducted for Hingula coal of size fraction -50+6mm using Air Fluidized Vibrating Deck Separator (AFVDS) at optimum operating conditions to validate the results. The results are mentioned in Table 3 below:

Table 3 : Results of dry processing of Hingula Coal

Feed Size (-50mm)	Products	Wt% (w.r.o)	Ash%	Recovery of combustible, %	Organic efficiency, %
-50+6mm (AFVDS)	Clean	66.4	33.88	75.3	90.96
	Reject	22.7	69.23	12.0	
-6mm (direct product)	-6mm	10.9	31.11	12.7	
	Total	**100.0**	**41.60**	**100.0**	

The dry beneficiation of coarse coal (-50+6mm) using AFVDS yields clean coal of 66.4% (with respect to original feed) with 33.88% ash and recovery of combustible is 75.3%. The study was also conducted to determine the effect of moisture content in coal on the dry beneficiation process. The experiments were conducted at varying moisture levels and it was found that 10-11% moisture is acceptable with the increased air flow rate. The -6mm fraction, which is 10.9% by weight with 31.11% ash content is directly mixed with the final product. The weight of the final product becomes 77.3% with 33.49% ash and 88.0% recovery of combustible. The organic efficiency of dry processing of coal is 90.96%. Error probable (Ep) of dry beneficiation of coarse coal was found to be 0.14 at a density of 1.77 gm/cc.

Techno-economic feasibility study was conducted for 100 tph demonstration plant based on the above dry process using AFVDS for the development of technology in dry beneficiation of non-coking coal. The estimated capital investment is Rs. 35.10 Crores and operating cost per tonne of raw coal input works out as Rs. 197.57. The techno economics indicates that the payback period of the 100 tph plant is 1 year 4 months.

Lakhanpur Coal : The pilot-scale campaigns (3 nos) were conducted for Lakhanpur coal of size fraction -50+6mm and -50+3mm using Air Fluidized Vibrating Deck Separator (AFVDS) at optimum operating conditions to validate the results. The results are mentioned in Table 4 & 5 below:

Table 4 : Results of Dry processing of Lakhanpur Coal (-50+6mm)

Feed Size (-50mm)	Products	Wt% (w.r.o)	Ash%	Recovery of combustible, %	Organic efficiency, %
-50+6mm (AFVDS)	Clean	24.8	30.38	31.1	72.8
	Reject	53.7	52.96	45.5	
-6mm (direct product)	-6mm	21.5	39.51	23.4	
	Total	**100.0**	**44.47**	**100.0**	

The dry beneficiation of coarse coal (-50+6mm) using AFVDS yields the clean coal of 24.8% (with respect to original feed) with 30.38% ash and recovery of combustible is 31.1%. The -6mm fraction, which is 21.5% by weight with 39.51% ash content is directly mixed with the final product. The weight of the final product becomes 46.3% with 34.62% ash and 54.5% recovery of combustible. The weight of the reject is 53.7% with 52.96% ash and 45.5% recovery of combustible. The organic efficiency of dry processing of coal is 72.8%.

Table 5 : Results of Dry processing of Lakhanpur Coal (-50+3mm)

Feed Size (-50mm)	Products	Wt% (w.r.o)	Ash%	Recovery of combustible, %	Organic efficiency, %
-50+3mm (AFVDS)	Clean	39.9	34.6	46.9	80.8
	Reject	42.4	55.47	33.9	
-3mm (direct product)	-3mm	17.7	39.17	19.2	
	Total	**100.0**	**44.26**	**100.0**	

The dry beneficiation of coarse coal (-50+3mm) using AFVDS yields clean coal of 39.9% (with respect to original feed) with 34.6% ash and recovery of combustible is 46.9%. The -3mm fraction, which is 17.7% by weight with 39.17% ash content is directly mixed with the final product. The weight of the final product becomes 57.6% with 36.0% ash and 66.1% recovery of combustible. The weight of the reject is 42.4% with 55.47% ash and 33.9% recovery of combustible. The organic efficiency of dry processing of coal is 80.8%.

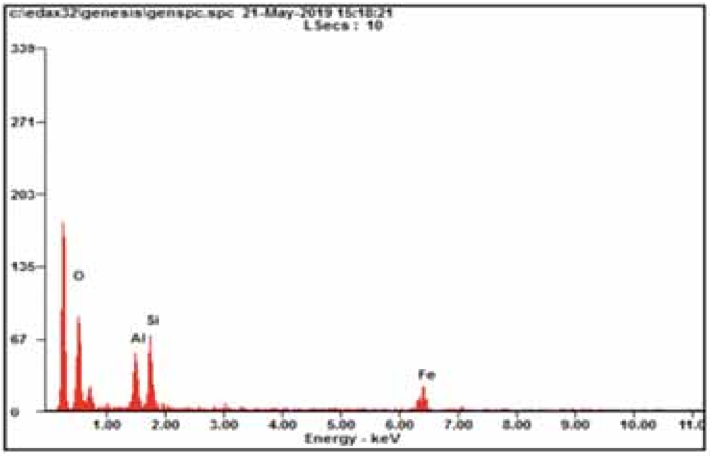
Error probable (Ep) of dry beneficiation of Lakhanpur coarse coal was found to be 0.28 at a separation density of 1.7 gm/cc. The study was also conducted on the effect of moisture content on dry beneficiation process. The experiments were conducted to increase moisture levels up to 12% moisture. The effect of surface moisture on dry processing was marginal up to 6.5%. The airflow used for fluidization of the bed material on the separating deck helps to dry the surface moisture of the feed sample exposed for separation. However, at higher moisture levels (after 6.5%), the same airflow does not respond effectively. The bed material could not get fluidized and stops the material flow on the deck. As a result, the yield of the lighter fraction increases and the reject yield decreases.

The reason for getting low ash (55.47%) in the reject stream was explored by Scanning Electron Microscopy (SEM) study for elemental analysis and shown in Fig 2. It was found that a lot of heavy minerals present in the coal matrix increases the actual density of the coal particles and thus increases the near gravity material (NGM). High NGM increases the misplacement between the product and reject. This causes difficulty washing in Lakhanpur coal using AFVDS. Dry processing of this type of coal by air fluidization technique, which primarily depends on the differential settling velocity of the particles associated with the particle density, gets affected due to the heavy minerals with high carbon values present in small quantity. Thus, coal particles even having high combustibles tend to report the reject stream and reduce the efficiency of the process.

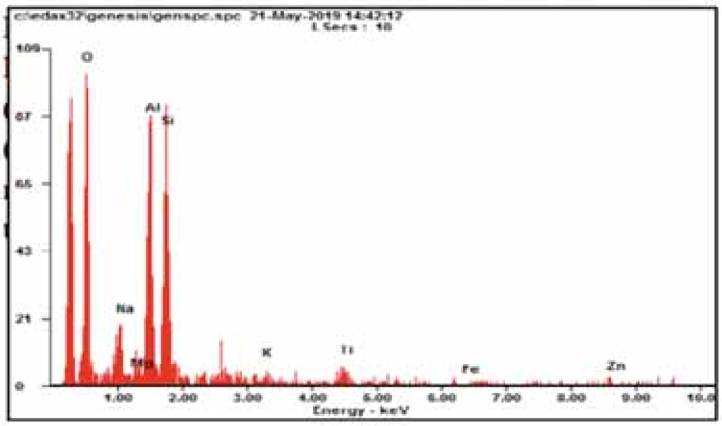
Due to poor washability characteristics and low thermal efficiency of the process, techno-economic feasibility study was not carried out for Lakhanpur coal.

6.0 Comparative Study of Hingula and Lakhanpur Coal Samples

The washing characteristics of two coal samples are shown in Fig 3. The figure shows that NGM of Hingula coal gradually decreases as the density of the separation increases. However, NGM was found to be very high for Lakhanpur coal.



Element	Wt %	At %
O K	31.66	51.16
AlK	16.06	15.38
SiK	20.21	18.60
FeK	32.08	14.85



Element	Wt %	At %
O K	39.99	53.63
NaK	06.56	06.12
MgK	01.04	00.92
AlK	21.48	17.08
SiK	26.37	20.14
K K	00.57	00.31
TiK	03.99	01.79

Fig 2 : SEM secondary electron image of Lakhanpur coal showing the presence of rutile (TiO_2) ans plagioclase feldspar ($NaAlSi_3O_8$) minerals in the coals sample. The representative wt% of each element has been shown in the corresponding table.

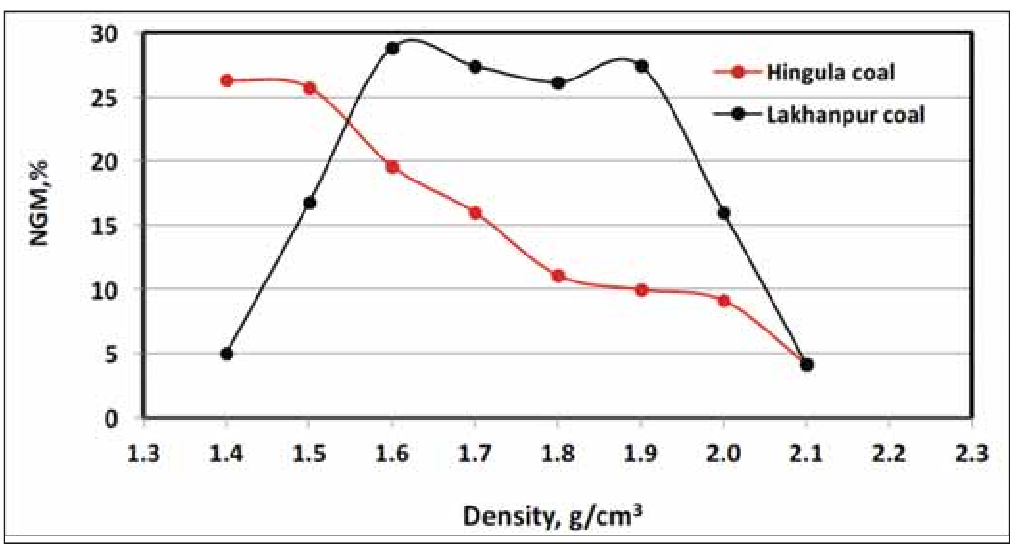


Fig 3 : Near Gravity Material of Hingula and Lakhanpur coal samples

The coal characteristics and response to the dry processing of Hingula and Lakhanpur coal samples are summarized in Table 2.

Table 2 : Summarized results of Hingula and Lakhanpur coal samples

	Size fraction	Clean		Reject		CR, %		OE, %	Ep
		Wt%	Ash%	Wt%	Ash%	Clean	Reject		
Hingula Coal	AFVDS (-50+ 6mm)	66.4	33.88	22.7	69.23	88.0	12.0	91.0	0.14
	-6mm	10.9	31.11	-	-				
	Total	77.3	33.50	22.7	69.23				
Lakhanpur Coal	AFVDS (-50+ 6mm)	24.8	30.38	53.7	52.96	54.4	45.5	72.8	0.28
	-6mm	21.5	39.51	-	-				
	Total	46.3	34.61	53.7	52.96				
Lakhanpur Coal	AFVDS (-50+ 3mm)	39.9	34.6	42.4	55.47	66.1	33.9	80.8	0.28
	-3mm	17.7	39.17	-	-				
	Total	57.6	36.0	42.4	55.47				

CR: Combustible Recovery; **OE:** Organic Efficiency; **Ep:** Error Probable

7.0 Conclusion

Dry beneficiation of coal using AFVDS is more effective in the case of Hingula coal than Lakhanpur coal. After beneficiation with AFVDS for size fraction of -50+6mm, the Hingula coal yields 66.4% weight clean coal with 33.88% ash and that of reject with 69.23% ash but the Lakhanpur coal yields only 24.8% weight clean coal with 30.35% ash and that of reject with 52.96% ash which is very low. The yield of clean coal for Lakhanpur coal is very low as high NGM leads to misplacement of clean coal in the rejects resulting in an increase in the yield of reject and also decrease in reject ash. The organic efficiency of AFVBS for Hingula coal is 91% which is much higher compared that for Lakhanpur coal which is 72.8%.

Lakhanpur coal was also treated for the size fraction -50+3mm with AFVDS which yields 39.9% weight clean coal with 34.6% ash and that of reject with 55.47% ash which is low. The misplacement of clean coal with rejects has been observed due to high Near Gravity Material.

AFVDS is much more effective for Hingula coal compared to Lakhanpur coal. The Error probable (Ep) for Hingula and Lakhanpur coal is found to be 0.14 and 0.28 respectively.

8.0 Acknowledgement

CMPDI expresses their sincere thanks to Coal India, Kolkata for sponsoring the collaborative R&D project on "Dry Beneficiation of high ash Indian Thermal coal". CMPDI is thankful to NML, Jamshedpur for the development of dry beneficiation technology for the treatment of non-coking coal. CMPDI is also thankful to MCL, Sambalpur for providing raw coal and other facilities for this project.

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Throwaway Coal Washery Rejects in terms of Calorific Value and its Utilisation/Disposal

— Shekhar Saran*, Sunil Kumar Jayswal, Abha Prasad*****
Vinod Kumar Pandey# & Pushp Raj Varma##

Abstract

Rejects are by-product of washing the Run-of-Mine (RoM) coal and have Gross Calorific Value (GCV) less than the GCV value of lowest grade of non-coking coal determined from time-to-time (currently the GCV value of lowest grade of non-coking coal is 2200 kcal/kg). Normally in Indian context, coking coal washeries are three product washeries producing clean coal, middlings and rejects whereas in non-coking coal washeries there are two products viz. washed (power grade) coal and rejects. Rejects generated from existing coal washeries have been stocked in areas adjacent to washeries over the years. Some of the rejects have been sold through various modes to consumers interested in its utilization while rest have remained unused/unsold creating issues concerning land and environmental degradation. Thus, reject disposal is an area of concern.

All rejects have certain market value depending on GCV and end use. Rejects having GCV of 1500 kcal/kg and above may be used in Fluidised Bed Combustion (FBC)/Circulating FBC (CFBC) based power plants whereas rejects of GCV less than 1500 kcal/kg (i.e. low GCV rejects) may be used as replacement of construction material for highways, railways, dams, embankments, reclamation of land, brick making etc.

Rejects should be stocked on surface in an environmentally sustainable manner until they are sold/utilized for consumption in FBC/CFBC power plants or as construction material. However, low GCV rejects may be dumped in mine voids/low lying areas, if it is difficult to stock the same on surface and use as construction material. Such low GCV rejects which are to be dumped in mine voids or low-lying areas may be termed as 'Throwaway Rejects'. Standard Operating Procedure (SOP) for stocking of rejects on surface or dumping in mine voids/low lying areas as the case may be, and any other statutory/ regulatory guidelines in this regard should be followed. An appropriate body may be authorized, with due approval of the Government, for development of a system for monitoring the functioning of all washeries with special emphasis on utilization/disposal of rejects generated from washeries.

Keywords : *Rejects, Throwaway, FBC/CFBC, Coal Washery Rejects.*

1. Background

Coal washing or beneficiation is a process of mechanical separation of impurities (ash) from coal, making it suitable for particular use. Normally in Indian context, coking coal washeries are three product washeries producing clean coal, middlings and rejects whereas in non-coking coal washeries there are two products viz. washed (power grade) coal and rejects. Rejects have high ash content with low calorific value. Thus, rejects are by-product of washing the Run-of-Mine (RoM) coal and have Gross Calorific Value (GCV) less than the GCV value of lowest grade of non-coking coal determined from time-to-time (currently the GCV value of lowest grade of non-coking coal is 2200 kcal/kg).

Rejects generated from existing coal washeries have been stocked in areas adjacent to washeries over the years. Some of the rejects have been sold through various modes to consumers interested in its utilization while rest have remained unused/unsold.

*Chairman-cum-Managing Director, CMPDI, Ranchi, India.
**Advisor, CMPDI, Ranchi, India.
***Chief Manager, CMPDI, Ranchi, India.
#Chief Manager, CMPDI, Ranchi, India.
##Dy.General Manager, CMPDI, Ranchi, India

As the rejects contain certain percentage of carbon and heat value, dump rejects cause environmental concern as they degrade and pollute the soil and groundwater. Also, reject stockpiles contain inherent risk of spontaneous heating due to oxidation.

Disposal of rejects generated from both coking and non-coking coal washeries in public & private sector is done by companies itself and are either utilized in FBC based power plants or sold to consumers through road sale/spot e-auction which adds to their revenue. In coking coal washeries, less quantity of rejects, generally having higher GCV as compared to rejects from non-coking coal washeries, are generated which are sold in market and so disposal of such rejects are taken care of by the owners/occupiers. However, in case of non-coking coal washeries, disposal of rejects is an area of concern as these rejects have lower GCV.

2. Data/information w.r.t. utilisation vis-à-vis GCV of washery rejects in various organisations

Data/information w.r.t. utilization vis-à-vis GCV of washery rejects from various organisations are as follows:

- CIL had set up 5 nos. FBC based Captive Power Plants (CPP) for gainful utilisation of rejects from its existing coal washeries. These CPPs were designed to handle coal washery rejects with minimum GCV of 1500 kcal/kg.
- M/s Thyssenkrupp utilizes washery rejects having ash of 58-60% and GCV of 2500 kcal/kg in its CFBC boilers. They have also been using coal washery rejects having GCV of 1800 kcal/kg in their 2 nos. 100 MW CFBC based power plants. However, their CFBC boilers can easily handle washery rejects having minimum GCV of 1500 kcal/kg with minor modifications.
- M/s BHEL have stated that minimum GCV of rejects that may be used in FBC based power plants is 1550 kcal/kg. They may offer CFBC boilers of capacity ranging from 30 MW to 125 MW.
- M/s Thermax stated that minimum GCV of Indian Coal Washery Rejects that is being fired in Thermax's FBC boilers for power generation for sustainable combustion is 1800 kcal/kg.
- M/s Singareni Collieries Company Limited (SCCL) is operating three non-coking coal washeries having annual throughput capacity of 1.0 Mt each and the yield of rejects is varying from 40% to 60%. The GCV of the washery rejects generated from these washeries is ranging from 1000 kcal/kg to 2000 kcal/kg. SCCL is not having any power plant based on FBC/Integrated Gasification Combined Cycle (IGCC) technology where coal washery rejects can be used. Hence, rejects are being sold to customers who are blending it with high GCV coal for use in FBC boilers.
- M/s Tata Steel is using coking coal washery rejects having minimum GCV of 2200 kcal/kg partly in their FBC boilers for power generation and the rest are being sold to end users.
- M/s Monnet Ispat & Energy Limited (MIEL), at present has two non-coking coal washeries viz.at Angul (Odisha) and Raigarh (Chattisgarh). MIEL has also constructed Patherdih Coking Coal Washery (5.0 Mty) of BCCL on Build-Operate & Maintain (BOM) basis. The rejects of this washery are sold through e-auction by BCCL.
- M/s Monnet Daniels Coal Washeries Ltd. (MDCWL) is operating a non-coking coal washery at KDHesalong, Dakra in Central Coalfields Limited (CCL) command area for Punjab State Power Corporation Ltd. (PSPCL). The rejects having ash content of 60-65% and GCV less than 2200 kcal/kg are being transported by Rail for use in FBC boiler power plants.
- M/s ACB's non-coking coal washery rejects are in the range of 1500 kcal/kg to 2200 kcal/kg. FBC/CFBC boilers are designed to use fuel having GCV in the range of 2400 to 3000 kcal/kg. They either blend the Coal Washery Rejects (CWR) with e-auction coal or they reprocess the CWR in jigs to extract reprocessed rejects which have higher GCV of around 2500-2600 kcal/kg.

- M/s Valmet has carried out laboratory and pilot scale tests in Finland using Indian CWR with a heating value of around 1100 kcal/kg. The tests were successful to establish the combustibility of such low-grade fuel with no support fuel. However, Valmet do not have any CFBC power plant using Indian CWR under commercial operation yet.
- M/s ISGEC, Foster Wheeler, USA stated that their CFBC boilers can handle Indian coal washery rejects having ash as high as 76% which works out to around 1000-1100 kcal/kg considering moisture of 2-3%.

Summary for minimum GCV of rejects that can be used in FBC power plants, as obtained from different organisations is given in Table 1.

Table 1 : Summary for minimum GCV of rejects for use in FBC power plants

Sl. No.	Particulars	Minimum GCV of rejects for use in FBC power plants (kcal/kg)	Remarks
1	FBC power plants in CIL	1500	Designed
2	Thyssenkrupp	1500	With minor modification
3	BHEL	1550	Designed
4	Thermax	1800	Designed
5	Tata Steel	2200	Operative
6	Valmet, Finland	1100	Pilot plant
7	ISGEC, USA	1000-1100	About 76% ash

Thus, with the present available technology in India, the minimum GCV of rejects that can be used as firing fuel in FBC/CFBC boilers is 1500 kcal/kg. Thus, rejects having GCV 1500 kcal/kg and above may be used in FBC/CFBC based power plants. Rejects of GCV less than 1500 kcal/kg i.e. low GCV rejects may be used as replacement of construction material for highways, railways, dams, embankments, reclamation of land, brick making etc. Globally also, coal washery reject is being used as a replacement of construction material.

Moreover, CSIR-CIMFR, Dhanbad is also working on a national project on utilization of coal washery rejects and effluents from Bharat Coking Coal Ltd. (BCCL) alongwith biomass for generation of cooking gas for the villagers in Gourigram Chandankiyari. A portable gasifier based on the above technology has been designed and fabricated. The technology was demonstrated to village people during their visit to CIMFR.

Further, with advancement of technology in future, rejects having GCV less than 1500 kcal/kg also might be used for power generation through FBC/CFBC boilers and owner/occupier may take appropriate decision in this regard.

All rejects have certain market value depending on GCV and end use. Hence, all the rejects generated from washeries is to be stored, preferably near to washery premises, till it is sold/used for FBC/CFBC based power plants or as construction material. However, if it is difficult to comply with the above recommendation of storage on surface and using the same, the owner/occupier may take a suitable view regarding dumping of low GCV rejects (i.e. rejects having GCV less than 1500 kcal/kg which cannot be used in FBC/CFBC power plants or as construction material) in mine voids/low lying areas in case of specific circumstances. Such rejects which are to be dumped in mine voids/low lying areas shall be termed as 'Throwaway Rejects'.

3. Global norms/practices of disposal of coal washery rejects

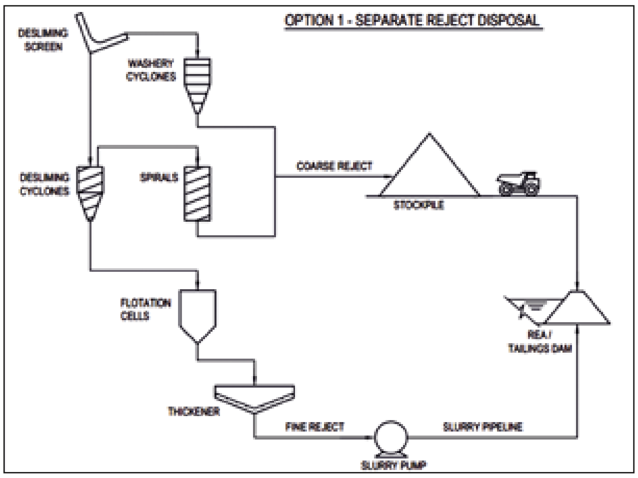
The global norms/practices of disposal of coal washery rejects in some of the countries are as follows:

i) Australia

The different options practiced in Australia for reject management are as follows:

a) *Option 1 :* Separate placement of coarse and fine rejects at the Reject Emplacement Area (REA), with a dam constructed from coarse reject and the fine tailings pumped as a slurry.

This option is the least favourable from an environmental perspective although it is likely to be the most cost-effective method when considering both capital and operational expenditure. Safety concerns are also an issue with this option, particularly with regard to closure of the Tailings Storage Facility (TSF). The closure position would likely include capping of the tailings to prevent future oxidation and potential for Acid & Metalliferous Drainage (AMD); however the low shear strength of the tailings may prove unsafe for earth moving equipment used for capping and rehabilitation purposes. Flow scheme for reject management for Option 1 is given hereafter.



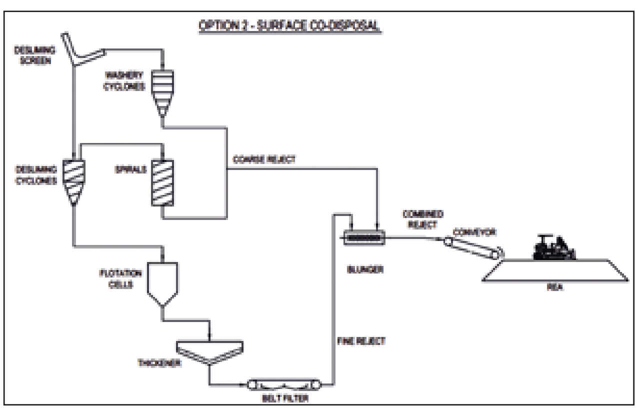
b) *Option 2 :* Dewatering the fine reject, mixing the coarse and fine reject streams at the Coal Preparation Plant and co-disposing of the combined rejects as a "dry stack" at Reject Emplacement Area.

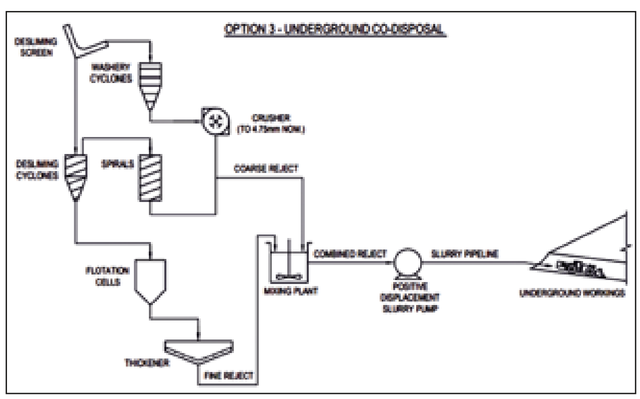
This option offers benefits over Option 1 such as improved efficiency of water usage, reduced risk of AMD and other water quality impacts, and reduced post-closure risks. Thus, it is considered to be comparatively favourable from an environmental perspective, provided any potential for AMD is appropriately mitigated. The landform should prove relatively straightforward to rehabilitate. Flow scheme for reject management for Option 2 is given hereafter:

c) *Option 3 :* Co-disposal of the combined coarse and fine reject streams as a slurry in existing underground workings.

This is the least favourable, primarily from a cost and safety perspective. The most significant additional cost may be the supply of pipelines capable of transporting combined rejects at 70% solids and pumping upto longer distances depending on the extent of the proposed mine workings. Management of the combined rejects may be labour intensive as the disposal point will need to be mechanically moved within the underground workings. This will present safety issues due to the combination of confined spaces and potential changes to the geotechnical stability of the workings, as well as the introduction of water. Flow scheme for reject management for Option 3 is given hereafter:

It can be observed from above that as per global practice, apart from disposal of rejects in mine voids, it is also done in some cases in underground workings in some countries like Australia. However, generally dumping of rejects in underground workings is not the preferred option.





ii) United States of America (USA)

Processing plant recoveries in the US range from 50 to 80 % depending upon seam thickness and associated strata in the roof and floor. The 35 to 40 % reject material consists of two components: coarse coal processing waste (CCPW) larger than 100 mesh (150 micron) size or in some cases larger than 3 mm (1/8 inch) size, and fine coal processing waste (FCPW) or slurry generally less than 100 mesh sizes. The CCPW is typically disposed dry as valley fills in mountainous regions and in embankments to develop impoundment structures for wet disposal of FCPW. Since about 30 to 40 % of the mined product is waste, coal waste management is a very important part of the cost of the mining operation particularly in view of the environmental impacts of coal waste. Furthermore, both CCPW and FCPW may contain a large percentage of pyrite that can oxidize to generate acid-drainage, elevated levels of sulphate in water discharges and trace metals.

In many cases coal waste is disposed within impoundments where FCPW (slurry consisting of ?100 mesh coal waste with about 15% solids content) is encased in embankments constructed of compacted CCPW. Alternatively, some facilities place dewatered FCPW (about 65% solids content) within these embankments. At a few U.S. facilities, co-disposal of CCPW and dewatered FCPW is practiced which lowers the disposal area footprint. Injection of coal waste into abandoned underground mine workings was commonly practiced in the coalfields but has become more difficult to practice for both technical and regulatory reasons.

In case of processing around underground coal mines, combinations of CCPW embankments, sediment ponds and surface drainage network are used to minimize adverse environmental effects of waste management, mining and processing. Majority of active mines dispose CCPW and FCPW in separate structures. Some operators have their CCPW structures built around FCPW structures at the center. Some operators co-dispose their FCPW and CCPW by mixing them together to take advantage of their geochemical properties. Some CCPW structures are constructed from CCPW mixed with clay or fly ash to improve their compaction and reduce their hydraulic conductivity. After the CCPW and FCPW structures are completed, they are capped by top-soil or sub-soil that have been removed and stored from within or outside the mine permits area.

In case of processing around opencast mines, the method of disposal of waste approaches similar to underground mines with regard to the management of overburden spoils. The surface mines also use a combination of spoil pits, surface drainage network and sediment ponds to minimize potential of run-off water contamination. Coal processing waste is typically deposited at the bottom of the pit after removal of coal. This is done prior to dumping of overburden spoils. Overburden spoils are dumped into the pit using shovel or dragline, or hauled to the pit that is typically at the back end of the mining front and dumped. Then, spoils are usually graded with light compaction. Similar to underground coal mines, topsoil and subsoil removed and stored previously are used as cover material and vegetated. Sediment/ dilution ponds in a surface mine also collect sediments and leachates, and help to minimize pollution potential.

iii) China

The majority of coal-reject in China has been used as a replacement of construction materials for highway, railway, dam, embankment, reclamation of land, and backfill of underground mined-out area, etc. Hence, coal-reject which is a by-product of coal mining and processing is now regarded as a resource instead of"waste" material. Based on geotechnical properties such as particle shape, permeability, seepage stability etc., coal-rejects are used for dam embankments, road construction and reclamation purposes.

iv) South Africa

Coal from the operational mining areas is transported via conveyors and trucks to the coal washing plant, from where the produced coal discard is dumped onto the Discard Dump. Two mechanisms are employed to manage seepage from the Discard Dump, i.e. an under-drainage system and a liner in order to protect the groundwater resource below and within the vicinity of the Discard Dump. The under-drainage system is designed to collect seepage on top of the liner and to achieve phreatic surface drawdown at the toe of the

Discard Dump. The proposed liner system for the Discard Dump generally consists of various layers such as in-situ soils, clay, high density polyethylene (HDPE) membrane and sand or similar suitable material.

4. Standard Operating Procedure (SOP) for storage of coal washery rejects on surface for further use or disposal in mine voids/low lying areas

All the rejects generated from washeries is to be stored, preferably near to washery premises, till it is sold/ used for FBC/CFBC based power plants, as construction material or any other use. The following Standard Operating Procedure (SOP) may be followed for storage of rejects on surface for further use and for dumping in mine voids/low lying areas of such rejects which cannot be used in FBC/CFBC or as construction material.

i) Characterization of Coal Washery Rejects (CWR)

For characterization of Coal Washery Rejects (CWR), reject sample may be collected as per Indian Standard: 436 (Part-I/Sec-I)-1964 or any revision thereof available for sampling of coal. The representative samples should be tested for physical and chemical parameters and records should be maintained by the Owner/Occupier of washery.

ii) Leachate studies

Leachate studies carried out earlier for rejects from some of the existing washeries have shown that there are problems of contamination with a few elements such as iron and manganese. Therefore, physico-chemical analysis of washery rejects along with the leachate tests (TCLP i.e. Toxicity Characteristics Leaching Procedure) should be carried out on case-to-case basis before storage of rejects on surface or dumping of rejects in mine voids/low lying areas with adequate control measures as coal is a heterogeneous material and reject generated from each washery might exhibit different characteristics.

For each washery, the actual condition of the ground water and surface water bodies around the reject dump should be assessed by regular monitoring and comparison with baseline ground water quality data. The tests must be done before taking decision regarding storage of rejects on surface or dumping of rejects in mine voids/low lying areas.

iii) Selection of storage site

The storage site should be kept away from the water bodies and human habitations. It should generally be kept in isolation as far as possible and away from public transport routes.

iv) Preparation of site for storage

Prior to stocking of the CWR at storage location, top soil from the site should be excavated and it may be utilized elsewhere for undertaking plantation. The storage of CWR should include detailed geo-technical investigation to ensure that there is no base failure on account of storage. Arrangement for storage of CWR should include adequate dust suppression measures both at the transportation roads and at storage site; plantation along the transport route and three tier plantation at the storage site; provision of catch drains and surface run-off treatment facilities and advanced treatment facilities for heavy metal treatment if present in the run-off, based on TCLP test.

v) Environmental Monitoring

Routine air and water quality monitoring should be carried out around the storage site.

In addition to above, the owner/occupier may carry out detailed study through organisations such as Central Building Research Institute (CBRI), Central Road Research Institutes (CRRI) etc. for ascertaining the suitability of low GCV rejects (which cannot be used in FBC power plants) as construction material. Marketing strategies may be devised to promote sale of low GCV rejects as construction material to avoid undue accumulation of rejects.

vi) Disposal practice (for throwaway rejects)

The CWR has characteristics for spontaneous heating owing to presence of combustible material and build-up of trace metals that may impact the ground and surface water regime. Generally, dumping of rejects in underground workings is not the preferred option. In India, if disposal of rejects is to be carried out in underground workings, a detailed case specific study may be required to be carried out to explore this possibility as washery rejects, having combustible material may pose a problem of spontaneous heating leading to safety issues. For disposal of CWR into mine voids and/or dumping into low lying areas, certain considerations such as depth of the ground water; leachate formation, contamination of ground water etc. should be kept in mind. For dumping of rejects in mine voids/low lying areas, the owner/occupier shall provide substantial proof to the competent authority that all other alternatives for reject utilisation have been tried but were not feasible. Thus, dumping of rejects into mine voids/low lying areas shall be the last alternative and be done only after due approval from the competent authority.

vii) Closure of the disposal site (for throwaway rejects)

Prior to closure of disposal site, a closure plan will be developed and subsequently implemented. This must ensure that the disposal site is safe, stable, the drainage lines are restored and is environmentally sustainable. The post-closure measure should include providing layer of top soil at the disposal site, and plantation. Peripheral garland drains should be provided to ensure avoiding ingress of monsoon water into the disposal sites.

A schematic diagram of technical Standard Operating Procedure for storage of coal washery rejects on surface for further use is given in Diagram-1.

A schematic diagram of Technical Standard Operating Procedure for dumping of coal washery rejects in mine voids and/or low lying areas is given in Diagram-2.

5. Monitoring mechanism for utilisation/disposal of rejects

An appropriate body may be authorized, with due approval of the Government, for development of a system for monitoring the functioning of all washeries with special emphasis on utilization/disposal of rejects generated from both coking and non-coking coal washeries. The owner/occupier of the washery should adhere with the SOP for stocking of rejects on surface or dumping in mine voids/low-lying areas or any other statutory/regulatory guidelines in this regard.

The washery owner/occupier may take a suitable view regarding dumping of low GCV rejects in mine voids/low lying areas in case of specific circumstances, if it is difficult to comply with the recommendation of stocking on surface and using the same as construction material. However, dumping of washery rejects in mine voids or low-lying area shall be the last alternative and be done after due approval from the competent authority.

For implementation of monitoring mechanism, statutory/regulatory guidelines may be formulated for empowering the authorized body to monitor the operation of washeries and take punitive actions in cases of non-compliance of the guidelines issued by it.

6. MoEF&CC Notification Dtd. 21st May 2020 & Its Impact on Utilisation of Rejects

As per the Gazette Notification dated 21st May 2020 issued by MoEF&CC, Govt. of India, it has been mentioned that "in case of washeries, Middling and rejects to be utilized in FBC (Fluidised Bed Combustion) technology based thermal power plants. Washery to have linkage for middling and rejects in Fluidised Bed Combustion plants." It is further mentioned that "This shall also be deemed to be additional conditions of the relevant Environmental

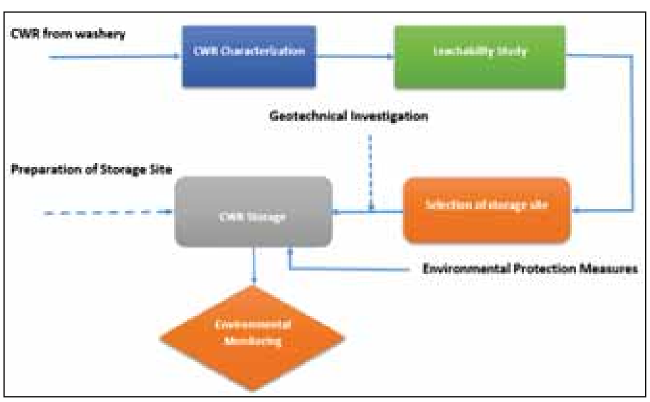


Diagram 1 : Schematic diagram of technical SOP for storage of CWR on surface

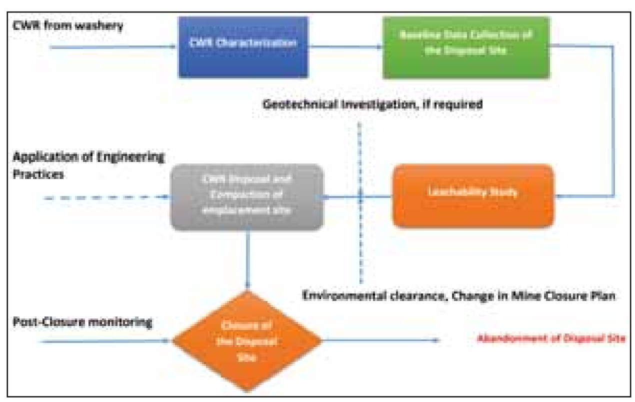


Diagram 2 : Schematic diagram of technical SOP for dumping of CWR in mine voids and/or low lying areas

Clearances for respective projects for financial year 2020-21 and onwards. The existing Environmental Clearances shall stand modified so as to make the above conditions operative for relevant sectors, The Consent to Operate shall be issued by respective State Pollution Control Boards accordingly." These restrictive clauses will result in a crisis in the coal beneficiation industry as operation of existing and future washeries as well as getting Environmental Clearance will be hampered unless there is compliance i.e. linkage to FBC plants for middling and rejects. In view of this, the restriction in utilisation of Rejects only in FBC/CFBC based power plants may be waived and the notification modified accordingly to provide for other usage of the rejects like dumping in mine voids/low lying areas. Also, since middlings have high GCV (4000-4600 kcal/kg) and is suitably utilized in conventional thermal power stations, the term 'Middlings' should be removed from the said Gazette Notification.

7. Conclusion

Generation of rejects from coal washeries is a necessary consequence of the coal washing process and is thus of considerable concern to washery owner/occupier. All rejects have certain market value depending on GCV and end use. A threshold for GCV of washery rejects as 1500 kcal/kg may be considered presently and rejects having GCV 1500 kcal/kg and above may be used in FBC/CFBC based power plants **whereas rejects of GCV less than 1500 kcal/kg (i.e. low GCV rejects) may be used as replacement of construction material for highways, railways, dams, embankments, reclamation of land, brick making etc.** Coal washery rejects alongwith biomass may also be used for generation of cooking gas. Rejects having GCV less than 1500 kcal/kg might be used for power generation through FBC/CFBC boilers with advancement of technology in future and owner/occupier may take decision in this regard.

An appropriate body may be authorized, with due approval of the Government, for development of a system for monitoring the functioning of washeries with special emphasis on utilization/disposal of rejects generated. Utilization/disposal of rejects should be done as per prevailing statutory/regulatory guidelines.

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9 Acknowledgement

We appreciate and thank our colleagues from MoC, CIL, BCCL, CCL, CIMFR, IIT-ISM, CCO, NTPC, SAIL, SCCL, BHEL, Tata Steel and various other organisations who provided insight and expertise that greatly assisted the paper.

Conservation of Water in the Operation of a Coal Washery

— Amit Ranjan*, Pankaj Kumar Tiwary**

Abstract

Jamadoba Coal preparation plan of Tata Steel was set up way back in 1952 to meet coking coal requirement of Steel plant at Jamshedpur works and this is supposed to be the oldest running Washery in Asia.

Jamadoba Washery set a target to minimise specific water consumption in the Washery operation to improve its environmental objectives. In Coal beneficiation Process we use raw water from our own mining sources. In the processing of Raw coal at Washery water gets consumed in the system. We have implemented several initiatives with technological intervention to reduce the consumption of process water at Jamadoba Washery this has resulted into reduction in the specific water consumption by about 50%.

However, there are more steps in the offing through superior technological intervention to further improve the water consumption at our Jamadoba Washery so that we could contribute to the cause of our national sustainability objectives.

Keywords : *Washery; Water Conservation; Coal; Beneficiation.*

1. Introduction

Tata Steel Operates its about 100 year old coal mines at Jharia in the Dhanbad district of Jharkhand. This is a major captive source of prime grade coking coal requirement for Tata Steel situated at about 150 kms from steel works at Jamshedpur. Raw coal quality from mines are upgraded using scientific coal beneficiation technology. While consistency in the supply of quality clean coal is our prime most objective however this must be achieved in a sustainable manner and therefore environment and safety performance is key for achieving our targeted objectives.

Responsible consumption and production are one of the seventeen sustainable development goals of India. Water Crisis and ground water depletion in Mining areas is a challenge for mining industry. Source of water for JCPP (Jamadoba Coal Preparation Plant) is Underground mine water through pumping from its underground mines. These waters also go to the water Treatment plant for drinking water supply and to the Colonies and local community. Less water consumption in the Plant will make more water available for public use.

2. Consumption of Water in Coal Beneficiation

In a coal beneficiation plant coal is beneficiated in a wet slurry form where large consumption of water is required. Water is also used for different service requirements in the operation of plant such as water sprinkler, dust suppression system etc.

Water consumption of Jamadoba coal preparation plant is as depicted in the fig. 1.1. Over last three years water consumption& specific water consumption of the Jamadoba washery has decreased this was achieved through various initiatives. We started our journey with a very high sp. water consumption and felt there was a need to review our beneficiation process and water consumption related to it.

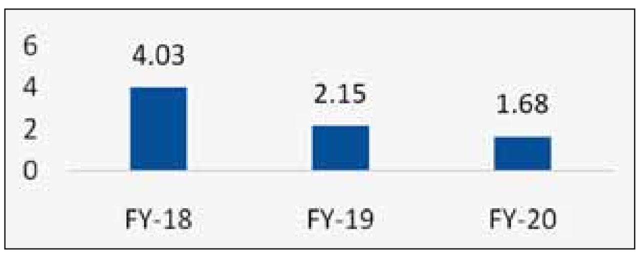


Fig. 1.1 : Water Consumption in LKL

Tata Steel has four Washeries two at its West Bokaro division and other two at its Jharia division we benchmarked our water consumption internally with each other to replicate the best performance among four Washeries (Fig 1.2). We found that amongst all four washeries Jamadoba had the highest specific

*Head, Jamadoba Coal Preparation Plant, Jharia Division, Tata Steel Ltd., Jharkhand.
**Sr. Manager (TQM).

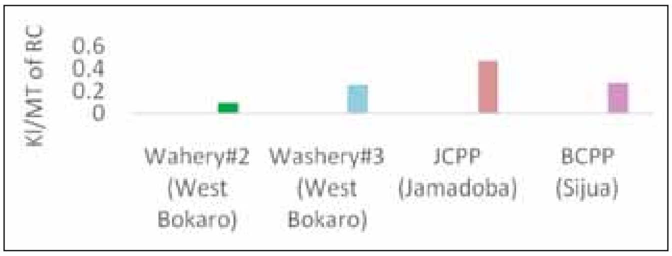


Fig. 1.2 : Water Consumption TSL Washeries

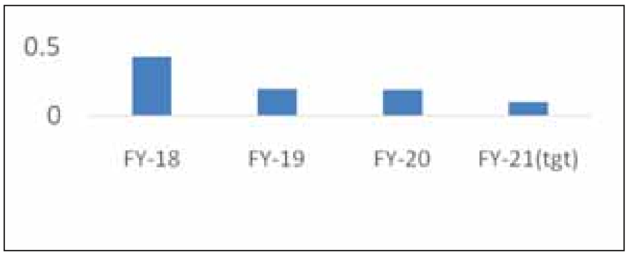


Fig. 1.3 : Sp. Water Consumption of Jamadoba washery (KL/MT of RC Processed)

water consumption. We worked on our process to understand the source of water consumption in the beneficiation process of Washery.

Water is added in the process of beneficiation, which is recovered at different stages of the product. In Jamadoba coal preparation plant water is added with the raw coal at the feed stage which is then subjected to size segregation through wet screening subsequently coarser fraction >0.5mm size is subjected to separation in a Dense Media Cyclone and finer fraction <0.5mm size is subjected to froth flotation process.

In the last stage of beneficiation, products are subjected to dewatering and water is recycled/ recovered from the circuit which is then reused in the process. Fresh water requirement is fulfilled from the underground mines sources. The different points of water recovery/recycling are coarse coal centrifuge, Screen bowl centrifuge Thickeners and Tailing ponds.

3. Sources of water consumption

At Jamadoba Washery 100% of the water gets recycled however major loss of water was observed at tailing pond and through the product moisture, possibilities of other in process losses of water also could not be ruled out. Our product moisture for clean coal is <10% and for coarse reject it is <7%. However, tailing is in the slurry form with Solid % ranging from 25-30%. Jamadoba Washery is a single cut Washery therefore in its coarse fraction it produces clean coal and coarse rejects only.

To recover or recycle water from the tailings pond series of ponds in a step form is required to allow fines tailing to settle in the pond and subsequently at the end clear water is recovered through a pumping station. Larger pond area causes larger natural losses through the same. Water is also required for other service purpose such as dust suppression or in the cleaning activities thus water gets consumed.

4. Initiatives to reduce the consumption of Water

We have used conventional technology such as centrifuges and thickeners to recover water from the products and tailings. However, more operational initiatives were required to further reduce consumption and recover wates in the process as tailing was the major source of water loss. We therefore took several actions to reduce the water consumption as described below:

a) Recovery of coarse fraction of the tailings through hydro-cyclone thickening and high frequency screen. This design was quite successful, and we could recover about 50-60% of the solids in the tailings from slurry with this process. This facilitated in requirement for lesser pond area.

b) ***Reduction in the tailing pond footprint :*** With lesser footprint recovery of water from pond was planned However, impediment in this was settling rate with smaller foot print of tailing pond. A new pump house was installed with the objective to reduce the tailing pond foot print by about 60%. Once we started operating the pump we found that the water was not clear and was causing process disturbances. We therefore added one intermittent flocculant dosing at the last stage of tailing pond subsequently recycled same water in the tailing thickener to get the clear water. Fig. 4.1 depicts reduction in tailing pond footprint

Fig. 4.1 : Tailings footprint of Jamadoba Washery

Fig. 4.2 : Tailings pond converted to green belt

and subsequent conversion of the area into green belt depicted in Fig 4.2 after refilling the pond.

c) To ensure maximum recovery from the tailing pond a continuous monitoring of water recycled was required therefore an Hour meter was installed to ensure maximum operation and recycling of the water.

d) We also required to control use of water for other service retirement we therefore installed a fixed sprinkler all along the plant roads and divided that into different zone so that we can sprinkle only optimum amount of water required for dust suppression.

4.1. Engagement of shop floor employees

Manthan Ab Shop Floor Se (MASS) is a shop floor initiative to engage people at workshop to solve any workplace related problems. This is a three-month structured programme. This programme has been very successfully deployed using leadership at the shop floor to solve the problems while creating high level of engagement at the workplace. We initiated a MASS wave focused on reducing specific water consumption and it was very successful in sensitising people and implementing shop floor ideas related to reduction in consumption of water through implementation of kaizens. Approach of this initiatives and some of the simple yet effective ideas generated and implemented through this shop floor initiative are as described below:

a) A MASS leader identified from the employees and bestowed with the responsibility of sensitizing employees and make them follow the commitments made by them in the session.

b) Through this programme an ideation cum awareness session was organized involving shop floor employees into the initiative. Their ideas were taken and implemented through various TPM circles. They were also sensitized towards the importance of water resources in the industries in specific and our daily life in general.

c) Employees suggested to install surveillance cameras over Fresh water tanks for remote monitoring could help operation people in optimising the use of water and pumping operation could be regulated.

Fig. 4.1.1 : Depicting use of surveillance camera to monitor water intake in tanks and pump operation

d) The old drains directed outside the plant towards the tailing pond were diverted to discharge water to increase the water recovery. The water which got wasted through drains is now recovered into the plant.

e) One of the suggestions was installed water tanks with level transmitter switches and auto control valves (Fig. 4.1.2) so that wastage of water could be restricted.

5. Challenges Faced in the implementation of ideas

The major challenge was faced in maintaining the quality of water recovered from the Tailings ponds. It was overcome by coagulant dozing in tandem with flocculant in the pond. Well planned regular mechanized excavation of ponds in parallel circuits enabled us to make available the fresh ponds always available to take fresh generated slurry.

Keeping the new Pump house up and running : It was vital to keep the new pump house up and running all the time to support the new tailing ponds regime and increased requirement of recycling. A standby pump was installation to ensure uninterrupted recycling. Recycled water was used to become turbid at times resulting into process disturbances to counter this problem we had to make parallel arrangement to recycle them back to the tailings thickener so that recycling hours could be increased, and more water could be recovered through ponds.

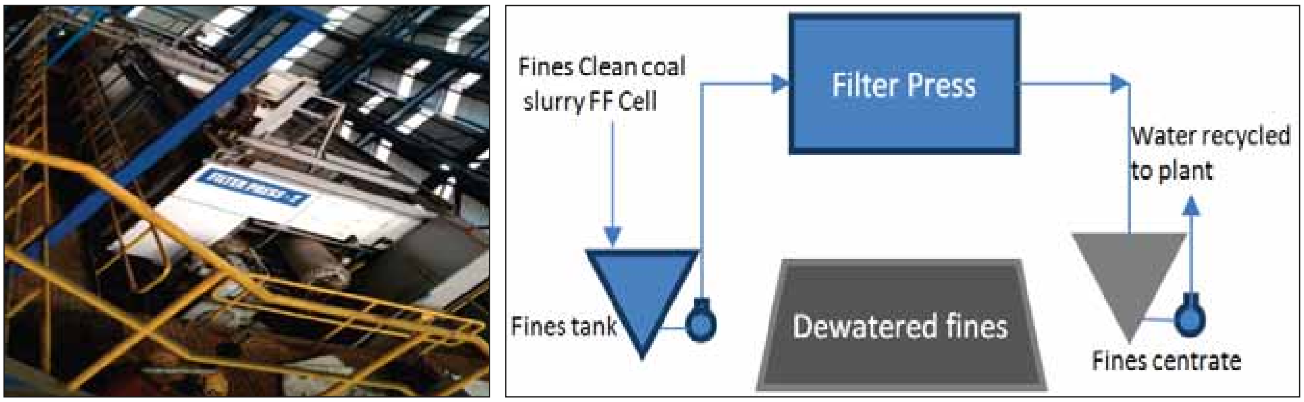
6. Upgradation in the technology and superior facility

We have upgraded our Washery and a 2 MT Jamadoba Washery is already in the process of stabilisation in its operation. Advance technological upgrades adopted in the new Washery for conservation shall further enhance washery's environmental performance.

a) Use of filter press for dewatering of tailing : this will help us reduce or eliminate tailing pond to recover water from fines coal refuse.

Fig. 4.1.2 : Level transmitter and control valve for the water storage tanks

Fig. 6.1 : Tailings Dewatering Plant



Pic. 6.2 : Fines Clean coal dewatering arrangement through filter press

b) ***Use of filter press for fines clean coal :*** we were using screen bowl centrifuge for dewatering of fines clean coal where moisture of the dewatered product where 22% we have replaced the same with technologically superior filter press.

c) Superior arrangement for drainage water and storm water around the plant, A catch pit has been prepared and all the drainage as well as storm water can be collected in the pit and can further be reused for the plant operation Fig. 6.3.

d) Effluent Treatment plant of 10KLD (Pic 6.4) capacity has been installed to treat the sewerage and waste water generated from Office building, canteen and Kitchen area. The clear water generated from the plant is used in the garden to water plants and flowers.

Fig. 6.3 : Catch pond for the plant drainage system

7. Conclusion & discussion

Through various initiatives the sp. water Consumption of Jamadoba washery has been reduced from 0.43 KL/Ton to 0.19 KL/Ton annually. With the

Pic. 6.4 : Effluent treatment plant

advanced technological upgradation in the washery, we have kept a target to reduce it to the level of 0.1 KL/Ton of RC.

Reduction in the tailings footprint and developing green zone while maintaining biodiversity will make land use to create a better natural environment around the plant area and will help us contribute to the sustainability cause of the nation.

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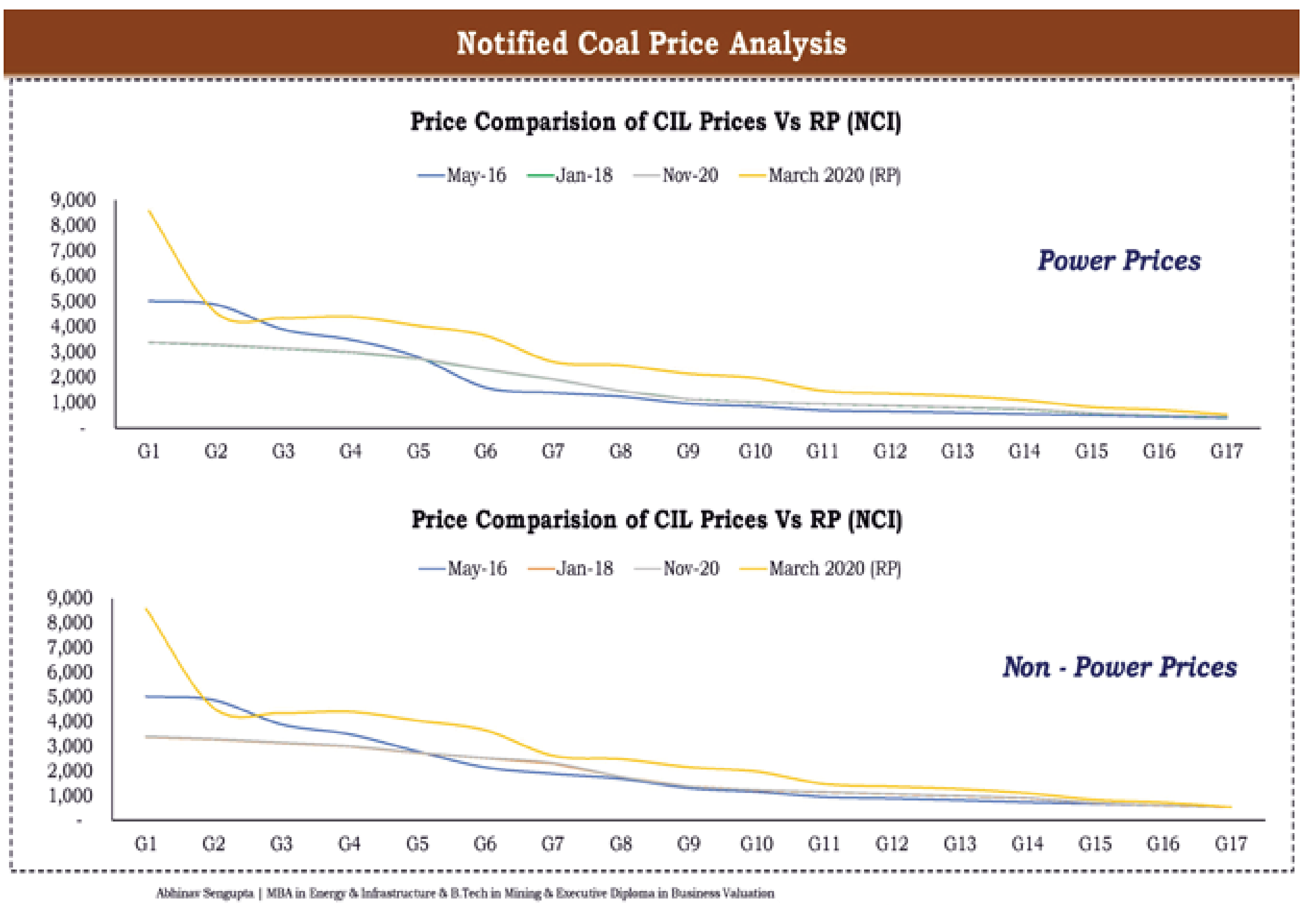


Coal Preparation for Industry in the New Scenario - Utilization of Coal Fines and Slurry

— R.B. Mathur*

1) Preamble

Coal industry is going through a period of transition and the victory of Joe Biden in USA in race for Presidency has again brought USA is the forefront of environment protection and created a potential risk for coal mining industry in USA, unless it undergoes a major change. Coal India plans to produce 1 billion tons of coal by 2023-24, but at the same time will have to close down 70% of its loss making mines. 170 coal mines produce less than 10% coal & employ 45% manpower, incurring a loss of 16000 crores. We have to think whether there is any logic to produce coal from underground mines which contribute hardly 4% of total coal production. it will be better to invest in coal preparation and making coal eco-friendly for survival of coal.

2. Mineral Allocation Policy - A Need to Relook at Current Policy

- As per National Mineral Policy 2008 and amendment of MMDR Act 2015, the intention of removing discretion and introducing transparency, the auction route gained ground and has become obligatory.
- The result is that there are no takers for coal blocks and other minerals blocks too.
- There is need to introspect on the existing allocation policy for minerals.
- All over the world, minerals are allocated to competent and financially sound parties, who are capable of investing money, as per the public knowledge.

3. Avenues for Investments in India's coal sector (Investment Opportunities):

- Commercial Mining - Post Covid
- Clean Coal Technologies
- Coal Logistics
- Coal to Gas/ Methanol
- Coal to Liquid
- Coal to Hydrogen

4. **The Paris Deal (COP 21) and Coal :** USA, China and India are key to achieve Paris agreement with Coal still being a major fuel driving the economies.

Paris Agreement

- Accord reached in December 2015
- Touted as the most ambitious climate change pact
- Lays out plan to curb GHG emissions and climate change
- Accelerates actions and investments needed for low carbon future
- Coal takes center stage

5. **195 countries participated to commit to reduce emissions. Developed world having already achieved pinnacle of growth are now looking to move away from coal despite the following:**

- Over 40%of world's electricity and 70% of steel is coal dependent
- Employ millions if not billions
- Most abundant fossil fuel
- Lack of other fossil fuels in emerging economies
- Coal cant be done away with
- Important fossil fuel for countries like China, India and other developing countries
- HELE (High Efficiency Low Emission) coal fired thermal power plants could be answer

*Former CMD - BCCL/SECL/CMPDIL/WCL.

- Coal usage in form of gas via UCG, CTL & CTG.
- CIL lender for conversion of coal to methanol

6. India's take on Coal post Paris Agreement:

- To meet COP 21 norms, India will be reducing its emission by 35% by 2030
- Low carbon approach like HELE, use of washed
- Coal, use of super critical and ultra super critical
- Technologies
- Clean Energy Cess has been doubled to INR 400/ ton, which supports financing of clean and renewable energy.
- 2030, 40% of country's installed capacity will be from renewable sources
- Coal will continue to be fuel of choice for electricity generation
- Coal linkage rules - relaxed transport-coal by any means

7. Why Clean Coal in necessary for India's Power Sector - The way forward to reduce emissions:

- Indian coals have high ash content which leads to inefficient combustion and adds to pollution
- Washing helps in reducing ash content and improves heat value, efficiency of combustion and reduces CO_2 emissions per KWh of electricity
- Washing also helps in reducing freight, less coal consumption and reduces ash handling
- In totality, washing coal helps in improving the combustion efficiency and environmental performance of coal in the electricity chain.
- Planned closure of U.G mines & national recognitions the +100 millions ton coal consumptions is need of hour.

8. Why Washing of Coal in necessary for India's Power Sector:

Adoption of 17 grades based on GCV system instead of 7grades as per erstwhile UHV system.

Grade	GCV Range in Kcal/kg
G1	Exceeding 7000
G2	Exceeding 6700 and not exceeding 7000
G3	Exceeding 6400 and not exceeding 6700
G4	Exceeding 6100 and not exceeding 6400
G5	Exceeding 5800 and not exceeding 6100
G6	Exceeding 5500 and not exceeding 5800
G7	Exceeding 5200 and not exceeding 5500
G8	Exceeding 4900 and not exceeding 5200
G9	Exceeding 4600 and not exceeding 4900
G10	Exceeding 4300 and not exceeding 4600
G11	Exceeding 4000 and not exceeding 4300
G12	Exceeding 3700 and not exceeding 4000
G13	Exceeding 3400 and not exceeding 3700
G14	Exceeding 3100 and not exceeding 3400
G15	Exceeding 2800 and not exceeding 3100
G16	Exceeding 2500 and not exceeding 2800
G17	Exceeding 2200 and not exceeding 2500

Now, there is limited scope of product differentiation, and the buyer can select the suitable grade corresponding to the most appropriate requirement based on station heat rate and economics of conversion of Coal Energy to Power. However the grading system serves as guide only, payments are on real quality basis.

9. Coal India Ltd. - The Stupendous Task & the Challenges:

- Coal India looking to increase production to a level of around 1 billion tonnes by 2023-24 from 605 million tonnes in 2019-20 is no doubt a stupendous task.
- Most of the increment will come from MCL and SECL, which mainly produce thermal coal of G12 to G15 grades. The bulk of coal washeries shall have to be established in those areas.

- ***Objectives:***
  - » 100% coal crushing achieved by now.
  - » Ash to be lowered to 34% for all coal moving more than 500 kms has been done away- A retrograde step.
- Main challenges which Coal India is facing now despite surplus coal availability scenario are:
  - » *Coal Grade Slippage :* It varies from 1 to 2 grades in SECL and MCL, but it may be even 3 grades in ECL & BCCL, Realistic grade declaration is the need.
- ***Declining %age of UG Mining :*** Current production levels are highly skewed towards the O/C mining due to cost. Almost 96% of Coal India's coal comes of O/C mining. There is a justification to make CIL, 100% open cast coal co.

10. Coal Washing in India:

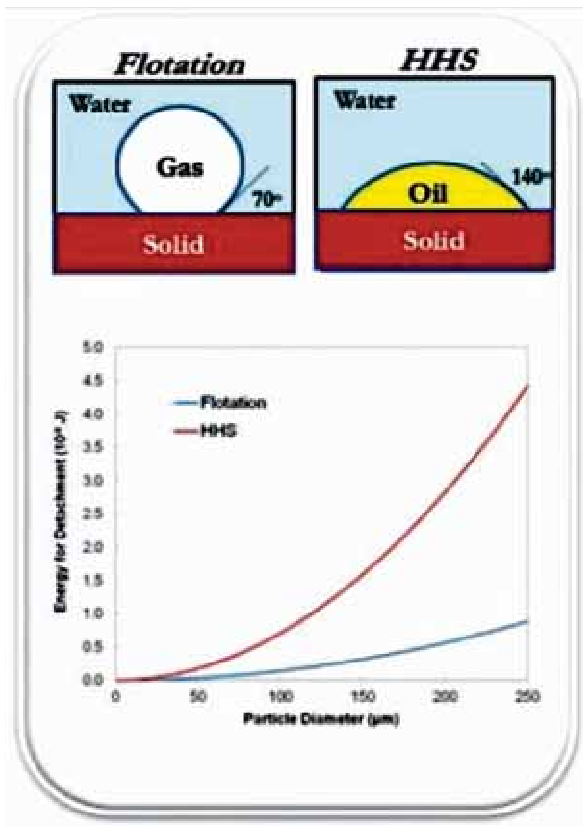
- Currently, Indian coal washing capacity is 122 million tonnes per annum only, out of which Private sector contributes majority of it (around 75 million tonnes per annum).
- By 2020, additional 256 million tonnes per annum washery capacity is required to be created.
- Washery product having GCV of less than 2200 kcal/kg is washery reject. Ash + Moisture may be around 65%.
- These rejects can be used for power generation using CFBC boiler technology near washery sites.
- However, the attempt of new tech technology should be to maximize washed coal percentage by recovering fine and ultrafine coal by HHS process, which has been successfully tried in the US.
- The biggest challenge is to keep coal mining profitable with last calory utilization.

11. HHS Technology:

- Indian coals are difficult to wash as mineral matter is finely disseminated in the organic coal matrix.
- Hydrophobic-Hydrophilic Separation (HHS) Process is capable of removing both mineral matter and surface moisture simultaneously.
- In HHS process recyclable oils are used to obtain low ash products at low oil consumption rate.
- Reducing the top size of the coal to be washed liberates the mineral matter, cleaning fine coal is the focus area of HHS technology.

11.1 HHS Process:

- Patented hydrophobic-hydrophilic separation (HHS) process has been tested successfully for the recovery and dewatering of ultrafine (-45 µm) coal particles.
- In the HHS process, oil droplets rather than air bubbles are used to selectively "collect "hydrophobic particles.
- Oil droplets give substantially higher contact angle than air bubbles for a given hydrophobic mineral or coal.
- Adhere more strongly on hydrophobic particles, promising high coarse particle recoveries, and
  - » displace surface moisture, producing dry concentrates regardless of particle size.



12. Mining Technology:

- Productivity in Indian Coal mines is matter of concern. We need economical coal mining at a cheaper cost with due considerations for:
- Safety Adoption of In pit crushing and conveying
- Conservation (Horizon Mining)
- Productivity- closure of high cost underground mines in CIL & SCCL
- Eco-friendly technologies. Higher use of electric equipments
- Surface miner has become popular in Indian Coal mines.

13. Facts to be Faced:

- High inherent ash content in Indian coals
- Continued dependence on coal for electricity generations and other primary manufacturing sectors like iron and steel, cement, etc.
- Limited Hydrocarbon resources
- Domestic coal is easily available in abundance and is economical to use
- India's coal mining sector also provides employment to millions both directly and indirectly
- With COP 21, there will be push to use clean coal technologies including coal washing, use of low emission electricity generation technologies
- Ressurgent Coal India shall further ease norms for rationalizing coal linkage. coal from any where by any mode of transport shall be welcome for power sector.

14. Concluding Remarks:

- India is undergoing fast changes with respect to energy security and demand is slated to keep rising.
- Coal will play an important role in India's energy sector and is expected to lead the power generation till 2050.
- Use of clean coal is not only beneficial for the thermal power plant operation but also reduces the impact on the environment in adherence with COP21.
- The ash content requirment for sourcing of coal have been watered down, so we are less vigilant now. the earlier stituation must be restored, as regards ash content.

Coal Downstreaming – Inconsistencies and Questionable Policy Choices#

— Bill Sullivan*, Christian Teo
& Claudius Novabianto

Introduction

Coal downstreaming has become an important topic in the ongoing public dialogue about the future of the Indonesian coal mining industry and as low coal prices squeeze the profit margins of Indonesian coal producers.

The Government is offering very significant benefits and incentives for coal producers that engage in downstreaming.

The term "coal downstreaming", however, is somewhat ambiguous and misleading as it is open to different interpretations. There are material inconsistencies in the New Mining Law and the Omnibus Law which create uncertainty as to just what qualifies as "coal downstreaming". It is also highly questionable whether or not all the permitted types of coal downstreaming should really attract the benefits and incentives currently being offered by the Government.

In this article, the writer will review what is meant by "coal downstreaming" in the New Mining Law and the Omnibus Law before turning to the issue of whether or not it makes sense for all permitted types of coal downstreaming to receive the various benefits and incentives being offered by the Government.

Background

The business prospects for traditional coal mining in Indonesia do not look very encouraging at this point in time.

Indonesia's coal producers are being confronted by a combination of weak international demand for coal and low coal prices. As Indonesia is one of the world's largest producers of coal for export, this is a worrying combination.

According to the Indonesian Coal Mining Association ("APBI"), Indonesia will export 395 million tons of coal in 2020, down from 455 million tons of coal in 2019 or a drop of 13.2% year on year. Although the Ministry of Energy & Mineral Resources ("ESDM") is projecting a modest 3.6% growth in 2021 coal exports to 430 million tons, this will still be 8.9% below the 2019 export figure. Further, ESDM is expecting coal exports to stagnate at 441 million tons per year during the period from 2021 until at least 2024.

The problem that the decline in Indonesia's coal exports creates for local coal producers is being exacerbated by low international coal prices. Although the Newcastle benchmark thermal coal price has shown some recent improvement, it has had considerable difficulty holding above US$60 per ton for an extended period. This is to be compared with an average 2019 coal price of US$77.89 per ton. Coal prices are not expected to improve significantly in 2021, with Bank Mandiri projecting an average coal price of US$59.2 for 2021. The coal price outlook for the period from 2021 to 2024 also remains subdued, with various forecasters surveyed by Bloomberg projecting coal prices of as low as US$53 per ton in 2024.

The fall-off in demand for Indonesian coal exports is the result of (i) reduced industrial activity and weak

*Bill Sullivan, Senior Foreign Counsel with Christian Teo & Partners and Senior Adviser to Stephenson Harwood LLP.

Bill Sullivan is the author of “Mining Law & Regulatory Practice in Indonesia – A Primary Reference Source” (Wiley, New York & Singapore 2013), the first internationally published, comprehensive book on Indonesia’s 2009 Mining Law and its implementing regulations.

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economic conditions generally as a result of the Covid-19 pandemic and (ii) the so-called "energy transition" from overwhelming reliance upon fossil fuels including, most particularly, coal to environmentally friendly renewable energy for electricity generation. While the Covid-19 induced reduction in industrial activity is presumably only a temporary phenomenon, the energy transition is expected to be a permanent phenomenon which is only likely to grow in importance with the passage of time. As such, it is probably not realistic to expect that export demand for Indonesian coal will ever return to its "glory days" of 2006 to 2016 when, according to an April 2019 study by the Institute for Essential Services Reform ("IESR"), Indonesian coal exports increased by more than 250% over 10 years.

Weak international demand for Indonesian coal would be much less of a problem for local producers if domestic demand for Indonesian coal was growing strongly. This, however, is not the case. As APBI has recently pointed out, not more than 25% of Indonesian coal production is absorbed domestically and this absorption level has been more or less unchanged for some years. With 75% of Indonesian coal production exported, it is impossible for local coal producers to avoid the fallout from weak international coal demand as exacerbated by low world prices for coal.

The poor business outlook for traditional coal mining in Indonesia is not only a problem for local coal producers. It is a major problem for the Government as well. Coal is Indonesia's most important mineral export and the Government relies heavily on revenue from the coal industry. The percentage contribution that the coal industry makes to Government revenue varies from year to year and is a matter of some debate. However, according to IESR, in recent years coal production royalties may, on average, have been as much as 80% of the Government's total non-tax and non-oil & gas state revenue.

The traditional coal mining industry is also a major contributor to the local economies of East Kalimantan, South Kalimantan and South Sumatera. During the 4 November 2020 launch of the Study Series Report on the Indonesian Energy Transition Road Map, it was suggested that as much as 70 percent of the economic activity in some regencies of East Kalimantan in particular is based on traditional coal mining, with more than 100,000 jobs at risk if the traditional coal mining industry cannot find ways to profitably evolve.

The myriad problems, which a declining traditional coal mining industry create for the Government as well as for various Provincial and Regional Governments, undoubtedly explain (at least in part) the growing concern, at the highest levels of the Government, about the slow growth in domestic absorption of Indonesia's coal production. During a limited cabinet meeting, on 23 October 2020, the President was reported as having said in exasperated terms:

"I want solutions to solve the slowness in the development of this coal derivative industry. Because we have been exporting raw coal for a long time, I think it must be ended."

Although it seems quite fanciful to imagine that domestic absorption of Indonesia's coal production can ever fully replace coal exports, the President's evident exasperation at the slow pace of domestic coal absorption is supported by Presidential Regulation No. 22 of 2017 re National Energy General Plan ("PR 22/2017"). PR 22/2017 contemplates that coal exports should be gradually fazed out before stopping altogether by not later than 2046. PR 22/2017 is, however, predicated on the assumption that domestic absorption of coal will reach more than 400 million tons in 2046. This level of domestic coal absorption is only achievable if there is a massive expansion of what is increasingly referred to as "coal downstreaming". Very diplomatically, the Executive Director of APBI was quoted in the 30 October 2020 on- line edition of Kontan as having said in response to the President's comments:

"We leave it to the government regarding the policy whether coal will be used entirely domestically or can still be exported."

Analysis and Discussion

1. *Preliminary Remarks*

"Coal downstreaming" is not a term that appears anywhere in either Law No. 3 of 2020 re Amendments to the 2009 Minerals and Coal Mining Law ("2009

Mining Law") ("New Mining Law") or Law No. 11 of 2020 re Job Creation ("Omnibus Law").

The common usage of the term "coal downstreaming" is both ambiguous and potentially misleading because "downstreaming" is a concept that actually applies to metal minerals rather than to coal in the sense of downstream "processing and refining" of metal ore in order to produce metal mineral products with a much higher metal content than the original unprocessed and unrefined ore. Downstream "processing and refining" of metal ore is synonymous with so-called local "value added activity" intended to produce metal products that can be sold for much higher prices than the original unprocessed and unrefined metal ore.

Casual observers might very logically expect that "coal downstreaming" must also necessarily mean processing coal to produce higher value derivative products. However, neither the New Mining Law nor the Omnibus Law requires holders of mining business licenses ("IUPs")/special mining business licenses ("IUPKs") for coal ("Coal IUPs/IUPKs") or holders of IUPKs resulting from the conversion of Coal Contracts of Work ("CCoWs") ("Continuation Coal IUPKs") to carry out local "value added activity". At the same time, both the New Mining Law and the Omnibus Law offer very significant benefits and incentives to holders of Coal IUPs/IUPKs and Continuation Coal IUPKs which carry out "Development and/or Utilization of Coal" ("Coal Development/Utilization").

Coal Development/Utilization, in fact, includes activities that are very different from local "value added activity" or downstream "processing and refining" as these expressions are used in the case of metal ore.

2. *Coal Development/Utilization*

2.1 *Whose Responsibility is Coal Development/ Utilization? :* The New Mining Law represents a very interesting departure from the 2009 Mining Law in terms of responsibility for Coal Development/Utilization.

Article 102 of the 2009 Mining Law required all Coal IUP/IUPK holders to:

"enhance the added value of minerals and/or coal in the implementation of mining, processing and smelting as well as utilization of minerals and coal."

In other words, prior to the New Mining Law it was compulsory/mandatory for Coal IUP/IUPK holders to carry out both "added value activity" in respect of their coal production and utilization of their coal production. That said, the Ministry of Energy & Mineral Resources ("ESDM") effectively gave Coal IUP/IUPK holders a "free pass" on compliance with their coal added value activity and utilization obligations while insisting that holders of IUPs/IUPKs for metal minerals complied with their corresponding added value and utilization obligations in respect of their metal ore production (i.e., "downstream processing and refining").

The New Mining Law, however, treats holders of Coal IUPs/IUPKs and holders of Continuation Coal IUPKs very differently. Article 102(2) of the New Mining Law provides that holders of Coal IUPs/IUPKs "may" (i.e., it is discretionary/ optional) carry out Coal Development/Utilization once they reach production operation. Article 169A(4) of the New Mining Law, though, provides that holders of Continuation Coal IUPKs "must" (i.e., it is compulsory/obligatory) carry out Coal Development/ Utilization.

It should be pointed out in passing that holders of Coal IUPs/IUPKs are also treated much better than are holders of metal mineral/mon-metal mineral/rock IUPs/IUPKs under the New Mining Law. Article 102(1) of the New Mining Law makes all too clear that holders of metal mineral/non-metal mineral/rock IUPs/IUPKs "must" carry out processing and refining in the case of metal minerals and processing in the case of non-metal minerals and rocks once they reach production operation.

The simple reader might reasonably assume that compulsory/obligatory Coal Development/ Utilization represents an onerous additional obligation that is imposed on holders of

Continuation Coal IUPKs only and as part of the "price" for former CCoW holders being allowed to receive Continuation Coal IUPKs upon the expiry of their CCoWs. As will become clear in 2.2 below, however, it is not the case at all that Coal Development/Utilization is necessarily going to be an onerous additional obligation for holders of Continuation Coal IUPKs. It all depends upon what is actually meant by the term "Coal Development/Utilization" as this term is used in the New Mining Law and the Omnibus Law.

2.2 *What is Coal Development/Utilization? :* Coal Development/Utilization is defined in Article 1.20b of the New Mining Law as being:

"efforts to improve the quality of coal with our without changing its initial physical properties"

The emphasis in the above definition on "improving the quality of coal" might suggest that Coal Development/Utilization must involve local "value added activity" to produce a coal product that will command a higher price than coal that has simply be mined and delivered to stockpile.

Elsewhere in the New Mining Law, however, it is made clear that Coal Development/Utilization is not necessarily confined to just activities or efforts that improve the quality of coal. More particularly, the Elucidation to Article 102(2) of the New Mining Law provides that Coal Development/Utilization may include:

(a) in respect of "Coal Development":

  (i) coal upgrading;

  (ii) coal briquetting;

  (iii) coke making;

  (iv) coal liquefaction;

  (v) coal gasification including underground coal gasification;

  (vi) coal slurry or coal water mixture; and

(b) in respect of "Coal Utilization", construction of mine mouth power plants.

Although not beyond doubt, the better view would seem to be that Article 102(2) of the New Mining Law probably allows holders of Continuation Coal IUPKs to choose whether to carry out (i) Coal Development only, (ii) Coal Utilization only or (iii) both Coal Development and Coal Utilization.

Coal Development (as explained above) seems to be generally consistent with the definition of Coal Development/Utilization in the New Mining Law and its apparent focus on improving the quality of coal or at least producing a higher value coal product than coal that is simply mined and delivered to stockpile. However, it is very hard to see how Coal Utilization (as explained above) is in any way consistent with definition of Coal Development/Utilization in the New Mining Law and its apparent focus on improving the quality of coal or at least producing a higher value coal product than coal that is simply mined and delivered to stockpile. More particularly, Coal Utilization apparently involves nothing more than constructing a mine mouth power plant intended to utilize as its energy source coal that has simply be mined and delivered to stockpile by or on behalf of the sponsor of the relevant mine mouth power plant. In other words, Coal Utilization does not involve either (i) any improvement in the "quality of coal" used as the energy source for the relevant mine mouth power plant or (ii) producing a higher value coal product than coal that is simply mined and delivered to stockpile. As it is explained in the Elucidation to Article 102(2) of the New Mining Law, Coal Utilization is a very surprising and, indeed, worrying departure from what seems to be actually contemplated by the definition of Coal Development/Utilization in the New Mining Law.

Does it really matter that Coal Development/Utilization is not necessarily confined to local value added activity intended to "increase the quality of coal" or at least result in a higher value coal product than coal that is simply mined and delivered to stockpile? As will become apparent in 3 below, "yes" it matters very much because there are important benefits and incentives being offered to companies carrying out Coal Development/Utilization and even, so it would seem, if it is only Coal Utilization that will neither increase the quality of coal nor result in a higher value coal product than coal that is simply mined and delivered to stockpile.

3. *Significance of Coal Development/Utilization*

3.1 *Extension of CCoWs :* As highlighted in 2.1 above, CCoW holders are entitled to Continuation Coal IUPKs if they are willing to assume the obligation of Coal Development/Utilization in addition to other obligations including "increasing state revenue" (Article 169A(1) and (2) of the New Mining Law).

Obtaining a Continuation Coal IUPK is hugely advantageous to CCoW holders as it ensures continued operating rights of up to 20 years and without any obligation to undergo a tender in circumstances where they otherwise had no clear right to an extension of their CCoWs. With many CCoW holders facing the imminent expiry of their CCoWs and the resulting shutdown of their coal mining operations, obtaining a Continuation Coal IUPK is not merely something that is desirable for CCoW holders but, rather, it is something that is essential to their very survival. In this regard, CCoW holders have, in recent years and with their CCoWs coming to an end, found it increasingly difficult to attract new equity investment and obtain bank financing. The legal certainty of continuing operating rights, which comes with obtaining Continuation Coal IUPKs, means that these investment and financing difficulties should be much alleviated.

Assuming that Coal Development and Coal Utilization are indeed individual alternatives, that do not both have to be carried out unless the relevant Continuation Coal IUPK holder so wants, undertaking Coal Utilization alone would seem to be a very easy way indeed for holders of Continuation Coal IUPKs to satisfy the Coal Development/Utilization obligation attaching to their Continuation Coal IUPKs.

3.2 *Life of Mine Right :* Holders of Coal IUPs/IUPKs/ Continuation Coal IUPKs, at the production operation stage and which carry out "integrated" coal getting and Coal Development/Utilization are entitled to (i) initial license terms of 30 years rather than 20 years and (ii) further 10 year extensions of their license terms "as per the relevant laws and regulations" (Article 47(g) and Article 83(h) of the New Mining Law).

Although not expressly stated in the New Mining Law, it is the writer's present understanding that holders of Coal IUPs/IUPKs as well as holders of Continuation Coal IUPKs, at the production operation stage and which carry out "integrated" operations, will be able to keep extending their Coal IUPs/IUPKs/Continuation Coal IUPKs until the end of the commercial life of the relevant coal concession area/mine. The same "life of mine" operating right is being offered to holders of metal mineral IUPs/IUPKs which carry out integrated operations of metal ore mining and downstream processing and refining of metal ore into value added metal products.

The term "integrated" is undefined in the New Mining Law. However, the writer's present understanding is that "integrated" means that a legal entity, which is the holder of a Coal IUP/ IUPK/Continuation Coal IUPK must carry out both the coal getting and the Coal Development/ Utilization of Coal.

Again assuming that Coal Development and Coal Utilization are indeed individual alternatives, that do not both have to be carried out unless the relevant Coal IUP/IUPK holder or Continuation Coal IUPK holder so wants, undertaking Coal Utilization alone and putting the resulting mine mouth power plant in the same company that carries out the coal getting (i.e., integration) would seem to be a very easy way indeed for both holders of Coal IUP/IUPKs and holders of Continuation Coal IUPKs to qualify for "life of mine" operating rights.

3.3 *Reduced Production Royalty :* Article 39.1 of the Omnibus Law amends the New Mining Law to include a new Article 128A as follows:

"Business actors carrying out value added activities in respect of Coal (as mentioned in Article 102(2) of the New Mining Law) may be granted special treatment in connection with their state revenue payment obligations [i.e., Production Royalties]."

The reference in new Article 128A to "value added activities in respect of Coal (as mentioned in Article 102(2) of the New Mining Law)" is ambiguous. Is it only Coal Development (as mentioned in Article 102(2) of the New Mining Law and which does clearly amount to "value added activity") that may be granted "special treatment" in respect of Production Royalties? Alternatively, is it Coal Utilization (as also mentioned in Article 102(2) of the New Mining Law but which does not really involve any "value added activity") as well as Coal Development that may be granted "special treatment" in respect of Production Royalties?

Just what is the "special treatment" contemplated by Article 128A of the New Mining Law is made clear in a recently circulated draft of Government Regulation re Implementation of Law on Job Creation in the Energy and Mineral Resources Sector ("Draft GR EMRS") which provides, in Article 1(1) and by way of elaboration of Article 128A of the New Mining Law, that:

1. "Holders of Coal IUPs/IUPKs/Coal Continuation IUPKs at the production operation stage which carry out Coal Development/ Utilization may be subject to a [reduced] Production Royalty of up to 0%."

   Article 1 of Draft GR EMRS goes on to provide that:

2. "The [reduced] Production Royalty of up to 0%...... shall be imposed in respect of the amount/tonnage of Coal used in connection with Coal Development/Utilization activities."
3. "Further provisions re the amount, requirements and procedures for the imposition of a [reduced] Production Royalty of up to 0% shall be set out in a ministerial regulation."
4. "Minister of Finance approval is required for the amount, requirements and procedures for the imposition of a [reduced] Production Royalty of up to 0% "

Self-evidently, it is a huge benefit for holders of Coal Continuation IUPKs to have their Production Royalty rate reduced from the present level of 13.5% to 0% in respect of coal produced by them and used as the energy source for a mine mouth power plant that they construct if this constitutes Coal Development/Utilization for the purposes of the New Mining Law.

We will have to wait for (i) Draft GR EMRS to be finalized and (ii) the ministerial regulation, referred to in Article 1(3) of Draft GR EMRS, to be issued in order to know for sure whether or not the Government intends that Coal Utilization, as well as Coal Development, qualifies for a reduced Production Royalty of 0%.

4. *Questionable Policy Choices*

4.1 *Preliminary Remarks :* Indonesia has, supposedly, taken the decision to move away from simply producing and selling low value unprocessed metal ore and coal in favour of concentrating on the production and sale of value added mineral and coal products that command much higher prices and will help ensure Indonesia and its people receive materially more benefit from the local mining industry than they do at present. Coal Development may be consistent with the stated focus on producing value added coal products that command higher market prices. Coal Utilization (in the form of the construction of mine mouth power plants) does not, though, seem to be in any way consistent with a focus on producing value added coal products that command higher market prices.

It must also be questioned whether, given the likely permanent nature of the energy transition phenomenon, Indonesia should be encouraging the development of more mine mouth power plants utilizing coal at all. Yet, this is the seemingly logical consequence of allowing holders of Continuation Coal IUPKs to only carry out Coal Utilization in order to satisfy their Coal Development/Utilization obligations.

There is not necessarily anything wrong with Coal Utilization as such other than, of course, from an environmental impact perspective. However, it does not seem that Coal Utilization by itself should be sufficient to entitle coal producers to favorable treatment from the Government whether in the form of Continuation Coal IUPKs for former CCoW holders or "life of mine" operating rights and 0% Production Royalties for holders of both Coal IUPs/IUPKs and Continuation Coal IUPKs.

4.2 *CCoW Extensions :* Indonesia's continuing dependency on the coal industry is probably unavoidable in the near to medium term at least and even if this is definitely not desirable from an environmental impact perspective. Accordingly, ensuring legal certainty of future operating rights for CCoW holders may be an entirely reasonable policy objective. It is, in any case, certainly a much better outcome than allowing state-owned enterprises to take over most of the former contract areas of CCoW holders once they receive Continuation Coal IUPKs.

Given how valuable Continuation Coal IUPKs are to CCoW holders, though, it might reasonably have been thought that the associated Coal Development/Utilization obligation would not have been capable of being satisfied through Coal Utilization alone. Is constructing a mine mouth power plant, that uses as its energy source the coal produced from the Continuation Coal IUPK holder's mining operations, properly to be regarded as an appropriate "price", even in part, for a Continuation Coal IUPK?

The writer readily acknowledges that holders of Continuation Coal IUPKs are also subject to onerous tax and other burdens intended to "increase state revenue" that form a critically important part of the "price" CCoW holders have to pay for their Continuation Coal IUPKs. The writer's concern is more that while the compulsory Coal Development/ Utilization obligation looks potentially onerous and something that seems to materially distinguishes holders of Continuation Coal IUPKs from holders of Coal IUPs/IUPKs, it is in fact not onerous at all if it can be so easily satisfied by undertaking Coal Utilization alone rather than either Coal Development alone or both Coal Development and Coal Utilization. This may be viewed as being part of the carefully crafted "window dressing" that has been included in the New Mining Law so that it looks as though the Government has extracted a much higher "price" from CCoW holders in return for Continuation Coal IUPKs than is really the case.

4.3 *Life of Mine Operating Rights :* Giving "life of mine" operating rights to non-PMA Company Coal IUP/IUPK holders and holders of Continuation Coal IUPKs which carry out integrated coal getting and Coal Development/Utilization also does not seem to be justified in the case of those Coal IUP/IUPK holders and holders of Coal Continuation IUPKs which are not foreign investment companies ("PMA Companies") and only carry out Coal Utilization. What real additional value is Indonesia getting, in return for "life of mine" operating rights, from integrated coal getting and Coal Utilization only by non-PMA Companies?

It must be remembered that most (but not all) of the CCoW holders and future Continuation Coal IUPK holders are wholly Indonesian owned companies, not PMA Companies. Accordingly, it is not necessarily the case that the "quid pro quo" for life of mine operating rights, at least in the case of Continuation Coal IUPK holders carrying on integrated operations, will be extension of the 51% divestiture obligation to their Coal Development/ Utilization Activities in addition to their coal getting activities. The extension of the 51% divestiture obligation is only relevant in the case of PMA Companies (or deemed PMA Companies) carrying on integrated coal getting and Coal Development/Utilization activities.

4.4 *Reduced Production Royalties :* The Government is understandably concerned about the poor outlook for traditional coal mining in Indonesia and the very serious economic implications of this for both the Government and those Provinces most dependent upon coal mining.

With no real prospect of a material improvement in coal exports, it is also understandable that the Government wants to ensure much greater domestic absorption of Indonesia's coal production than is currently the case. To this end, it may well be sensible (other than from an environmental protection perspective of course) to provide incentives to holders of Coal IUPs/IUPKs and holders of Continuation Coal IUPKs which facilitate greater domestic coal absorption. Is, however, constructing a mine mouth power plant really sufficient to justify a 0% Production Royalty in respect of the coal used as the energy source for that mine mouth power plant? This seems particularly problematic in the case of holders of Continuation Coal IUPKs which would otherwise pay a 13.5% Production Royalty in respect of that coal.

Summary and Conclusions

Despite the widespread usage of the term "coal downstreaming", this is not what the New Mining Law and the Omnibus Law encourages and, in some cases, requires. Rather, the New Mining Law and the Omnibus Law, in fact, seek to encourage and in some cases require Coal Development/Utilization.

Value added activity is not necessarily part of Coal Development/Utilization as envisaged by the New Mining Law and the Omnibus Law.

Coal Utilization, involving the construction of mine mouth power plants, would seem to be a very doubtful "value added activity", especially in a time of growing environmental concern about the use of fossil fuel for electricity generation and given the reality of energy transition which is, apparently, here to stay.

While Indonesia's dependence upon the coal industry is not likely to change any time soon, the Government needs to make sure that the benefits and incentives it offers to the coal industry, in order to ensure its continuity and prosperity, are justified with respect to what Indonesia and its people receive in return for those benefits and incentives. The Government also needs to ensure that these benefits and incentives do not encourage Indonesian coal producers to ignore the energy transition phenomenon and continue to build mine mouth power plants when the rest of the world is moving towards electricity generated from renewable energy.

The New Mining Law and the Omnibus Law reflect some very questionable policy choices when it comes to the apparent acceptance of Coal Utilization alone as being sufficient to constitute Coal Development/ Utilization and thereby qualify parties carrying out the same for very significant benefits and incentives.

Can Coal Be Made Environment-friendly?

— Dr. G.V. Ramana*

The task before Coal Preparation Society of India (CPSI) and world coal community is an onerous one. It is necessary to plan for a balance between how to preserve coal's role as a major source of energy while addressing concerns raised by anti-coal environment lobby about coal's adverse impact on environment.

In the 20th Anniversary Celebrations of CPSI, the inaugural session was interesting. Justice Swatantra Kumar, Chief Guest, an eminent person involved in environment justice, pointed to the need for energy planning for sustainable development and not merely jumping into something which appears promising clean energy but whose long term adverse impact on environment is unknown. He was referring to solar and hydroelectricity. Hydropower has huge environment impact in terms of deforestation and siltation. Solar too can have devastating impact when lifecycle of project ends and the facilities have to be dismantled and disposed off.

Dr. V.K. Saraswat, Guest of Honour, laid out a road map for sustainable development of coal industry till 2040. He raised two important issues that can address a large part of coal's adverse impact on the environment. He stressed on the need for technologies for carbon sequestration and hydrogen which can be thought of as focus areas for coal to enable it to continue its primary role in the energy sector in India.

Why hydrogen? It has 2.5 half times energy content of methane per unit weight. Unlike methane, it does not emit any carbon dioxide during combustion only water vapour which can be condensed into water. Storage techniques are known and can be further improved. Hydrogen for power generation or transportation are reasonably developed but not brought in to mainstream commercial mode due to present fascination with battery technology.

What is the best way to produce hydrogen? It would depend on the country's energy resource base. Electrolysis of water is a known method that first comes to mind but involves high electricity consumption. This may be viable in countries which have invested in and recovered the cost of hydropower or solar installations and surplus power is available for this purpose. Reformation of methane using high pressure steam is another which may suit those countries that have natural gas resources and would like to divert some of them to produce hydrogen. This makes sense in a falling LNG or CNG market.

Certain chemical reactions, such as aluminium with alkali, zinc with hydrocholoric acid, refinery residues at high temperatures reformed with steam are also known. And there is potential for disruptive technologies which can change the game altogether. A decade ago, Tata Steel Ltd. developed a brilliant and innovative technology, which they patented, for producing hydrogen from hot slag of blast furnace, i.e., waste heat. Hopefully, this technology will go beyond the proof-of-concept stage with proper focus from the Tata group.

Of all the technologies to produce hydrogen, electrolysis and steam methane reformation routes are the most prevalent. Methane is naturally available or manufactured through a number of techniques such as coal bed methane, coal mine methanation, bio-methanation, etc. In this paper, we focus on hydrogen from coal through bio-methanation process.

Why coal? Every country should plan its technology development or acquisition based on its needs. In the energy sector; India is rich in coal (though of poor quality) and solar energy. Hence, energy planning has to be based on what we have. By planning for optimum utilisation of available energy sources, preferably with technology and production capabilities built indigenously, India can fulfil its dream for rapid development of the country.

Solar energy is available in plenty but technology for this energy source is largely imported. Second, battery technology, for storage of power, is largely based on

*Managing Director, Ardee Hi-Tech Private Ltd.

lithium ion, a metal which is not available in the country. While India should continue efforts to develop low cost alternatives for solar energy including generation and storage, this will take time and we may be dependent on imports for critical inputs into battery storage technology.

This is where coal will continue to remain important. The approach towards converting coal into a clean fuel like hydrogen by 2040 needs several intermediate steps. First and foremost is to stop using raw coal directly in end use by preparing it prior to despatch. Not only is it inefficient to use untreated and unprepared low quality fuel it has huge attendant costs like higher transportation costs per unit of energy, high level of emissions, huge costs incurred in arresting, minimising and handling emissions to comply with environment regulations.

Since India has abundant coal, it is possible transform this into methane in the first stage and then to hydrogen. This technology is within the grasp of Indian technologists and scientific community and needs support to transform a promise into reality. With careful planning, a step-wise progress towards a hydrogen-based energy economy can become a reality sooner than later. What are the technological issues involved and how to go about addressing those?

The primary step is to ensure that each and every tonne of coal gets prepared and beneficiated at the pithead itself. Even simple crushing and re-sizing exercise can substantially reduce costs at user end by expediting wagon unloading and subsequent handling. If coal is deshaled or beneficiated, energy balance at user end increases positively, thereby, improving viability.

Rather than talk about zero emissions in the distant future, we can set modest targets like reducing emissions by say 20% over next 5 years and 50% over next 10 years through supply side improvements? To re-iterate, the first step towards this goal is to prepare coal - size, wash / deshale raw coal either through wet or dry methods. Otherwise, we are simply transferring the nuisance of handling contaminants, causing unnecessary emission of fly ash at user end and passing on these costs to customers and the environment.

These are the paradigms around which India, the CPSI and indeed the world coal community are endlessly striving for a solution. This has been well highlighted in the 20th Anniversary Celebrations. All participants agreed that the time for action is now. As of today, focus is on converting coal at pithead into a more environment-friendly fuel. Coal bed methane is one such technology already in vogue at certain underground mines. This technology extracts the free methane gas in the coal beds by injecting steam and helping release the trapped methane gas which is then captured and sent by pipelines to a preparation unit. The scope for this is limited due to the overwhelming domination of open cast mining in coal production.

Next is mined coal gasification or surface gasification. This involves transforming the coal into methane using the gasification route. From this gas, methanol can be produced which is a direct replacement for Liquefied Natural Gas (LNG). There is a proposal at Coal India for producing methanol from coal. While the initiative certainly needs to be lauded for transforming coal into a more environmentally-friendly fuel. attention needs to be given to economic viability. The capex and opex costs of the project appear to be high. As ex-Chairman of Coal India Ltd., Mr. Partha Bhattacharya, pointed out, high capital costs of such technologies may be a deterrent to wide-scale adoption of the technology. He questioned the use of premium grade coal from Eastern Coalfields in this process. The opportunity cost of direct sales of these coals when transposed into cost of production of methanol would probably cause this fuel to be priced out of the market. The output cannot compete with LNG, a gas being traded internationally. Certainly, this is food for thought and suitable review by government and Coal India.

Other known technologies are the coal gasifier for producing syngas using Lurgi or liquification of coal using Sasol process or similar such technologies are known for several decades. Again Sasol or Lurgi process cannot use high ash coals and it requires a policy decision as to whether low ash coals can be reserved for methanation or liquefaction and let other consumers make do with high ash coals.

There are several simple coal gasifiers already in operation in states like Gujarat. Here many gasifiers use imported Indonesian coal rather than lignite locally available. Efficiency of these processes has not been studied scientifically and quality of gas produced is unknown. In some instances, its operations can be polluting and indicates the need for better pollution control practices. There is a need to standardise the specifications so that highly polluting technologies do not crowd out the better technologies merely on economic viability criteria.

The point to note is that methane, though a cleaner fuel than coal, is still an intermediate stage for the goal of zero emissions. Gas or liquid from coal does not eliminate emissions totally. During combustion, they emit carbon dioxide which is a greenhouse gas. For them to be acceptable in the target for reduction of emissions, carbon capture technologies are additionally required. These carbon capture or sequestration techniques are expensive at present and most users are averse to investing in such facilities. The task for our coal producer and user companies is to find indigenous low cost solutions that are efficient, inexpensive and easy to implement. There is need to invest in R&D to develop solutions that are clean, inexpensive and easy to implement to ensure relevance of coal in the future.

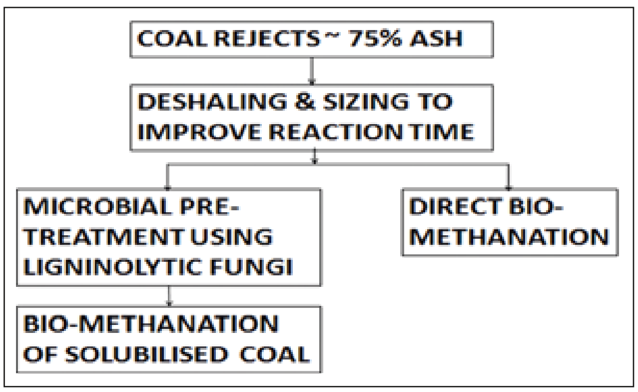
There remains the question of energy balance. While conventional coal gasification technologies such as gasifiers use some heat to convert coal into gas, there is one technology that utilises virtually no heat energy in converting coal into methane. This is coal bio-methanation, a known process that was briefly taken up half a century ago and abandoned in India. Internationally, researchers are working on this process with some degree of success. The basic process is that introducing bacterial microbes in a specially designed reactor helps release methane. This is scrubbed to remove carbon dioxide and carbon monoxide that are co-produced yielding clean methane gas similar to natural gas.

The icing on the cake for this technology is that after the bacteria has converted the entire carbon in coal feed into gas; the non-carbonaceous residue left behind is rich in humic acid. Unlike fly ash, a by-product of combustion, this residue can be utilised as a soil additive and boost resurrection and restoration of de-coaled areas.

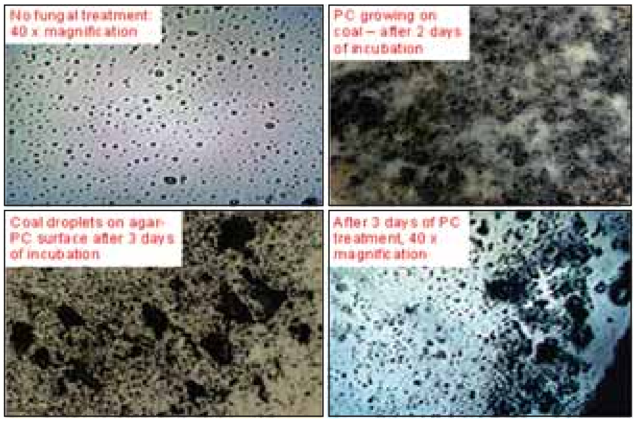
This technology has passed proof of concept stage and requires further research in areas like optimising bacterial combination either sequentially or direct, nutrient addition, digester reactor design and acceleration of reaction time. After suitable scrubbing and compression, the methane producted can be used to generate power in a combined cycle power plant with much higher thermal efficiencies than directly burning coal. Or it can be transported by pipelines to distant locations at a fraction of the cost of rail or truck transportation. The nutrient rich residue can be used to restore de-coaled areas or distributed in neighbouring area of the mine as a part of Corporate Social Responsibility (CSR).

This helps address a number of issues simultaneously. Requirement of water for deep washing coal comes down since bio-methanation is not too sensitive to coal quality except that it requires deshaling to reduce volume overload on reactors and improve gas yield. Bio-methanation also requires sizing and pulverisation (< 5 mm) to improve surface area exposure to bacteria and reduce conversion time. Whether for direct coal use or for bio-methanation some amount of preparation of the coal is a pre-requisite for approaching the target for emission reduction.

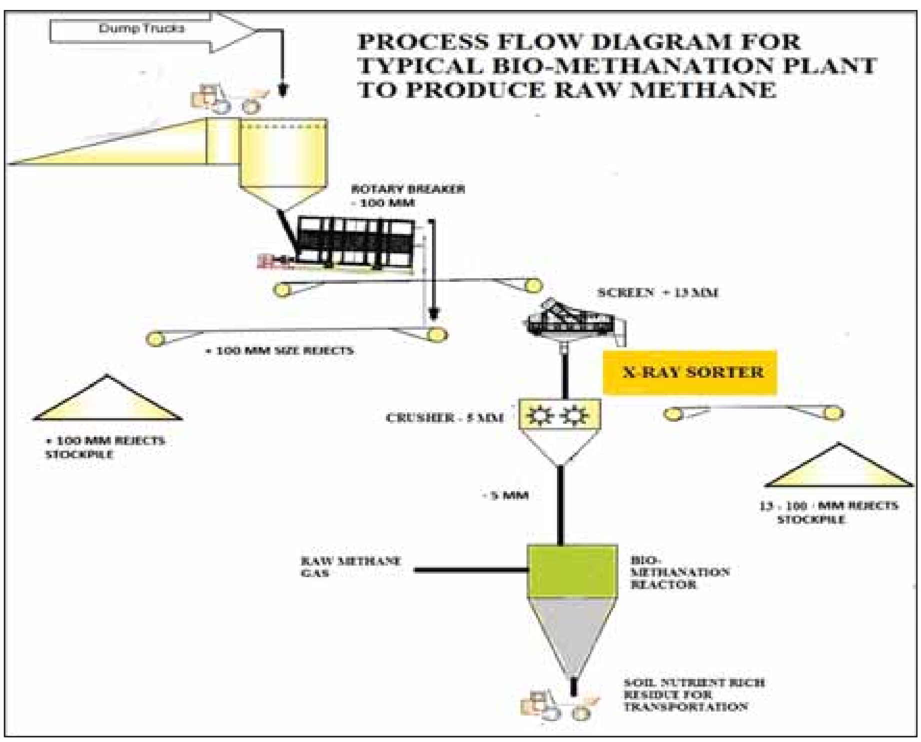
A lab study done on high ash rejects (~ 75% ash) of Talcher coal by Ardee in association with BITS Pilani, Hyderabad Campus and jointly funded by Department of Bio-Technology and Ardee followed two routes. Solubilisation of pulverised coal through microbial fungi treatment and thereafter bio-methanation using bacteria. Second approach was direct bio-methanation. The same is represented below:



Primary solubilisation of coal had better yields (~ 20cc of gas/gm) than direct bio-methanation though process is slightly more elaborate. A picture of transformation of coal to gas is given below:



Though both methods are viable, final decision on route to be taken can be finalised after determining costs of conversion. Further, every coal needs to be tested before deciding on the optimal bio-methanation route. Irrespective of type of coal, before undergoing bio-methanation, the coal has to be prepared, deshaled, sized and pulverized. The ideal process flow for this technology to be successful as its objective towards final target is given below:



Bio-methanation, is a strong contender for a futuristic role for coal. However, it forms the base but not the end. Methane still remains an intermediate fuel since carbon dioxide generation takes place during bio-methanation and also during combustion of methane gas. Zero emissions objective requires transformation of this methane gas into hydrogen which is a true zero emissions fuel. Several institutes have done excellent research and reported zero energy loss in this transformation from methane into hydrogen. The proof of concept exists and research and development efforts and resources are needed to refine these technologies, further reduce costs and improve efficiencies.

Work on a parallel footing should go on for carbon sequestration. A lot of work has gone into this area but more needs to be done before it can be mandated as a compulsory facility and adapted as a widely accepted norm in the industry. Merely imposing a mandatory requirement without addressing the attendant cost economics or compensation mechanisms will render many power utilities and user industries bankrupt or forcing consumers to pay a steep price.

A lot of innovation, out-of-the-box thinking and allocation of resources - scientific, policy and monetary - is required to achieve these technology targets and keep coal relevant. There are risks that are associated with development of these technologies. Cost of technology development is high and beyond the capacity of small companies and scientific institutions to arrange for the funding required. Government has the primary role in taking up these steps on a war footing. Industry giants and stakeholders need to get involved in the development of these technologies either on their own or as a consortium. The government on its part can play a role in incentivising these risks through a knowledge or technology fund apart from tax incentives and grants.

Industry leaders in the coal and power sector need to think of achievable goals with a roadmap in the next 5 - 20 years on how to make the best use of our coal resources without attracting flak for its environment fallout. The time to start is yesterday. Work on new technologies, energy transformation, utilisation techniques, carbon capture and extracting full range of mineral value from coal to improve techno-economics of process takes several years to be ready for the market.

The world is not going to allow business to continue as usual as far as coal is concerned. As it is, oil and gas are now facing heat. Countries in Europe and even cities like Delhi are banning or severely restricting new vehicles using fossil fuels. Also, both energy sources have limited life. The only two clean energy technologies that have the potential for competing in transportation and energy sector are lithium ion battery and hydrogen. India does not have lithium deposits and depends on imports, which is being controlled by few global companies.

Hydrogen appears to be by far more promising for India. It is a clean fuel with zero emissions. Its emissions are basically water vapour which can be easily condensed to give pure water. This is where bio-methanation and carbon sequestration combination route have a distinct advantage for India since it has a positive energy balance vis-a-vis conventional methanation of coal.

Further, even lithium ion battery technology requires electric power for charging. Option is to get it from solar energy or from hydrogen. This is where coal to hydrogen technology and solar can complement each other. While one generates power for an average of 8 hours per day, the other is a 24 hour operating process. These two combined can address peak load issues and balance power requirement.

What are the steps to be taken by coal industry?

1. Invest in cost-effective and clean technologies for primary treatment of coal, either dry or wet, before it is utilised for end use. Objective is to minimise overloading user or conversion equipment with contaminants.
2. Invest in R&D in potentially highly promising technologies like bio-methanation for transforming low quality coal into methane, a less polluting fuel than coal.
3. Find methods to extract useful chemicals and minerals from the residue of the bio-methanation process.
4. Invest in technologies for conversion of methane into hydrogen.
5. Optimise and convert combined cycle power plants to generate power from hydrogen.
6. Improve on carbon capture and sequestration process including how to make it more effective in terms of cost and space required.
7. Investigate potential uses of carbon emissions and whether carbon nano-particles can be produced which have tremendous uses in a wide range of applications.

Hopefully, coal producers and user industries will realise the warning signals being flashed and work towards keeping themselves relevant in the coming days.

Theoretical Quantification of Generation of Washery Rejects from Non Coking Coals of Odisha Coalfields

– T. Gouri Charan*, U.S. Chattopadhyay*

Introduction

The Gondwana origin Indian coals contain high ash and possess difficult to very difficult washability characteristics. Beneficiation of high- ash non-coking coals of India has become the prerequisite for improving the overall economics and efficiency of power generation. The state of Odisha contains approximately 23% of India's reserves of non-coking coal and distributed in Talcher and Ib Valley coalfields. The coals are required to be washed before it is sent to power stations and due to vide variation in the ash content quantification of rejects becomes very vital for setting up of commercial coal washeries. Due to the high raw coal ash content, the generation of rejects is expected to be on higher side after the clean coal is extracted at 34% ash content. Conventional float - and - sink testing was carried out to determine the theoretical yield of clean coal at 34% ash content and the corresponding rejects generation. Due to the high raw coal ash content, the generation of rejects is expected to be on higher side after the clean coal is extracted at 34% ash content. On detailed studies of the washability data for the coals of feed ash ranging from 36% to 55% for both Talcher and Ib Valley, it is possible to quantify theoretically the percentage of rejects generation considering the respective feed ash . Such data will be useful for getting information regarding the variation of the quantum of rejects with respect to feed ash content. The paper presents the relation between the feed ash content and the rejects generated at 34% clean coal ash content.

Experimental

The coal samples were collected from the working benches with the help of a Haulpack and payloader, by scraping the entire cross section of the bench at various places from each of the collieries from Talcher and Ib Valley Coalfields. After proper and thorough mixing, about 10 tons of sample from each colliery were collected and brought to the laboratory for further studies.

The raw coal was taken and first screened at 75 mm; the plus 75 mm fraction was crushed in a single roll crusher. Representative samples from the overall combined fraction of the product below 75 mm was taken for studies like raw coal characterization, size analysis and size wise float and sink tests. Representative sample was subjected to dry screen analysis at sizes 50, 25, 13, 6, 3 and 0.5 mm. The individual size fractions were subjected to float - and - sink tests, and the relative density range was 1.40 to 2.00. The washability and Mayers curve was plotted for determination of the recovery of clean coal and rejects. The minus 0.5 mm coal fractions were not subjected to float-and- sink tests.

Results and Discussions

The characterization of the coal revealed that the ash content of the raw coal of Talcher is less compared to that of the Ib Valley coals. The washability characteristics of Talcher coals are good comparative to Ib Valley coals. The washability data obtained from the float and sink test of different coals was used for estimation of the theoretical recovery of clean coal at 34% ash content and corresponding the recovery of rejects. The data is shown in Table 1.

*CSIR – Central Institute of Mining & Fuel Research, Dhanbad, India.

Table 1 : Theoretical recovery of clean coal and rejects

Feed Ash% (dry)	Theoretical Recovery (%) (at 34% clean coal ash)	
	Cleans	Rejects
	Wt%	Wt%
36	95.4	4.6
37	92.3	7.7
38	89.1	10.9
39	81.8	18.2
41	77.6	22.4
42	69.9	30.1
43	66.5	33.5
45	60.5	39.5
47	55.6	44.4
50	51.7	48.3
55	44.9	55.1

The data is shown graphically and depicted in Figure 1.

It may be observed from the Figure 1, that a linear trend was observed for both rejects and cleans and the R2 is 0.99 indicating that there is a good relationship between the feed ash content and the recovery of rejects and cleans. The above relationship may be used for rough estimation of the percentage of rejects that will be generated based on the feed ash content.

However, it is to be mentioned that the theoretical yield of clean coal at 34% ash content and the corresponding reject as mentioned in the above Table 1 may not be achievable in actual plant practice due to dynamic system of the washers. The practical yield to be obtained from the commercial plants varies in quality and quantity depending on the efficiency of the washing system and the Near Gravity material at the particular gravity of cut.

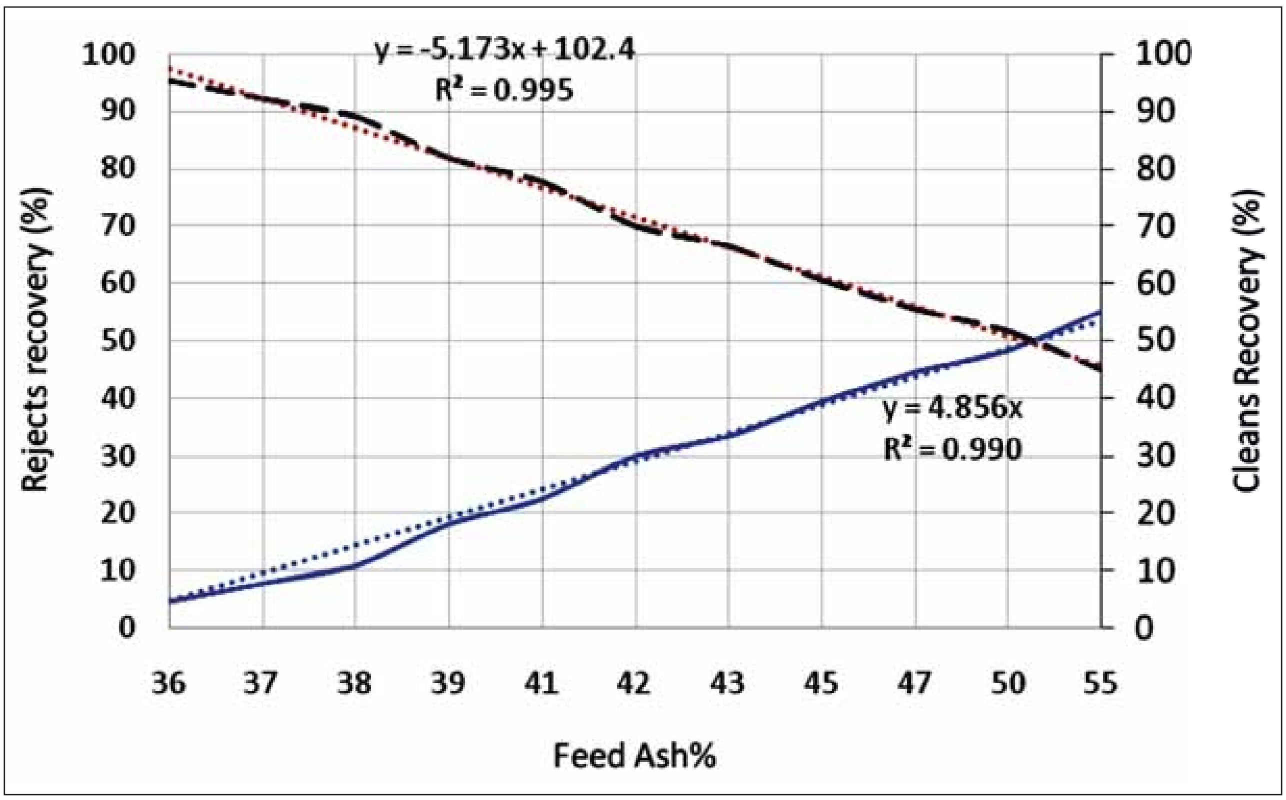


Figure 1 : Plot between Feed ash% Vs Reject % & Cleans%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Dr. V K Saraswat
Hon'ble Member NITI Aayog
Eminent Panellists
Shri Jairam Ramesh
Member of Parliament (RS)
Shri Alok Perti
Ex Coal Secretary
Shri Anil Razdan
Ex Power Secretary
Shri Sanjay Srivastava
Ex Coal Secretary
Shri Partha Bhattacharya
Ex CMD, Coal India Ltd.
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Former Chairman, CERC
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Captain R S Sindhu
Chairman, ACB (India)
Shri Sandeep Jajodia
CMD, Monnet Group
Ms. Michelle Manook
CEO, World Coal Institute
Shri Vinay Prakash
CEO, Adani Enterprises
Shri Surojit Samanta
CMD, S K Samanta & Co.
Invited Experts
Shri Shekhar Saran
CMD, CMPDIL
Dr. David Woodruff
UK
Dr. Andrew Minchener
IEA Clean Coal Centre, UK
Dr. T Gouricharan
Chief Scientist,
HORG : Coal and Mineral Processing
Coordinator : General Engineering
Prof. Quentin Campbell
South Africa
Dr. G V Ramana
Managing Director, Ardee-Hitech
Prof. Sumantra Bhattacharya
IIT (ISM)
Supporters
JINDAL STEEL & POWER
ACB (INDIA) LIMITED
COTECNA
QA Testing Laboratories Private Limited
For any assistance & Registration, contact : +91 9990602039, 9810302360 • E-mail : tm@qatestinglaboratories.com, rksachdev01@gmail.com

Gist of Deliberations in the Anniversary Conference

held on 4th December, 2020 on virtual platform.

Theme: Coal to dominate India's Energy Mix : Preparing it for responsible usage is an imperative

To celebrate completion of 20 years of very fruitful existence Coal Preparation Society of India (CPSI) organised a one-day Anniversary Conference on 4th December 2020 on a very topical theme 'Coal to dominate India's Energy Mix: Preparing it for responsible usage is an imperative'. Mr. Justice Swatanter Kumar (Retd), Former Chairperson, National Green Tribunal (NGT) was the Chief Guest and he also delivered the inaugural address. Dr. V K Saraswat Member NITI Aayog was the Guest of Honour at the conference.

An expert panel comprising of S/Shri Alok Perti, Ex Coal Secretary, Anil Razdan, Ex Power Secretary, Shri Sanjay Srivastava, Ex Coal Secretary, Shri Partha S Bhattacharya, Ex CMD, Coal India Ltd, and Shri Peeyush Kumar, Director (Technical) in the Ministry of Coal discussed various issues pertaining to the energy sector in general and coal industry in particular, keeping in mind the theme of the conference. Shri R K Sachdev, President, CPSI moderated the panel discussions.

Panel discussions were followed by industry leader's session in which S/Shri Ramesh Babu Director (Operations) NTPC, V R Sharma, MD, JSPL, Sandeep Jajodia, CMD, Monnet Group, Ms. Michelle Manook, CEO, World Coal Institute and Shri Vinay Prakash, CEO, Adani Enterprises, V B Sahay, Sr. VP, ACB (India) participated.

Various subject experts who participated in the technical session included Shri Shekhar Saran, CMD, CMPDIL, Mr. David Woodruff, FLSmidth, UK, Dr. Andrew Minchener, IEA Clean Coal Centre, UK, Prof. Quentin Campbell, North West University, South Africa, Dr. G V Ramana, Managing Director, Ardee-Hitech and Dr. T Gouricharan, CIMFR, Dhanbad.

Gist of Deliberations:

In his opening remarks, Shri Alok Perti Ex Coal Secretary and Chairman, CPSI welcomed the Chief Guest Justice Swatantra Kumar, (Retd), the Guest Honour, Dr. V K Saraswat, Member NITI Aayog, all panellists, experts and the participants. Shri Alok Perti mentioned that the Coal Preparation Society of India (CPSI) has completed 20 years of unblemished and dedicated service to coal, power, steel, cement and their allied industries. He further said that despite its decline in various western countries, coal will continue to be a major contributor to India's energy demand well through the 2040s and beyond.

Shri R K Sachdev, President CPSI also extended a very warm welcome, both to the Chief Guest and the Guest of Honour. He mentioned albeit very briefly how and why the Coal Preparation Society of India (CPSI) was set up with the objective to promote washing of domestic coal containing high ash content and improve its heat value so that it burns efficiently with significantly reduced emissions. He further mentioned that CPSI represents India in the International Organising Committee (IOC) of the International Coal Preparation Congress (ICPC) which is held once in three years in different parts of the world. During November, 2020 the 19th International Coal Preparation Congress & Expo (ICPC) was held in New Delhi under the aegis of CPSI. This prestigious global event on coal was held in India after 37 years and CPSI hosted it. The last one was the 9th ICPC held in New Delhi in 1982. He expressed satisfaction that as a result of a persistent and dedicated campaign carried out by CPSI a large number of coal washeries have been set up in the coalfield areas.

In his inaugural address, Justice Swatantra Kumar, (Retd), Former Chairperson, National Green Tribunal, an eminent person involved in environment justice, highlighted the need for energy planning for sustainable development and not merely jumping into something which appears promising clean energy but whose long-term adverse impact on environment is yet unknown. In this context he was referring to solar and hydroelectricity. He observed that hydropower has a huge environmental impact in terms of deforestation, siltation and human displacement. Solar too can have devastating impact when life of a project ends and the facilities have to be dismantled and the solar panels that contain toxic elements have to be disposed of in an environmentally acceptable manner. According to the Chief Guest, in each development project, all environmental and sustainability aspects must be studied before launching the project.

Justice Swatanter Kumar spoke at length about various energy sources and stressed upon the policy makers and the project developers to be sensitive about the environmental sustainability aspects of production, storage, transportation and utilisation of dry fuels like coal and hydrocarbon fuels namely oil and natural gas.

While referring to India's natural endowment of coal in abundance vis a vis the limited known oil and gas resources, the Chief Guest stressed upon the need of adoption and adaptation of clean technologies for ensuring country's economic development with least adverse impact on human lives and fauna, flora and aquatic life.

While concluding his address the Hon'ble Chief Guest, stressed upon the need of setting up coal washeries for improving the quality of domestic coal so that its heat value and combustion efficiency and emissions are consequently reduced. He further stressed upon the fact that adequate care must be taken while designing and establishment of coal washeries so as to ensure that these facilities do not pollute air and water bodies in their vicinity.

Justice Swatanter Kumar released the special Anniversary Issue of CPSI Journal and congratulated the Society for its dedicated service to the Nation in promoting cleaning of coal and adoption of clean coal technologies in India.

While congratulating CPSI for its persistent efforts and campaign for promoting coal washing, Dr. V.K. Saraswat, Member NITI Aayog, Guest of Honour, made a very exhaustive and well researched presentation covering all aspects of coal production-supply-utilisation chain and laid out a clear road map for sustainable development of coal industry till 2040. He raised important issues pertaining to coal's adverse impact on the environment. He stressed on the need for adoption / adaptation of high efficiency clean technologies for coal usage and also stressed upon the need for research for carbon sequestration and utilisation as a focus area for coal to enable it to continue its primary role in the energy sector in India.

While highlighting the challenges before Indian coal sector, Dr. V K Saraswat in his detailed presentation, covered the entire gamut operational and economic challenges facing the sector including, inter alia, coal mining, preparation, transportation, utilisation, new advanced emerging technologies and products, R & D and allied developments.

He also dwelt upon new policy imperatives that must be addressed at home and the need for reducing coal import dependency due to inadequate domestic production, both in terms of quality and quantity. In this context he observed that the establishment of a coal regulator with a clear mandate to enable a competitive market structure in the coal sector in India is needed immediately.

He cautioned that India's commitment under Paris agreement does not allow us to expand our coal consumption in the long-run. Therefore, for sustainability of coal demand and consumption, there is a need to develop coal in a new carbon age powering a wave of innovation in advanced products like - Coal to liquid fuels and chemicals; carbon fiber, activated carbon, graphite, electrodes, graphene, building and construction products, carbon foam and carbon black and other emerging industrial applications including biotech, medical and agriculture uses.

Dr. Saraswat highlighted that Coal Beneficiation for quality enhancements of coal for special product applications will have to be adopted on a very large scale. As over 90% coal is produced by open cast methods, deterioration of quality of coal often takes place, which makes a proper beneficiation of coal an integral part of coal production and supply chain.

Highlighting the government's strategic vision 2030 for Coal Sector, Dr. Saraswat mentioned various imperatives that inter alia, covered steps to cut down delays in mine development, improving operating performance, optimisation of the environmental performance of energy systems, reducing impacts on water and other resources and so on.

The entire focus now has to be towards transforming fossil energy systems for the future through development of technologies to enable highly flexible and reliable power systems with carbon-neutral or net-negative emissions. In this context he extensively explained the role of Hydrogen economy as well.

In the panel discussions and in subsequent discussions amongst subject experts, various policy related as well as technical aspects were deliberated in great details.

In the panel discussions and in subsequent discussions amongst subject experts various policy related as well as technical aspects were deliberated in great details and the following conclusions were reached:

- In development coal and allied projects, all environment and sustainability aspects of production, storage, transportation and utilisation must be studied before launching the project.
- There is an urgent need for adoption and adaptation of clean technologies for ensuring the country's economic development with least adverse impact on human lives and fauna, flora and aquatic life.
- Wherever coal washing is required for quality enhancement of domestic coal, adequate care must be taken while designing and establishment of coal washeries so as to ensure that these facilities do not pollute air and water bodies in their vicinity.
- For coal to continue its primary role in the energy sector, there is an urgent need for the introduction of high efficiency clean technologies for coal usage and this calls for research for carbon sequestration and utilisation (CCUS).
- There is an immediate need to address new advanced emerging technologies and products through R & D and allied developments.
- New policy imperatives for reducing coal import dependency due to inadequate domestic production, both in quality and quantity.
- Establishment of a Coal Regulator with a clear mandate to enable competitive market structure in the coal sector in India is needed immediately.
- In line with India's commitment under Paris agreement, for sustainability of coal demand, there is a need to develop coal in a new carbon age powering a wave of innovation in advanced products like – Coal to liquid fuels and chemicals; carbon fiber, activated carbon, graphite, electrodes, graphene, building and construction products, carbon foam and carbon black and other emerging applications in biotech and medical and agriculture uses.
- Coal Beneficiation for quality enhancements for special product applications will have to be adopted on a very large scale.
- In order to realise the government's strategic Vision 2030 for Atam Nirbharta in the coal sector, steps are required to cut down delays in mine development, improving operating performance, optimisation of the environmental performance of energy systems, reducing impacts on water and other resources and so on.
- The entire focus now has to be towards transforming fossil energy systems for the future through development of technologies to enable highly flexible and reliable power systems with carbon-neutral or net-negative emissions. In this he extensively explained the role of Hydrogen economy as well.

Recommendations:

Based on the Conclusions of the deliberations held in the conference, the following Recommendation emerged:

1. Invest in cost-effective and clean technologies for primary treatment of coal, either dry or wet, before it is utilised for end use. Objective is to minimise overloading users or conversion equipment with contaminants.
2. Greater focus on cost competitiveness of domestic coal must be ensured in order to retain their competitiveness as compared to imported one.
3. As India's coal is high in ash content, coal beneficiation should be done to reduce the ash content and improve its grade.
4. Introduce IT focused at mechanization and automation and digital technologies in mining in collaboration with a leading global organization.
5. Establish a Coal Regulator with a clear mandate to enable competitive market structure in the coal sector in India.
6. There is a need for improvement in safety performance in Indian coal sector. A dedicated effort has to be made to ensure achievement of the goal of zero fatalities and injuries.
7. Increase ash utilization in coal mine filling; collaborate and develop necessary frameworks, infrastructure and cost sharing mechanisms.
8. Increase adoption of remote sensing, core open drilling and geophysical and geochemical logging, 2D and 3D seismic survey.
9. Create a National Mission to promote coal consumption from alternate usage (coal gasification, coal to methanol, fertilisers, coal to chemicals, hydrogen, coal-bed methane etc.).
10. Invest in R&D in potentially highly promising technologies like bio-methanation for transforming low quality coal into methane, a less polluting fuel than coal.
11. Find methods to extract useful chemicals and minerals from the residue of the bio-methanation process.
12. Invest in technologies for conversion of methane into hydrogen.
13. Optimise and convert combined cycle power plants to generate power from hydrogen.
14. Improve on carbon capture and sequestration (CCUS) process including how to make it more effective in terms of cost and space required.
15. Investigate potential uses of carbon emissions and whether carbon nano-particles can be produced which have tremendous uses in a wide range of applications.

Coal Preparation Society of India,

Website : www.cpsi-india.org.in

One-Day Anniversary Conference

(at Virtual Platform)

Coal to dominate India's Energy Mix : Preparing for responsibleusage in animperative

04-12-2020

Dr V K SARASWAT
Member
NITI Aayog

NITI Aayog

Key Coal Data

- **Coal Production:**730 Mt, up by 48% since 2007.
- **Coal Imports:** 248 Mt imported (52 Mt coking coal and 197 Mt Non-Coking coal), up by 350% since 2007.
- **Consumptionby Sector:** 74% of Electricity Generation, 16.9 % Industrial Sector, 5.8 % Coke Oven and Blast Furnace, 3.3% Other residential and services.
- **Share of Coal:** 44% of Total Primary Energy Supply and 74% of Electricity Generation.
- Since 2071, use of coal for power generation has increased from 50% to the present level of 74%.

To satisfy growing coal demand amid production shortages, imports have been increasing since last two decades. There is need for opting **COAL TECHNOLOGIES** suitable for **INDIAN COAL** to lower down the import.

Importance of Coal

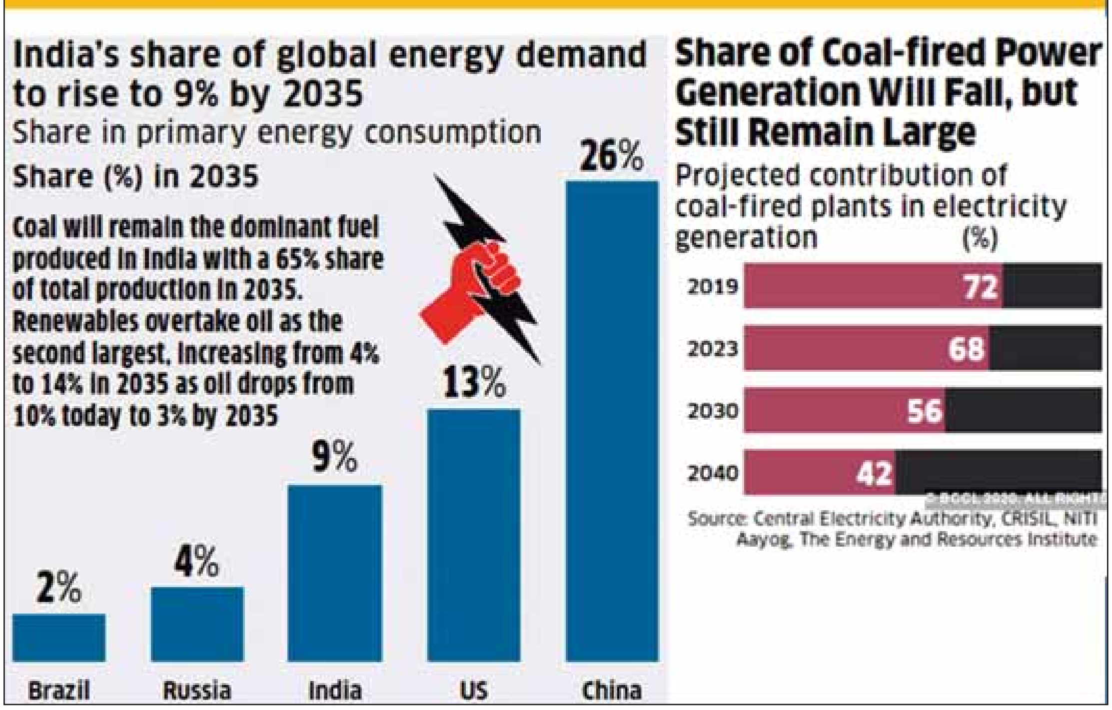
Value of Developing Coal Energy Technologies

- Cheap & Abundant: Coal prices historically low and stable over time
- Ease of Transport & Storage:
  - Spills and explosions a non-issue, multi-modal transport infrastructure in place
  - Multi-month stockpiles are the norm (not the case for natural gas and biomass storage)
- Good Backstop Fuel: Easily used in other solid fuel energy systems
- Burgeoning Use in Developing Nations:
  - Developing nations are expanding coal use as they industrialize
  - High efficiency technologies can dramatically reduce long-term emissions growth

What is the Path Forward?

- Identify pathways for coal to compete on both a cost and emissions basis
- Pathways must enable expanded use of renewable energy
  - Support and even leverage intermittent nature of certain renewable technologies
  - Bring down the cost of large scale integration

The role of coal in India's energy ambitions



India's INDC Targets for Meeting Climate Change Commitments

- Emissions intensity of GDP to be reduced by 33-35 percent (from 2005 level) by 2030.
- 40 percent of total power capacity to come from non-fossil fuel-based energy sources by 2030.
- Carbon sink of 2.5 to 3.0 billion tonnes of CO2 through additional forests by 2030.

State of Flue Gas Desulphurization (FGD)

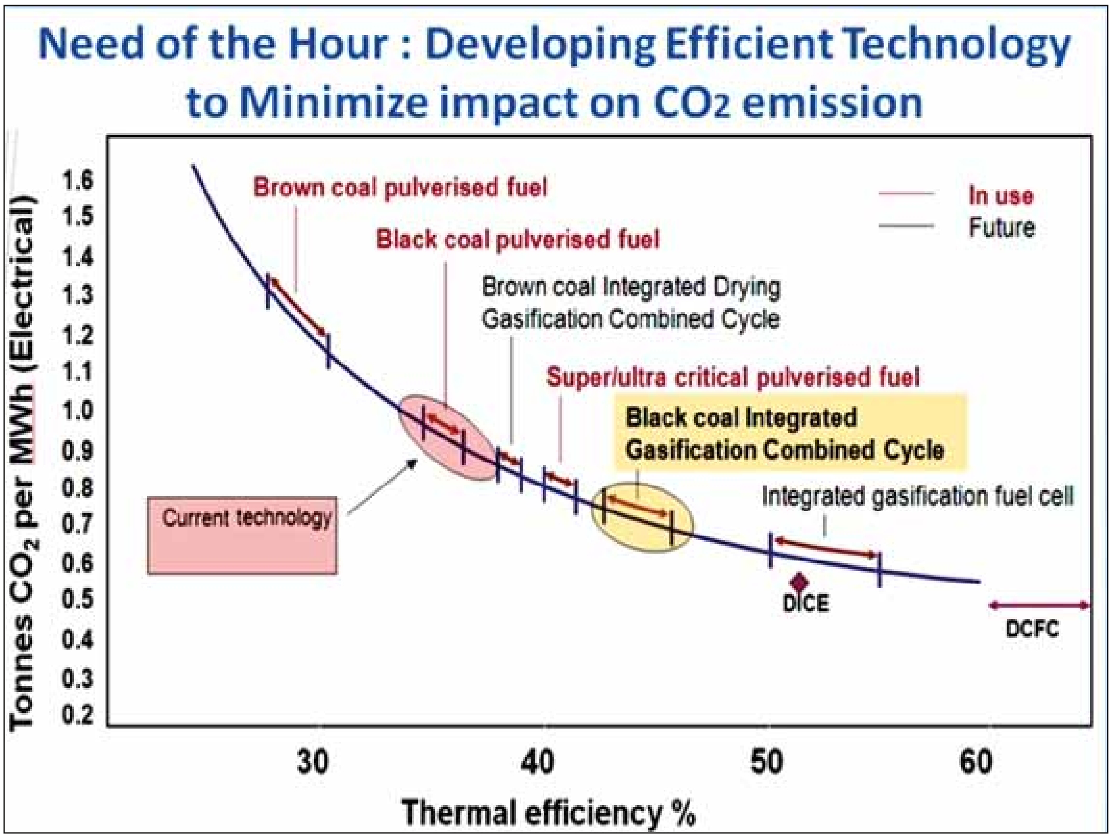
- Flue Gas Desulphurization for meeting reduced SOx, NOx levels on thermal power units emissions.
- 415 units identified by Central Electricity Authority to install FGD.
- NTPC has installed at two units, in process at 38 units including upcoming.
- No private player has met deadline of installing FGD system which was 2017.
- Now deadline extended to 2022.

COVID-19 has led to unprecedented energy market upheaval; uncertainty over the outlook for coal is the highest of all power generation fuels

- The COVID-19 crisis destabilized energy markets to an unprecedented degree in 2020. The IEA expects a sharp drop in **power sector coal demand in 2020 BY 8%.**

- The use of coal in power generation is being displaced by low-carbon energy sources such as hydro, wind, solar and nuclear, which have all been less affected by the COVID-19 crisis. Hence, changes in economic activity and the associated electricity demand have a tremendous effect on coal-fired electricity generation and overall coal consumption.

- A greater decline in coal demand is expected in India, where economic growth and power production are slowing significantly. Despite the recovery expected later in the year, a decline in coal power generation will push coal use down for the second year in a row.



Coal challenges for the next decade

- Clean Coal Technologies reducing the carbon footprint
- Technological leadership towards sustainable mining
- Alternative use of coal areas for renewables
- Valorization of coal products
- Mine reclamation, land restoration and post-mining activities
- Digital transformation
- Workforce development

Issues in Indian Coal Sector (1/4)

Import dependency:

- India has one of the largest reserves of coal but annual production from monopoly miner Coal India has not been enough to meet the increasing demand.
- Further, India does not have enough reserves of good quality coking coal. The imports are mainly to compensate the lack of good quality coal, especially coking coal.
- Boilers of many thermal power plants are designed to run only on imported coal

Lack of adequate technology:

- Technology adoption in underground mining is very limited. 87 per cent of the underground coal mines of CIL are either semi-mechanised or non-mechanised (manual).

Higher operational and maintenance costs:

- Coal plants have higher operation and maintenance costs because of strict regulations.

Issues in Indian Coal Sector (2/4)

Issue in demand side:

- Steel and power sector are two major consumers of coal. These sectors are one of the main reasons for NPA (non-performing asset) crisis in banks.
- There is shrinkage in global coal consumption, due to threat of climate change and also due to global economic slowdown.

International commitment:

- India's commitment under COP21 (Paris agreement) of UNFCCC does not allows us to expand our coal consumption in the long-run.

Limited mechanization:

- Small-scale mining is prevalent across the sector with limited mechanisation.

Delays in getting requisite clearances and the resultant cost overrun

Issues in Indian Coal Sector (3/4)

Logistics infrastructure is a key bottleneck:

- Coal resources in India are available in only six–seven states in the country, of which 80 per cent is concentrated in four states.
- This necessitates better logistics for bulk transportation over long distances. But growth in coal production is not adequately supported by growth in infrastructure.

Tax structure and transportation cost:

- Coal sector is constrained by tax structure and transportation cost. Taxes, duties and levies account for up to 25 per cent and freight accounts for up to 34 per cent of the overall coal cost undermining its competitiveness.

Monopoly of public sector:

- CIL produces almost 80 per cent of coal in India.

Ecologically bad practices:

- Recently Government done away with the regulation requiring power plants to use 'washed' coal, by terming it an unnecessary cost on coal user.

Issues in Indian Coal Sector (4/4)

Operating performance of the Indian coal sector is lower than its global peers:

- For instance, similar class of shovels in international mines are operated 40–50 per cent more hours annually than they are at CIL

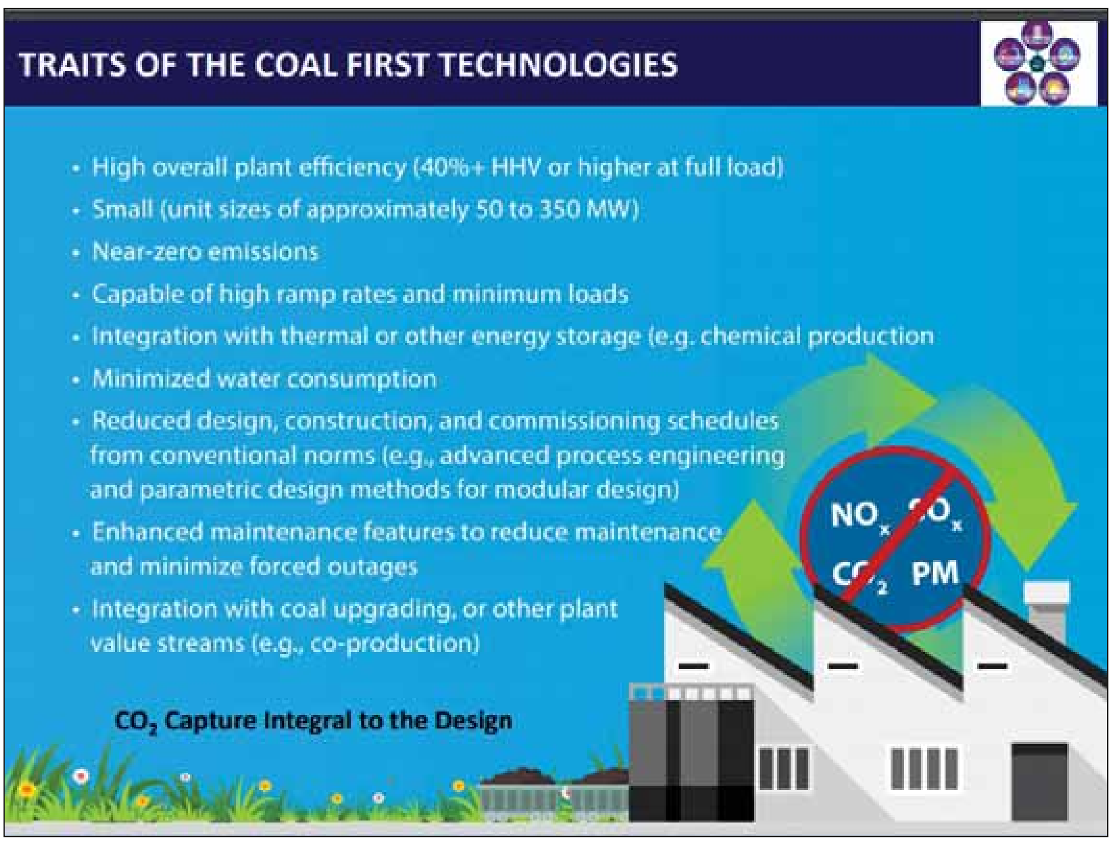
Chances of reduced coal demand in future:

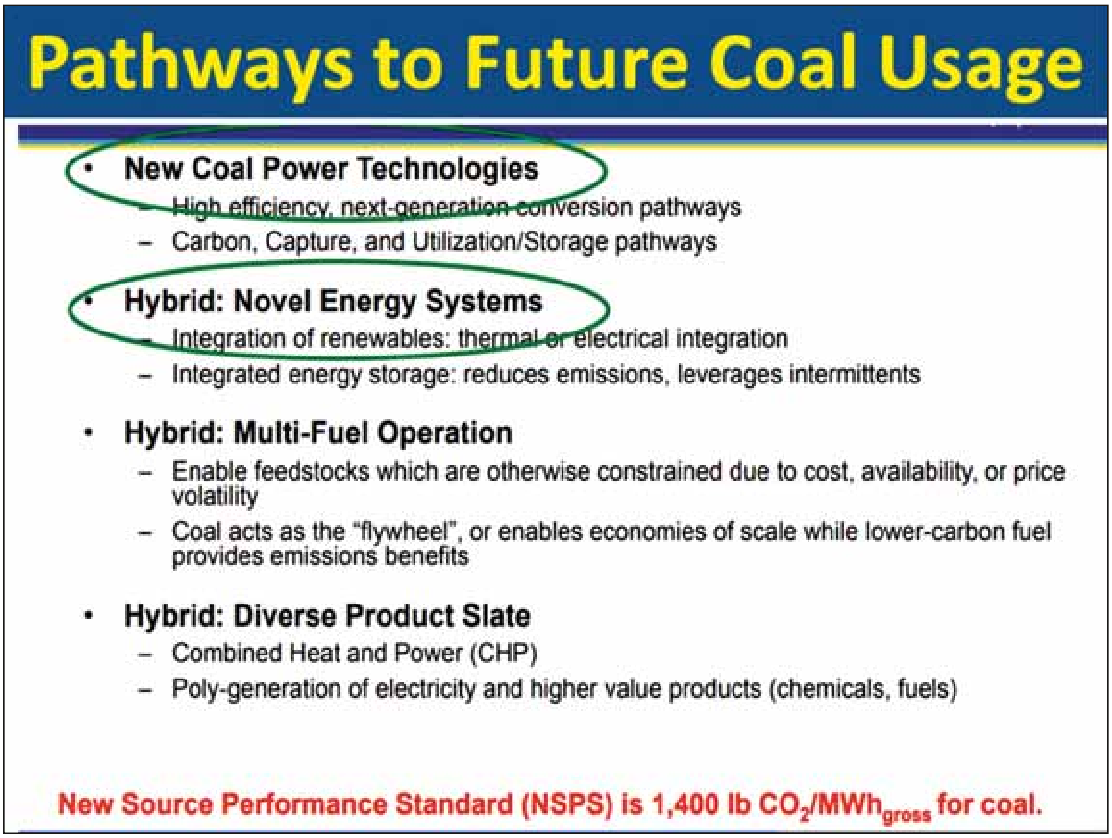
- With the increasing efficiency in solar power generation, the prices are expected to reach about Rupees 1.9–2.0 per kWh by 2025, which is comparable to coal-based generation cost. Such price levels could drive the substitution of coal-based power sources with renewables.
- Because of the rise in energy efficiency due to technology advancement and various energy saving initiatives by the government, energy intensity of GDP is estimated to continue to reduce. Thus reducing the energy demand growth for the same economic growth and thereby reducing the coal demand

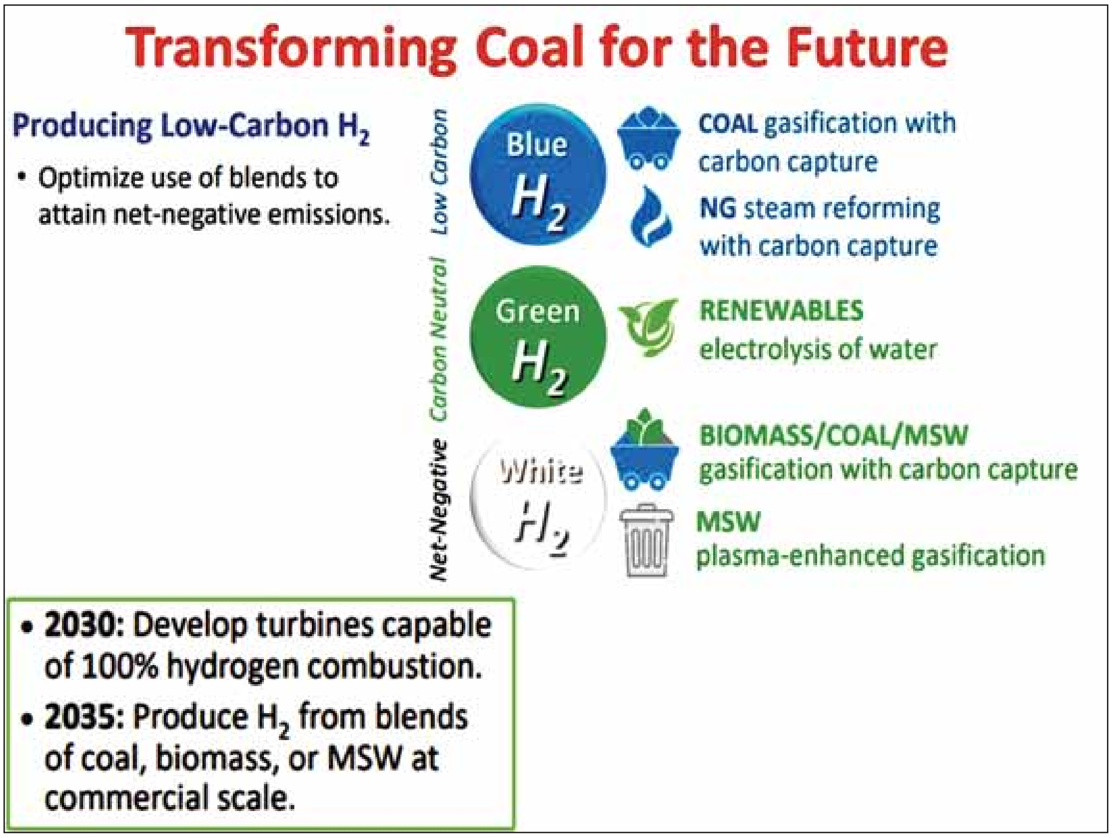
Coal in a new carbon age powering a wave of innovation in advanced products & manufacturing

Need to develop advanced markets for coal-derived products, materials and technologies

- **Coal to Liquids** – fuels and chemicals
- **Coal to Solid Carbon Products** – carbon fiber, activated carbon, graphite, electrodes, graphene, building and construction products, carbon foam and carbon black
- **Rare Earth Elements** – component minerals for health care, military, transportation, power generation, petroleum refining and electronics applications
- **Coal Beneficiation** – quality enhancements to coal for specialty product applications
- **Life Science, Biotech and Medical** – prosthetics and biosensors
- **Agricultural Uses** – fertilizer




Pathways to Future Coal Usage
• New Coal Power Technologies
– High efficiency, next-generation conversion pathways
– Carbon, Capture, and Utilization/Storage pathways
• Hybrid: Novel Energy Systems
– Integration of renewables: thermal or electrical integration
– Integrated energy storage: reduces emissions, leverages intermittents
• Hybrid: Multi-Fuel Operation
– Enable feedstocks which are otherwise constrained due to cost, availability, or price volatility
– Coal acts as the "flywheel", or enables economies of scale while lower-carbon fuel provides emissions benefits
• Hybrid: Diverse Product Slate
– Combined Heat and Power (CHP)
– Poly-generation of electricity and higher value products (chemicals, fuels)
New Source Performance Standard (NSPS) is 1,400 lb CO_2/MWh_{gross} for coal.


Transforming Coal for the Future
Producing Low-Carbon H_2
• Optimize use of blends to attain net-negative emissions.
Low Carbon
Carbon Neutral
Net-Negative
Blue H_2
Green H_2
White H_2
COAL gasification with carbon capture
NG steam reforming with carbon capture
RENEWABLES electrolysis of water
BIOMASS/COAL/MSW gasification with carbon capture
MSW plasma-enhanced gasification
• 2030: Develop turbines capable of 100% hydrogen combustion.
• 2035: Produce H_2 from blends of coal, biomass, or MSW at commercial scale.

Coal for Future

Developing 21st Century Coal Plants

- Design compact, modular, efficient, resilient coal-powered units.
- Complement the modern grid.
- Deliver carbon neutrality.
- Advance power generation systems.
- Offer utility-scale energy storage.

CoalFIRST

Flexible
Innovative
Resilient
Small
Transformative

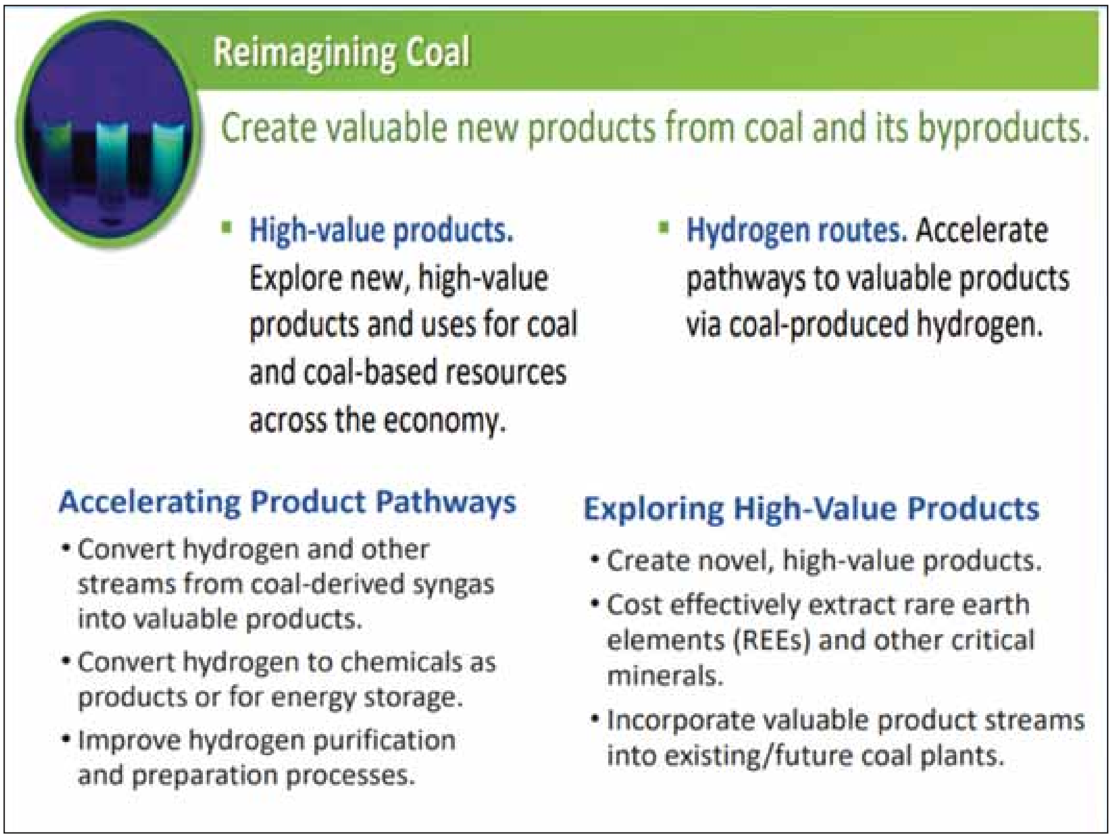
Achieve high overall plant efficiency (40% or more) at full load, with minimal reductions in efficiency over the required generation range.

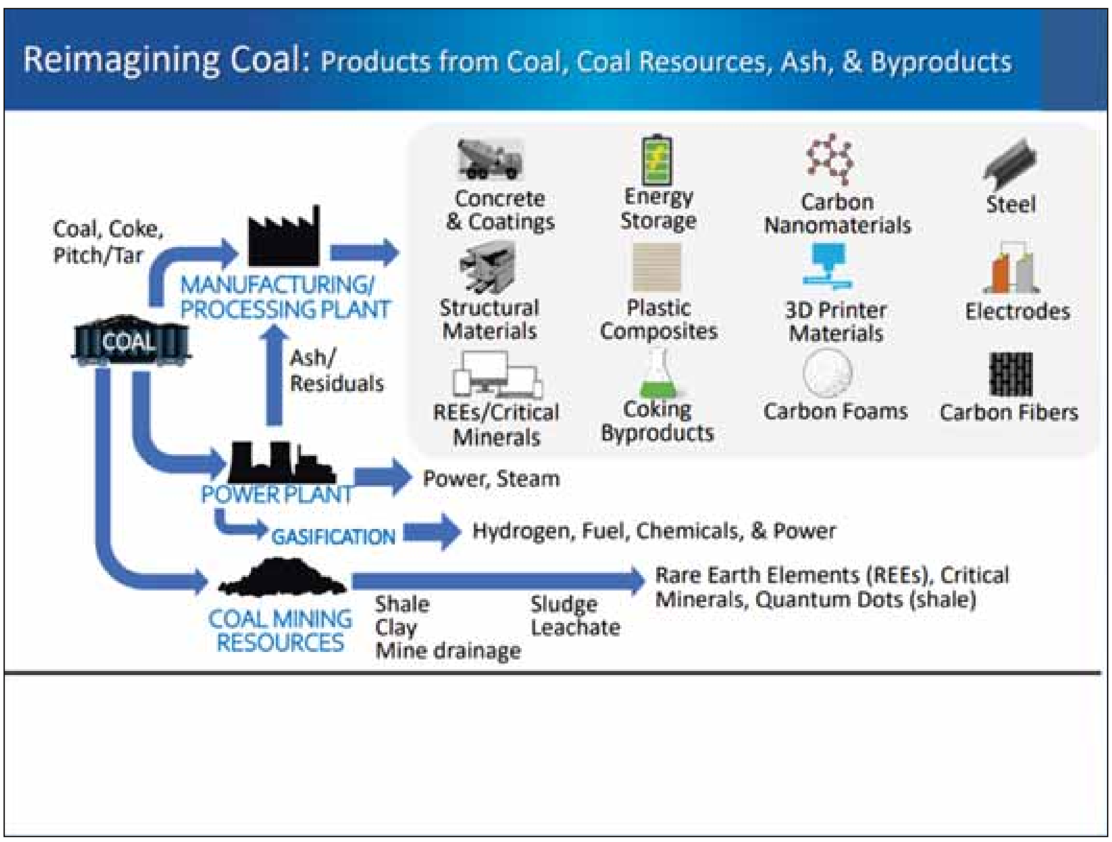
Transforming Fossil Energy Systems for the Future

Protecting the Environment

- Control and reduce emissions.
- Improve water use efficiency and security.
- Increase cooling/heat recovery efficiency.
- Monitor water quality long term.

- Accelerate development/use of efficient technologies for freshwater use and reuse.
- Reduce non-CO_2 criteria pollutants and solid and liquid emissions.
- **2025:** Achieve in-practice use of advanced emissions reduction technologies.


Reimagining Coal
Create valuable new products from coal and its byproducts.
High-value products. Explore new, high-value products and uses for coal and coal-based resources across the economy.
Hydrogen routes. Accelerate pathways to valuable products via coal-produced hydrogen.
Accelerating Product Pathways
• Convert hydrogen and other streams from coal-derived syngas into valuable products.
• Convert hydrogen to chemicals as products or for energy storage.
• Improve hydrogen purification and preparation processes.
Exploring High-Value Products
• Create novel, high-value products.
• Cost effectively extract rare earth elements (REEs) and other critical minerals.
• Incorporate valuable product streams into existing/future coal plants.


Reimagining Coal: Products from Coal, Coal Resources, Ash, & Byproducts
Coal, Coke, Pitch/Tar
MANUFACTURING/ PROCESSING PLANT
COAL
Ash/ Residuals
Concrete & Coatings
Energy Storage
Carbon Nanomaterials
Steel
Structural Materials
Plastic Composites
3D Printer Materials
Electrodes
REEs/Critical Minerals
Coking Byproducts
Carbon Foams
Carbon Fibers
POWER PLANT
Power, Steam
GASIFICATION
Hydrogen, Fuel, Chemicals, & Power
COAL MINING RESOURCES
Shale
Clay
Mine drainage
Sludge
Leachate
Rare Earth Elements (REEs), Critical Minerals, Quantum Dots (shale)

Coal gasification

1 mln ton of coal

=

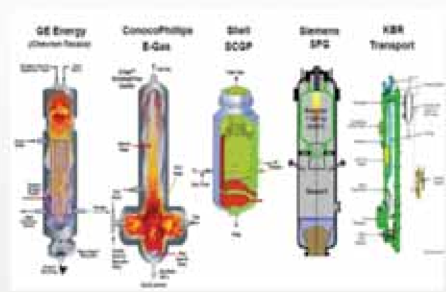
0,4 bln m^3 natural gas

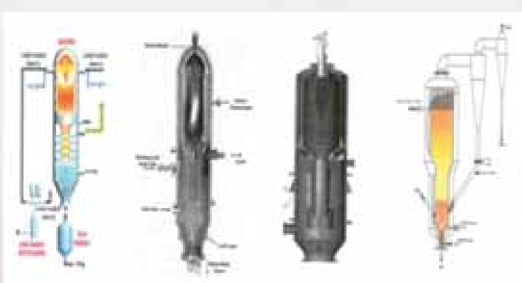
coal consumption for gasification around 300-400 mln t/y

few hundreds commercial gasifiers

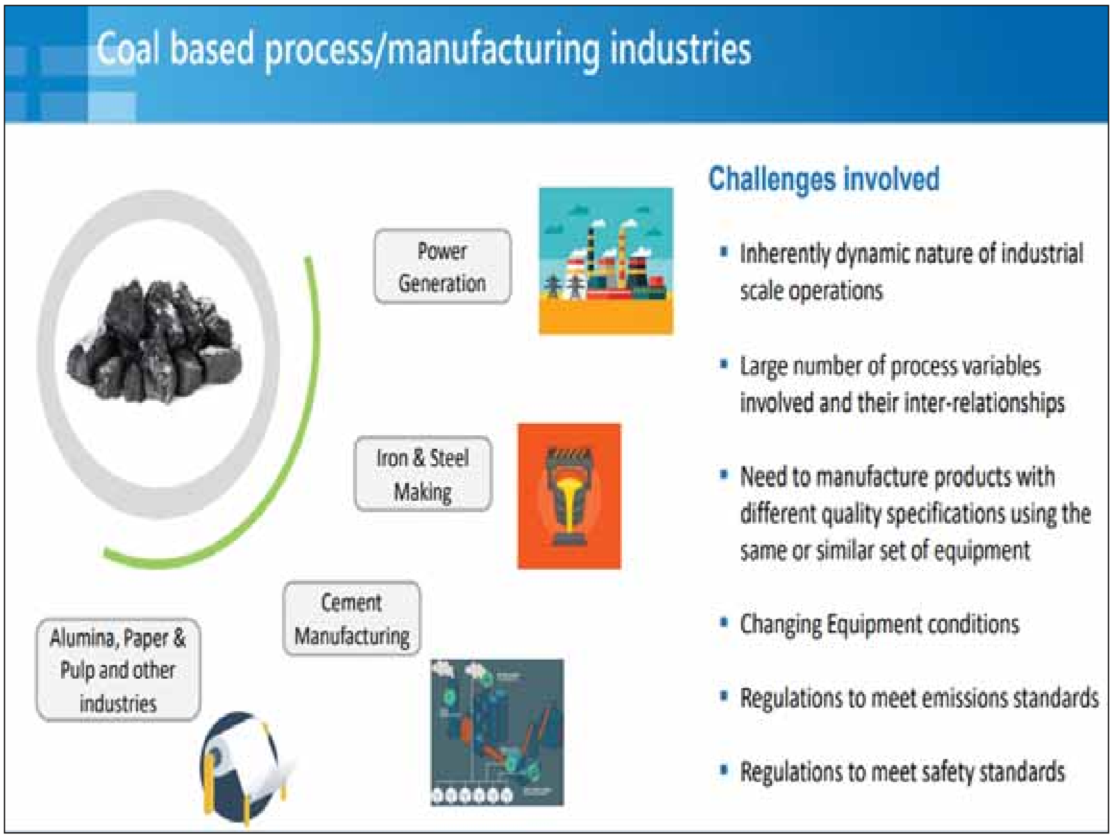
Coal gasification – commercial technologies

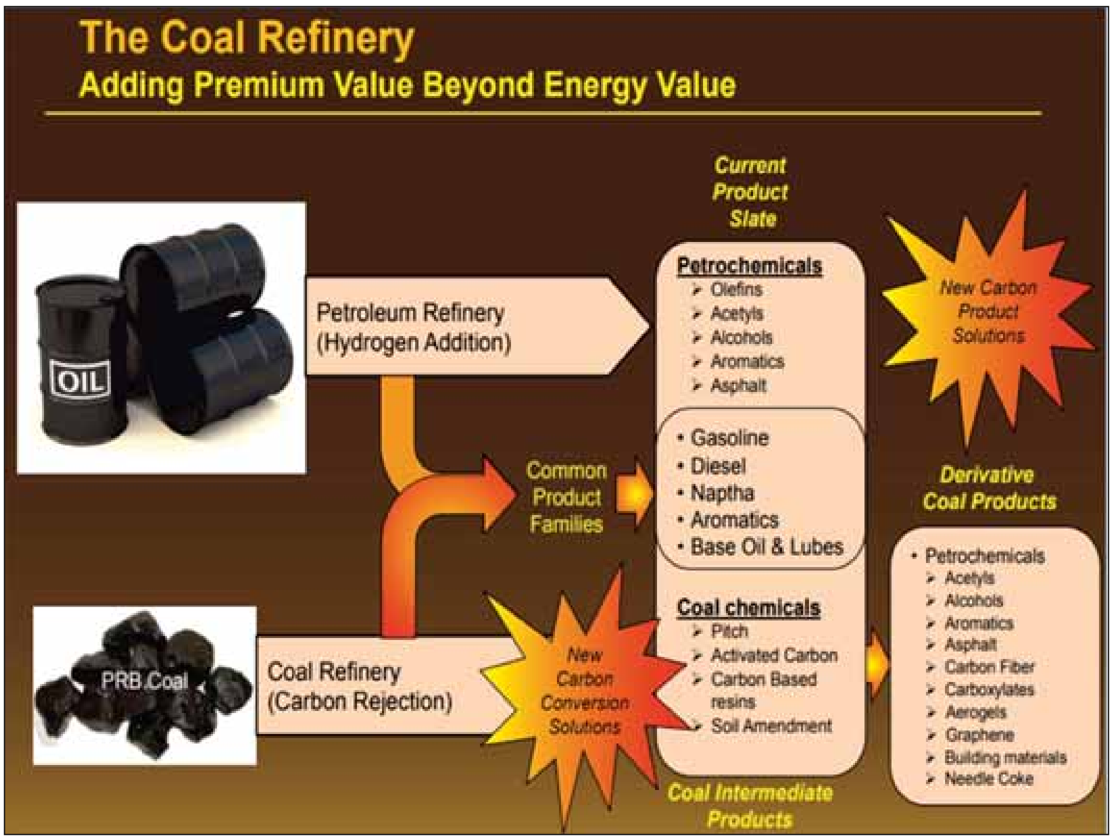
- **Entrained flow technologies**
  - **Water slurry and dry feeding**
- **Fluidized bed technologies**
- **Fixed bed technologies**

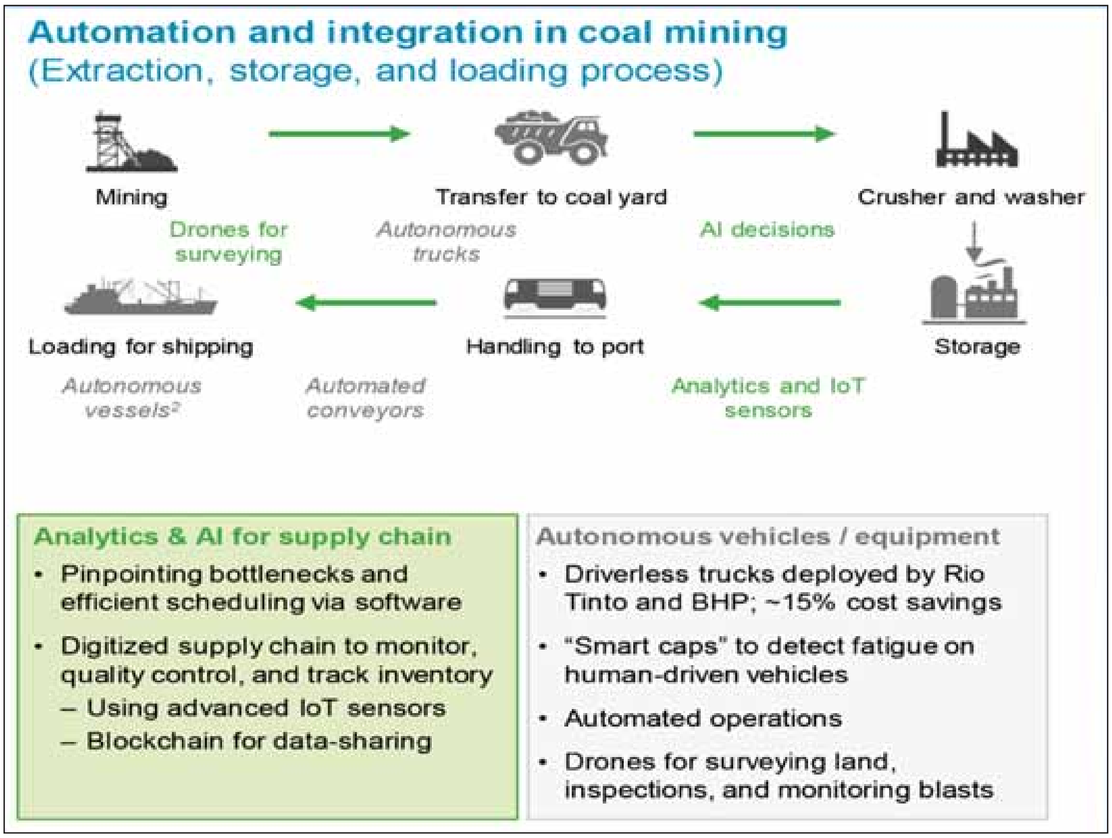




- East China University of Science and Technology **(OMB: Opposed Multi-Burner Gasifier)**
- Northwest Research Institute **(MCSG: The Multi-Component Slurry Reactor)**
- Aerospace Science and Technology Corporation **(HT-L: Pressurized, Down-Flow, Entrained Reactor)**
- Institute of Coal Chemistry **(AFB: Ash Agglomerated, Fluidized-Bed Reactor)**


Coal based process/manufacturing industries
Power Generation
Iron & Steel Making
Cement Manufacturing
Alumina, Paper & Pulp and other industries
Challenges involved
Inherently dynamic nature of industrial scale operations
Large number of process variables involved and their inter-relationships
Need to manufacture products with different quality specifications using the same or similar set of equipment
Changing Equipment conditions
Regulations to meet emissions standards
Regulations to meet safety standards


The Coal Refinery
Adding Premium Value Beyond Energy Value
Current Product Slate
OIL
Petroleum Refinery (Hydrogen Addition)
Petrochemicals
Olefins
Acetyls
Alcohols
Aromatics
Asphalt
New Carbon Product Solutions
Gasoline
Diesel
Naptha
Aromatics
Base Oil & Lubes
Common Product Families
Derivative Coal Products
PRB Coal
Coal Refinery (Carbon Rejection)
New Carbon Conversion Solutions
Coal chemicals
Pitch
Activated Carbon
Carbon Based resins
Soil Amendment
Petrochemicals
Acetyls
Alcohols
Aromatics
Asphalt
Carbon Fiber
Carboxylates
Aerogels
Graphene
Building materials
Needle Coke
Coal Intermediate Products

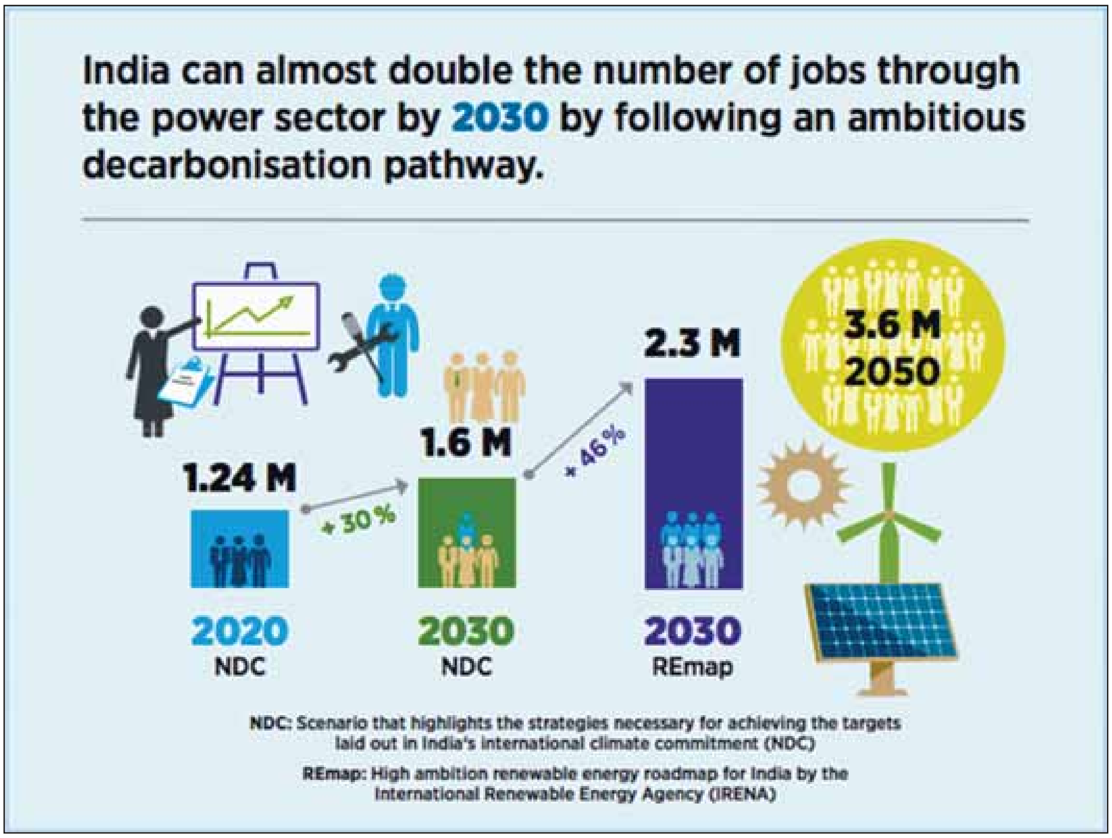


Carefully assess coal-fired-power investments against long-term sustainability goals

Building unabated coal plants today risks locking in emissions over the long term and stranding assets. Policy measures are required to ensure that processes are in place to:

- Assess the potential to deploy lower-carbon generation options.
- Check that new coal-fired unit efficiencies are consistent with global best practice (currently supercritical or ultra-supercritical technologies).
- Ensure that new coal-fired units are constructed CCUS-ready whenever possible, so that CCUS can be deployed quickly when policy or economics dictate.

These measures are particularly important for India, where electricity demand is rising and coal remains the fuel of choice to meet it.



AREAS OF INNOVATION

- **Prevention of waste arising**:
  - implementation of the symbiosis of economic relations in the State,
  - priority for anthropogenic products,
  - high recycling targets becoming realistic,
  - harmonized methods of calculations and reporting

- **Improving properties of minerals in power engineering:**
  - prevents arising of waste in Power Plants,
  - improves properties of minerals to product grade in power processes,
  - Power Plants should release anthropogenic products, not waste.

AREAS OF INNOVATION

- **Allocation of CO2 in power sector**
  - allocation of part of emissions to mineral products, not only to heat and electricity,
  - savings up to 10% of current emissions from power sector
  - realization of environmental and financial benefits resulting from Trading system.

- **Green Public Procurement**
  - measurable goals for procurers in priority for anthropogenic products,
  - economic instruments,
  - bringing costs of the use of natural resources closer to reality.

Our Strategic Vision 2030 for Coal Sector

1. Transforming Fossil Energy Systems for the Future

- Develop technologies to enable highly flexible and reliable power systems with carbon-neutral or net-negative emissions.
- Modernize existing coal plants to achieve far greater efficiency, flexibility, and resilience.
- Integrate hydrogen production and storage to support grid flexibility and resilience.
- Optimize the environmental performance of energy systems, reducing impacts on water and other resources.

2. Managing Carbon with Confidence

- Accelerate the development of transformational carbon capture and storage technologies (Carbon Capture & Storage)
- Build and advance the capabilities needed to measure, scale, and validate CCUS technologies.
- Advance direct air capture, storage, and negative emissions technologies to extend the reach of carbon management.
- Pursue new products and uses for captured carbon dioxide.

Our Strategic Vision 2030 for Coal Sector

3. Reimagining Coal

- Explore new, high-value products and uses for coal and coal-based resources across the economy.
- Accelerate pathways to valuable products via coal-produced hydrogen.

4. Creating Opportunities with Analysis and Engagement

- Inform and educate stakeholders based on strategic analysis.
- Engage with the international community to elevate awareness and accelerate global technology progress.
- Build strategic partnerships with domestic government and industry.

5. Research & Development

- Establish a focused R&D program on coal-to-products.
- Accelerate research-to-commercial deployment in coal-to-products markets.
- Incentivize private sector investment in coal-to-products production and manufacturing sectors.

Short Term Recommendations (1/2)

- Improve the design of the auctions for new commercial coal mines and ensure a one-stop-shop for permitting of new mines.
- Ensure that coal allocation and pricing formulas incentivize companies to direct coal to its most efficient use.
- Further improve railway logistics for coal supply, for example by allowing dedicated lines to be built in areas where future mining capacity will increase and by reducing cross-subsidy.
- Access the wider potential role of CCUS in India, including a thorough survey of Carbon dioxide storage potential.

Short Term Recommendations (2/2)

- Focus on rapidly retrofitting and upgrading the current coal generation fleet to:
  - Continue to improve coal power generation efficiency through low-cost measures, including wider adoption of best practices, which will reduce coal consumption and emissions both of pollutants and Carbon dioxide.
  - Support investment in the flexibilisation of coal plants with new state-of-the-art technologies.
  - Continue to reduce air pollution from coal power generation by fostering compliance with enacted emission standards and closing down the oldest plants, if they cannot be refurbished, in line with National Electricity Plan proposals to close 22.7 GW by 2022.

WAY FORWARD

- Greater focus on cost competitiveness of domestic coal must be ensured in order to retain their competitiveness as compared to imported one.
- As India's coal is high in ash content, coal beneficiation should be done to reduce the ash content and improve its grade.
- Create CoE focused at mechanization and automation and digital technologies in mining in collaboration with a leading global organization.
- Establish a coal regulator with clear mandate to enable competitive market structure in coal sector in India.
- There is a need for improvement in safety performance in Indian coal sector. A dedicated effort has to be made to ensure achievement of the goal of zero fatalities and injuries.

WAY FORWARD

- Establish an online platform for coal trading/transactions in India including spot/ forward auction of CIL, sale of coal by commercial mining companies (private and SMDCs).
- Create a national mission to promote coal consumption from alternate usage (coal gasification, coal-bed methane etc.).
- Increase ash utilization in coal mine filling; collaborate and develop necessary frameworks, infrastructure and cost sharing mechanisms.
- Increase adoption of remote sensing, core open drilling and geophysical and geochemical logging, 2D and 3D seismic survey.

Global Coal Preparation Technology Review and Options for Processing Indian Power Station Coals

David Woodruff Coal Preparation Consultant UK

India, Power Supply for Industrialisation, Local and Global Issues. A View from the Outside

- India will need to significantly increase Electrical Power generation to create a modern industrial society.
- Although use of Renewable sources of Power are increasing, Coal Fired Power Generation will, almost certainly, continue to be the primary large scale power generation option for India.
- The Western World is turning away completely from using Fossil Fuels for Power Generation. The Climate Change Lobby is demanding this change.
- Wealthy Western Countries with small, stable, or declining Population, can afford the vast financial capital cost of Carbon neutrality. India does not currently have this luxury.
- From a Global Political perspective, India faces a difficult task in expanding it's Electrical Power supply and simultaneously controlling Greenhouse Gas Emissions.
- The emission of CO_2 is <u>the</u> major issue of concern for the Global community. Many countries are now committed to zero carbon emissions by 2050
- So what can India realistically do in the short term?

Suggested Future Strategy for Indian Power Generation Short Term 0 – 10 years

As an initial significant step, India could burn lower ash, washed Coal instead of higher ash, raw Coal, for Power Generation. By doing this studies have shown 10 - 15% reduction in CO_2 per kWh produced could be achieved

In general figures, India currently burns 600 Million Tonnes of Coal per year for Power Generation. 170 Million Tonnes is imported lower ash Coal. Only 18% (78 MTPA) of the Indigenous Coal is washed prior to combustion. Leaving 352 MTPA unwashed.

For each Tonne of unwashed Coal combusted in Indian power stations, approximately 1.33 TPH of CO2 is produced*. For 352 MTPA this is 469 MTPA of CO_2. If this Coal were washed and 15% reduction in CO_2 emissions, was achieved, this would equate to a reduction of 70.3 Million Tonnes of CO_2 per year, for the same Electrical Power output.

This is A REDUCTION OF 3% IN INDIA'S TOTAL CO_2 EMISSIONS^.

Global Review of Current Coal Preparation Technology for Power Station Fuel Processing

Country	Degree of Difficulty	Most Common Processes Used
• China	Moderate/Variable	Dense Medium/Flotation
• USA	Moderate/Variable	Dense Medium Spirals/ UCS/Flotation
• Australia	Difficult	Dense Medium Spirals/ UCS/Flotation
• South Africa	Very Difficult	Dense Medium/ Gravity Concentration
• Russia/Europe	Moderate/Variable	Dense Medium Spirals/ Flotation/Jigs
• India	Very Difficult	Dense Medium Jigs/ Flotation

Best Choice of Plant Design for Indian PSF

- As Indian Coals present very difficult separation problems, the most obvious major process selection would be a Dense Medium System.
- To achieve a product ash of 30 – 33%, this should be able to be achieved with a single stage separation, with or without fines treatment.
- A flexible, but standardised, Simple Dense Medium plant of 3–5 MTPA capacity could be designed which is suitable for all Indian Coal types. This could be a standard repeatable design
- This Plant would be able to utilise single large unit equipment Which can be manufactured in India.
- Plant capacity can be regulated by the number of streams required and additional streams can be easily added if Mine output increases.
- Major Plant features are: crushing to 50mm top size and using Large Diameter Dense Medium Cyclones.
- The next slide shows a new plant of a similar design in South Africa which consists of 4 x 5MTPA identical streams.

Conclusions/Opportunities for India

- A building programme to install Coal washing at all Indian plants could be achieved in 10 years or less, at a fraction of the cost of the equivalent reduction in CO_2, achieved by installing equivalent capacity Nuclear or renewable energy sources.
- Due to the urgent requirement, a modular, highly flexible standard plant design of 3 MTPA – 5 MTPA capacity could be considered. Larger plants would use multiple identical modules.
- This would reduce the design, equipment, and operating costs and accelerate construction schedules.
- A reduction of 70.3 MTPA of CO_2 is the same CO_2 emission reduction as achieved by building 4 x 3000 MW Nuclear plants, or 6000 x 2MW Wind Turbines.
- 70 x 5 MTPA Coal Washing plant modules would cost in the order of 13,125 Crore Rupees ($25 million USD per module).
- 4 x 3000 MW Nuclear plants would cost in the order of 300,000 Crore Rupees ($10 Billion USD per 3000MW Nuclear plant).
- 6000 x 2MW Wind Turbines would cost 12,000 x 6.85 Crore Rupees = 82,200 Crore Rupees"

Assumptions in the Calculations

- 1 MWh of power requires approximately 0.75 TPH Indian Coal to be combusted*
- For Low Ash Washed Coal in the West 0.4 – 0.5TPH produces 1 MWH.
- Figures for the TPH of CO_2 produced globally range from 1.25 - 2.5 TPH.
- The figure for Indian unwashed Coal or Lignite is 1.33 TPH per TPH of Coal burnt*.
- A Nuclear Power Plant of 3000 MW capacity emits zero CO_2.
- A Coal Fired Plant of the same capacity would burn 1500 TPH. As Nuclear plants work 24 Hrs per Day / 365 Days per year, this is equivalent of burning 13.14 Million TPA. At 1.33 TPH CO_2 produced per TPH Coal burnt = 17.47 MTPA OF CO_2 emitted.
- By washing 352 MTPA of Indian Coal we reduce CO_2 emissions by 15%, = 70.3MTPA. This is the equivalent of 70.3/17.47 = 4 x 3000 MW Nuclear Stations.
- 1 x 3000 MW Nuclear Station in the West costs ~ $20 Billion USD# to construct. Wind turbines in India currently cost 6.85 Crore Rupees per MW"
- In India the construction costs would be less so a figure of $10 Billion (75,000 Crore Rupees) per 3000 MW Nuclear Station has been assumed.
- 1$USD = 75 Indian rupees. 1 Crore Rupees = 10 Million Rupees .

Source of Data

- *"Estimates of Emissions from Coal Fired Thermal Power Plants in India"
  Authors: Mittal, Sharma and Singh

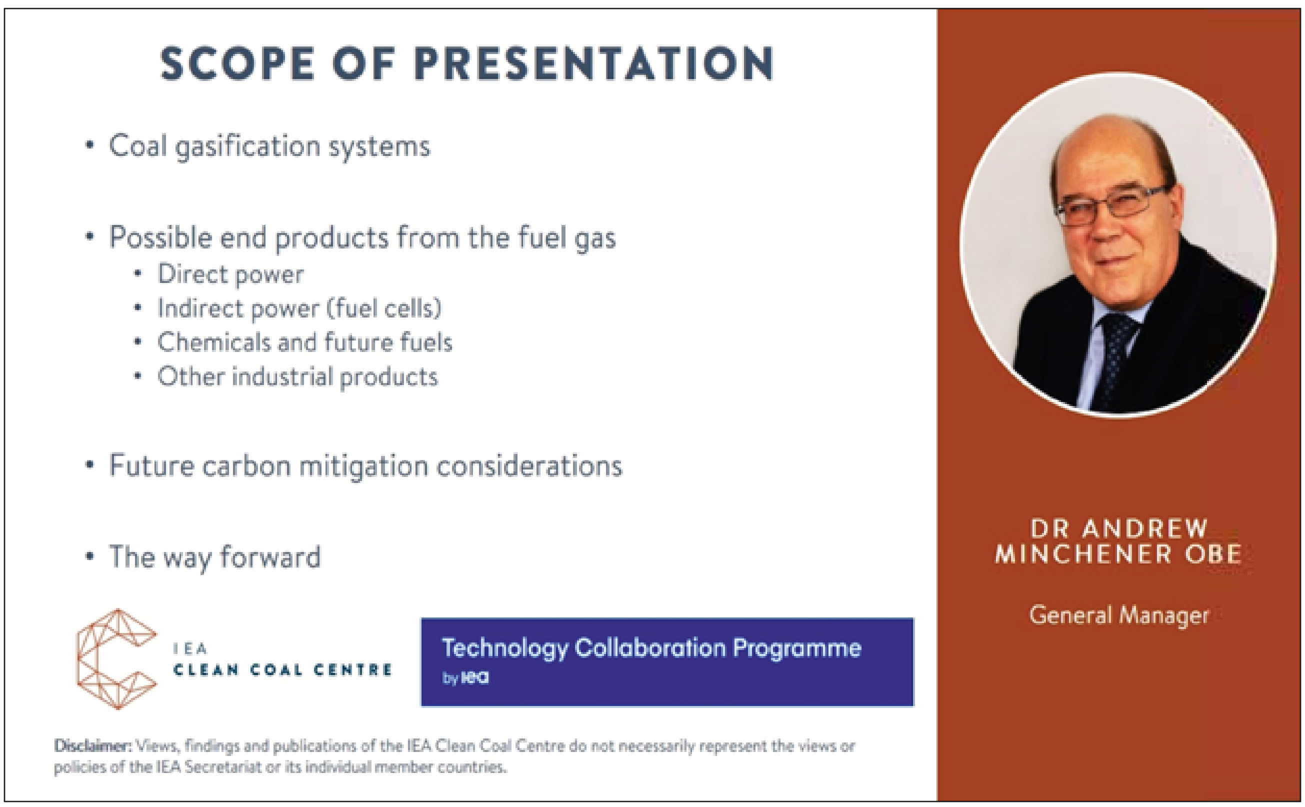
^ BP Statistical Review of World Energy 2019 Page 57 Global CO2 Emissions

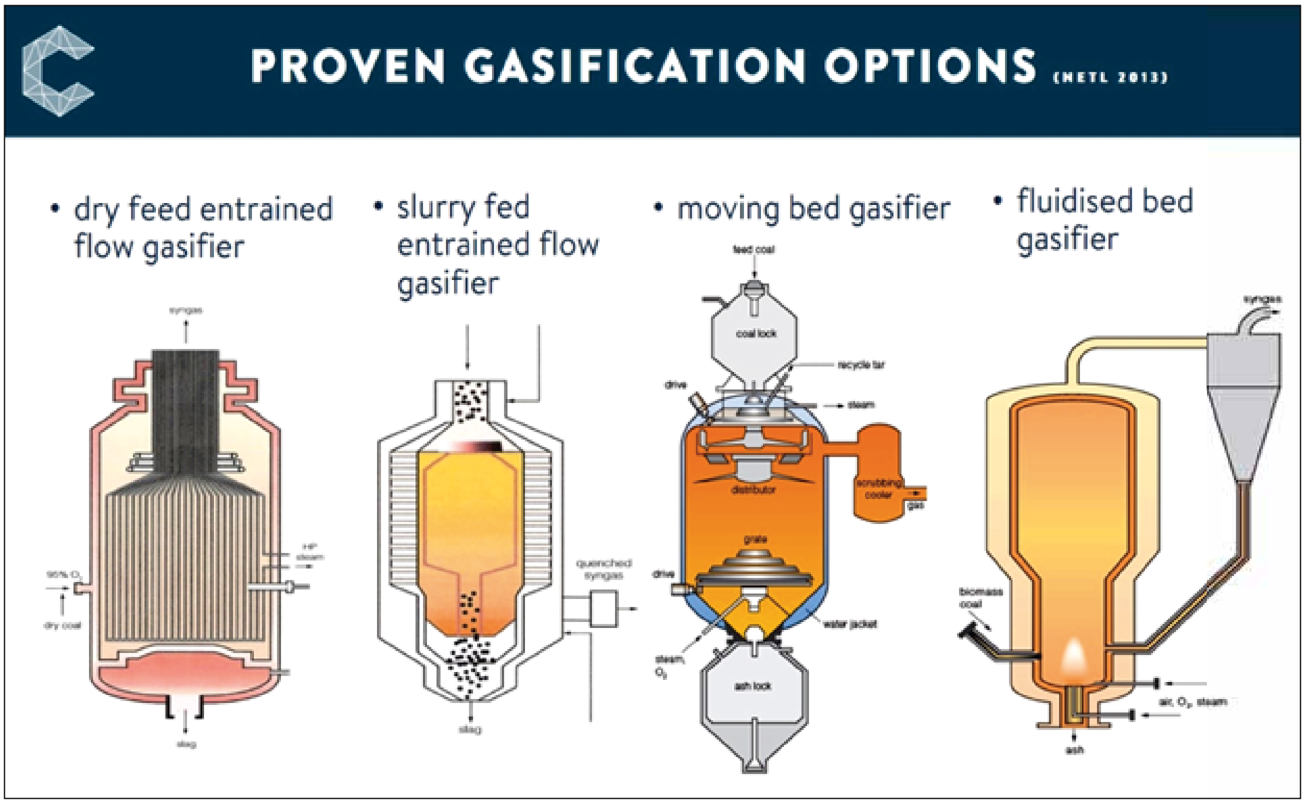
" Green World Investor . "Wind Power Plants in India" 2020.

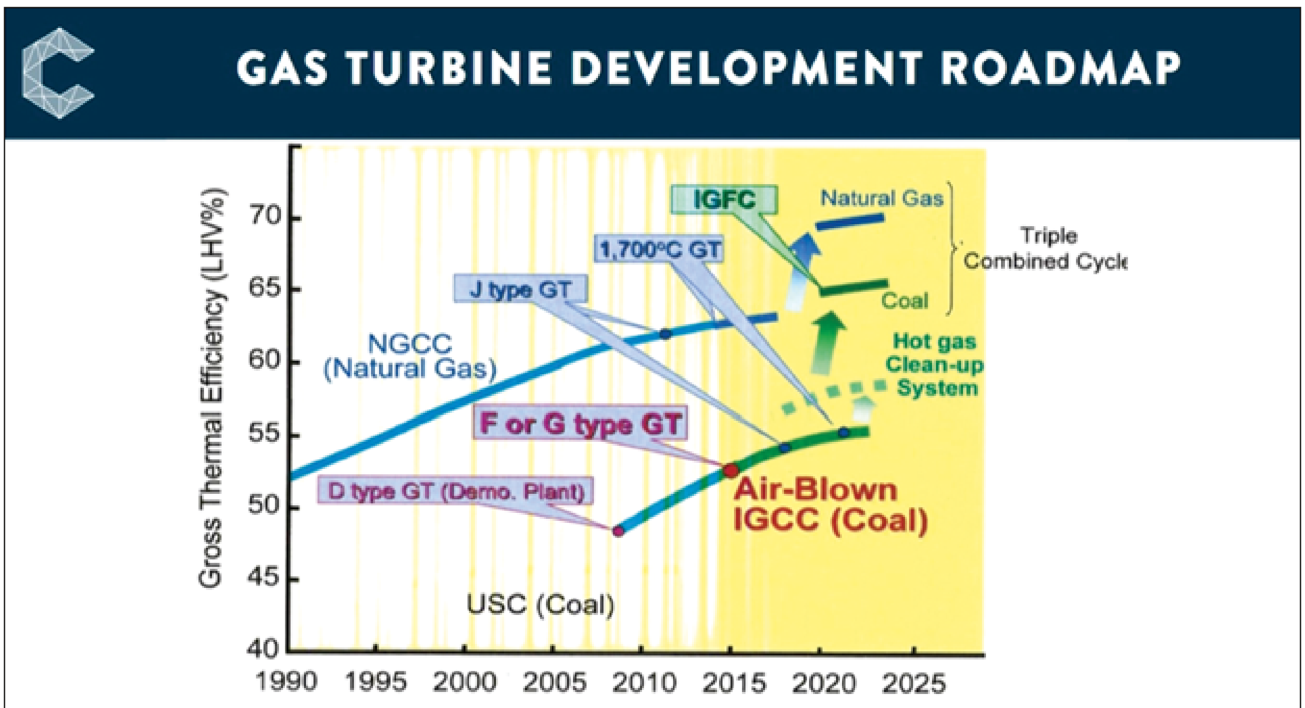
Current projected outturn cost of Hinkley Point C nuclear power plant UK = $20 – 30 Billion.

Plant Photo is of the new plant at Tweefonteign RSA courtesy of DRA

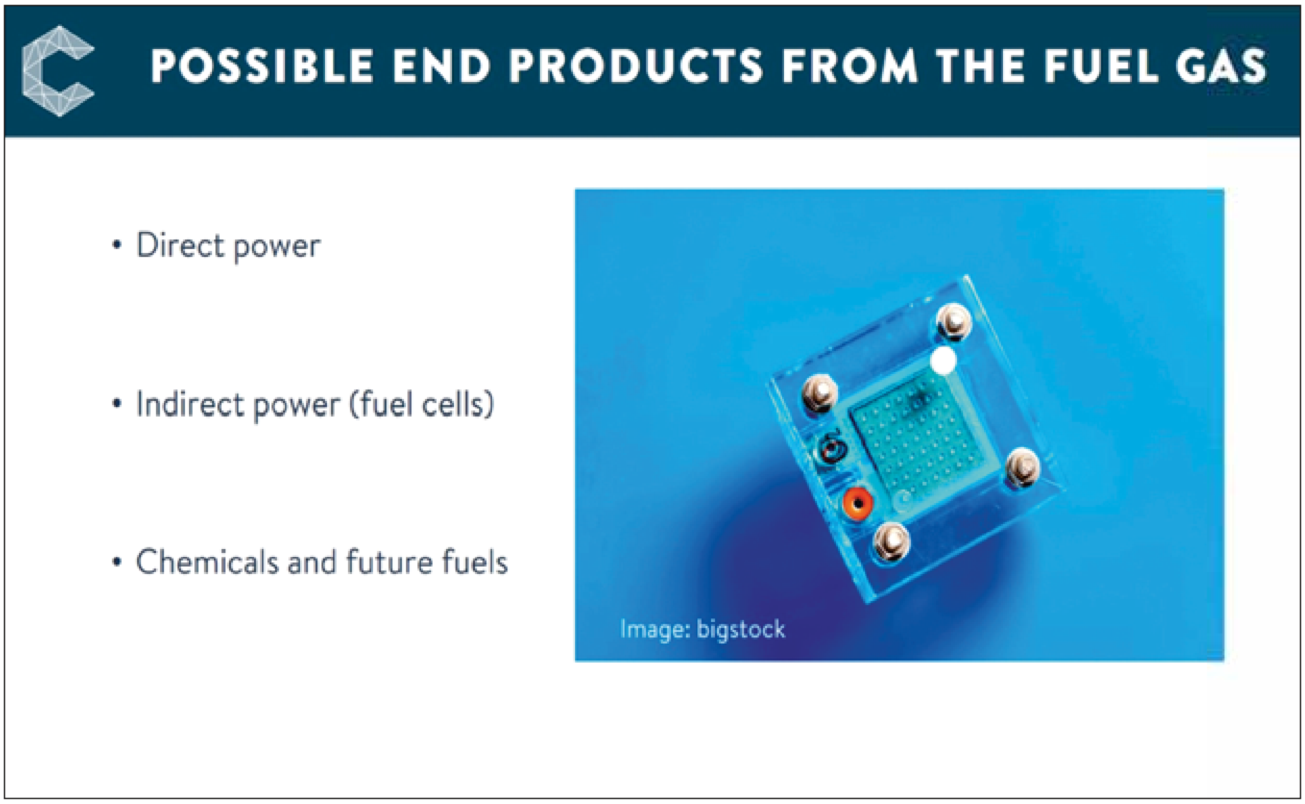

GLOBAL COAL
GASIFICATION RTD
DR ANDREW MINCHENER OBE
GENERAL MANAGER
IEACCC
CPSI MEETING 4 DEC 2020
IEA
CLEAN COAL CENTRE

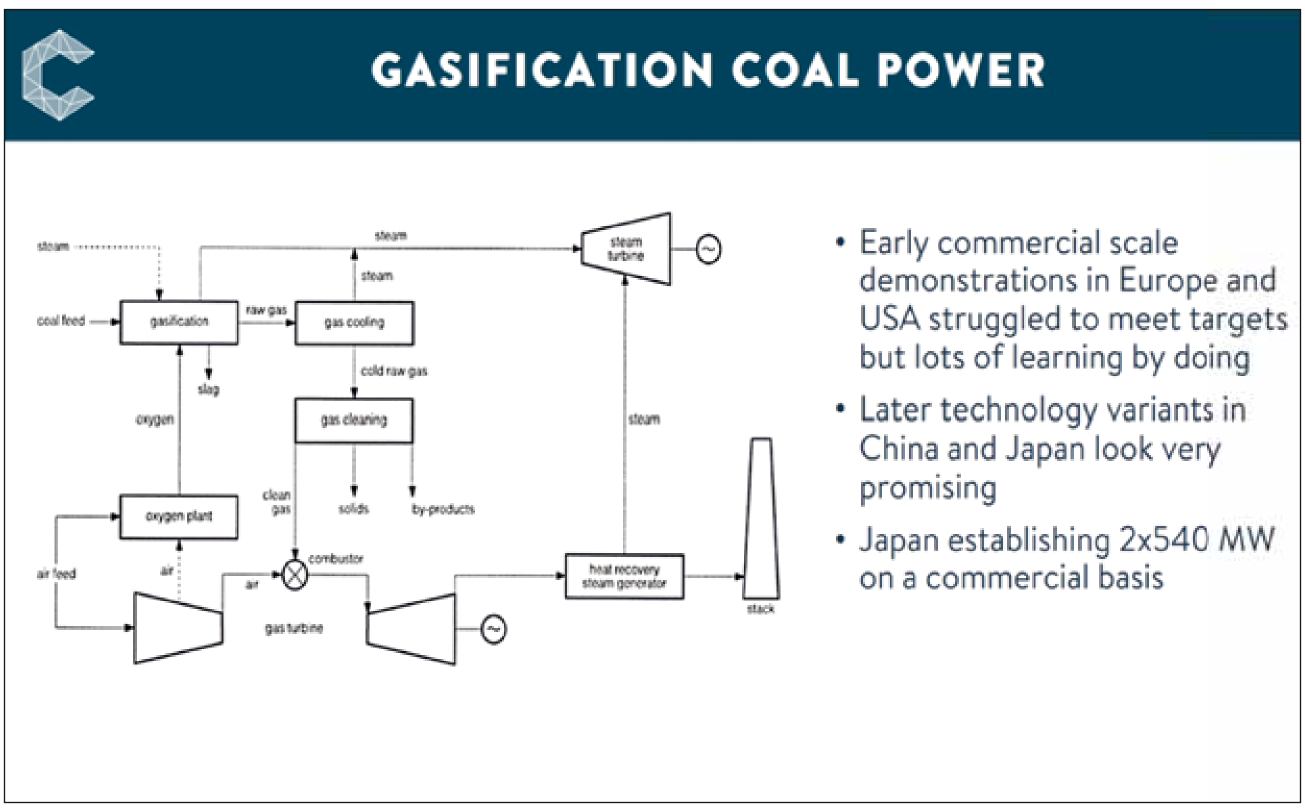

SCOPE OF PRESENTATION
• Coal gasification systems
• Possible end products from the fuel gas
• Direct power
• Indirect power (fuel cells)
• Chemicals and future fuels
• Other industrial products
• Future carbon mitigation considerations
• The way forward
IEA
CLEAN COAL CENTRE
Technology Collaboration Programme
by iea
Disclaimer: Views, findings and publications of the IEA Clean Coal Centre do not necessarily represent the views or policies of the IEA Secretariat or its individual member countries.
DR ANDREW
MINCHENER OBE
General Manager



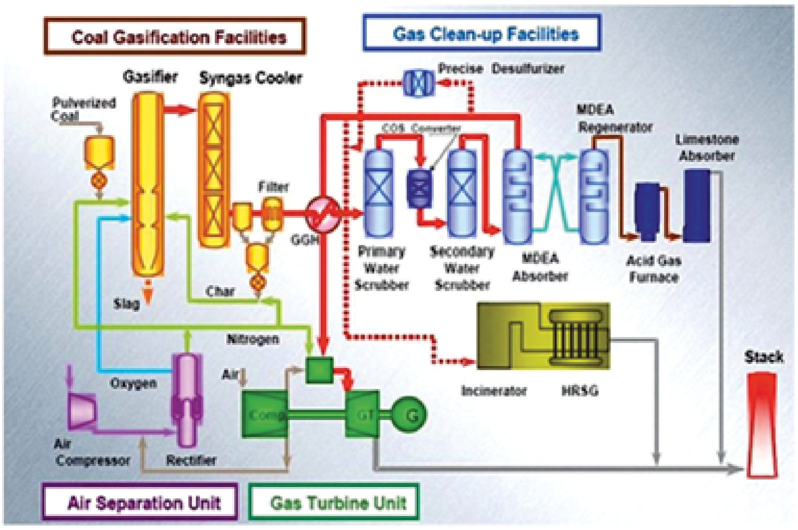


Thermal efficiency inter-linkages between natural gas combined cycle and IGCC operations (Sakamoto 2011)


POSSIBLE END PRODUCTS FROM THE FUEL GAS
• Direct power
• Indirect power (fuel cells)
• Chemicals and future fuels
Image: bigstock

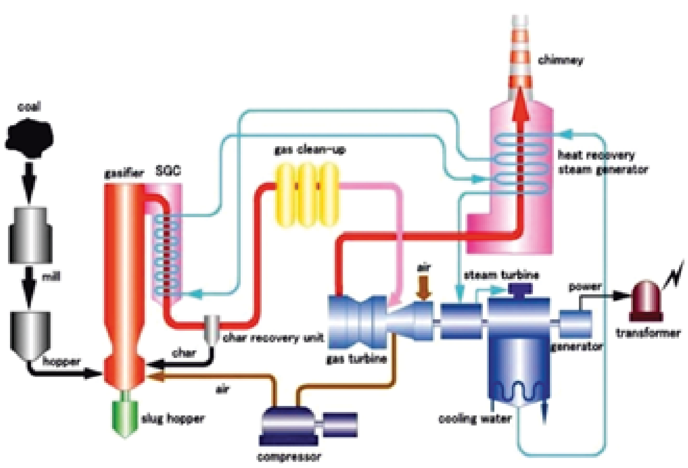

GASIFICATION COAL POWER
steam
coal feed
gasification
raw gas
gas cooling
steam
steam turbine
cold raw gas
slag
oxygen
gas cleaning
steam
clean gas
solids
by-products
oxygen plant
air feed
air
air
combustor
gas turbine
heat recovery steam generator
stack
• Early commercial scale demonstrations in Europe and USA struggled to meet targets but lots of learning by doing
• Later technology variants in China and Japan look very promising
• Japan establishing 2x540 MW on a commercial basis

JAPAN HAS SUCCESSFULLY ESTABLISHED IGCC



EAGLE IGCC oxygen blown industrial pilot IGCC unit (Hideo 2000)

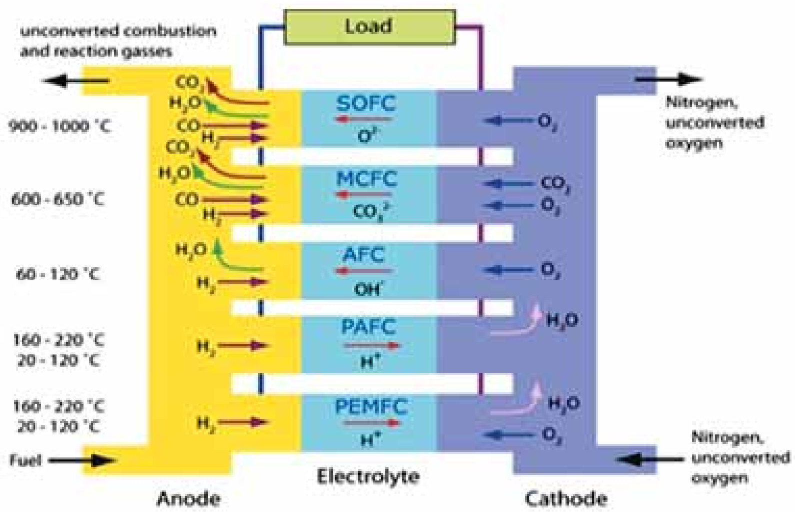
NAKOSO AIR BLOWN IGCC AND BEYOND (MAKOTO 2013)



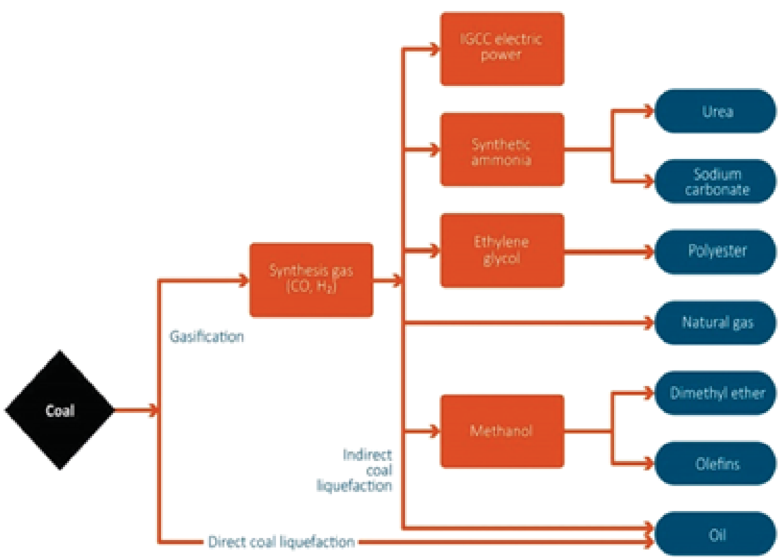
- More than 16,000 hours of operational testing to end 2013
- Plant now operated on a commercial basis by Joban Joint PowerCo.
- Nakoso achieved 42% efficiency achieved with a 1200oC D-class turbine
- MHPS suggests that a 480MWe net plant would achieve 48% efficiency with a G-class gas turbine and 50% for a 580MWe unit with a J-class machine
- Tokyo Electric Power Co. is building two new 540 MWe coal-fired IGCC plants in Fukushima Prefecture

JAPAN IS TAKING FORWARD FUEL CELLS

- Fuel cell (FC) is an emerging technology towards zero emission, high-efficiency coal power plants

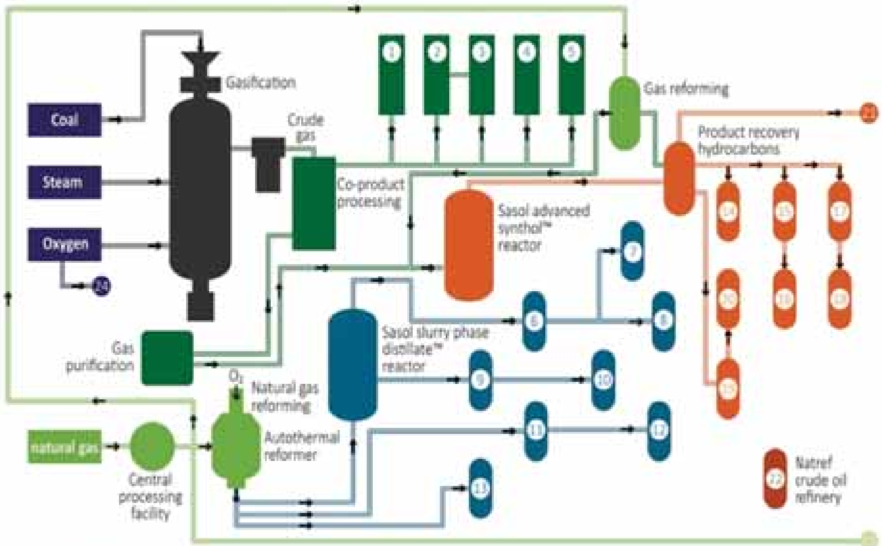


COAL GASIFICATION TO PRODUCE CHEMICALS AND FUTURE FUELS



- Large reserves of low-cost gasifiable coal, with stranded assets, due to either too low quality or location, likely to be particularly attractive
- Host government with the ability and will to provide enabling support for the very large capital investments that are required
- Need to cover the costs for infrastructure needs both for the supply of feedstocks and for transporting the end products
- Means to ensure adequate institutional capacity requirements

EARLY TECHNOLOGY CHAMPIONS



1 Ammonia
2 Tars and pitch
3 Green and calcined coke
4 Xylenols, phenols, cresols
5 Sulphur

22 Unleaded petrol, diesel, liquefied petroleum gas, jet fuel, illuminating paraffin, bitumen, sulphur

23 Pipeline gas

24 Rare gases

Sasol Infrachem
low-temperature conversion

6 Ammonia
7 Fertilisers
8 Explosives
9 Hard waxes, candle waxes, speciality waxes
10 Paraffin
11 N-butanol
12 Acrylic acid
13 Methanol

Sasol Synfuels
high-temperature conversion

14 Alcohol, acetic acid, ketones, acetone
15 Propylene
16 Polypropylene
17 Ethylene
18 Polyethylene
19 Petrol/diesel, liquefied petroleum gas, jet fuel, propane, butane, fueloil, illuminating paraffin
20 1-pentene, 1-hexene, 1-octene
21 Pipeline gas

(NETL, 2011)

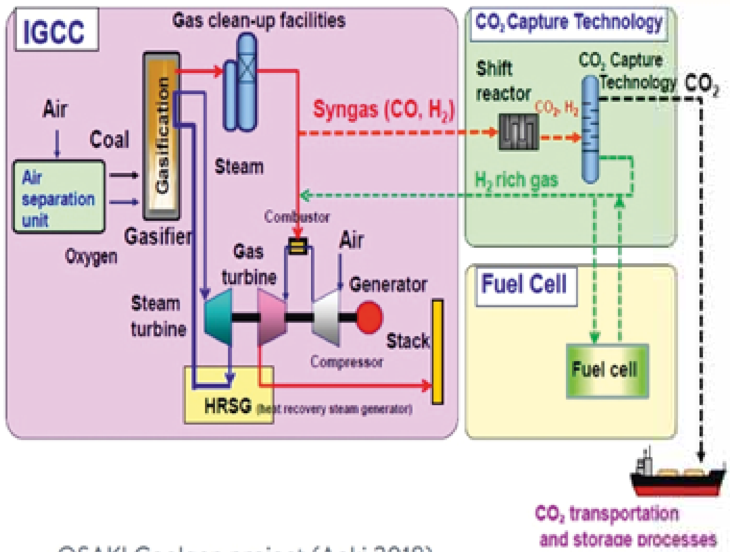
CHINA ENERGY A MAJOR TECHNOLOGY DEVELOPER

- 1Mty direct coal to liquids (2009-)

- 2Mty indirect coal to liquids (2017-)

FUTURE CARBON MITIGATION CONSIDERATIONS

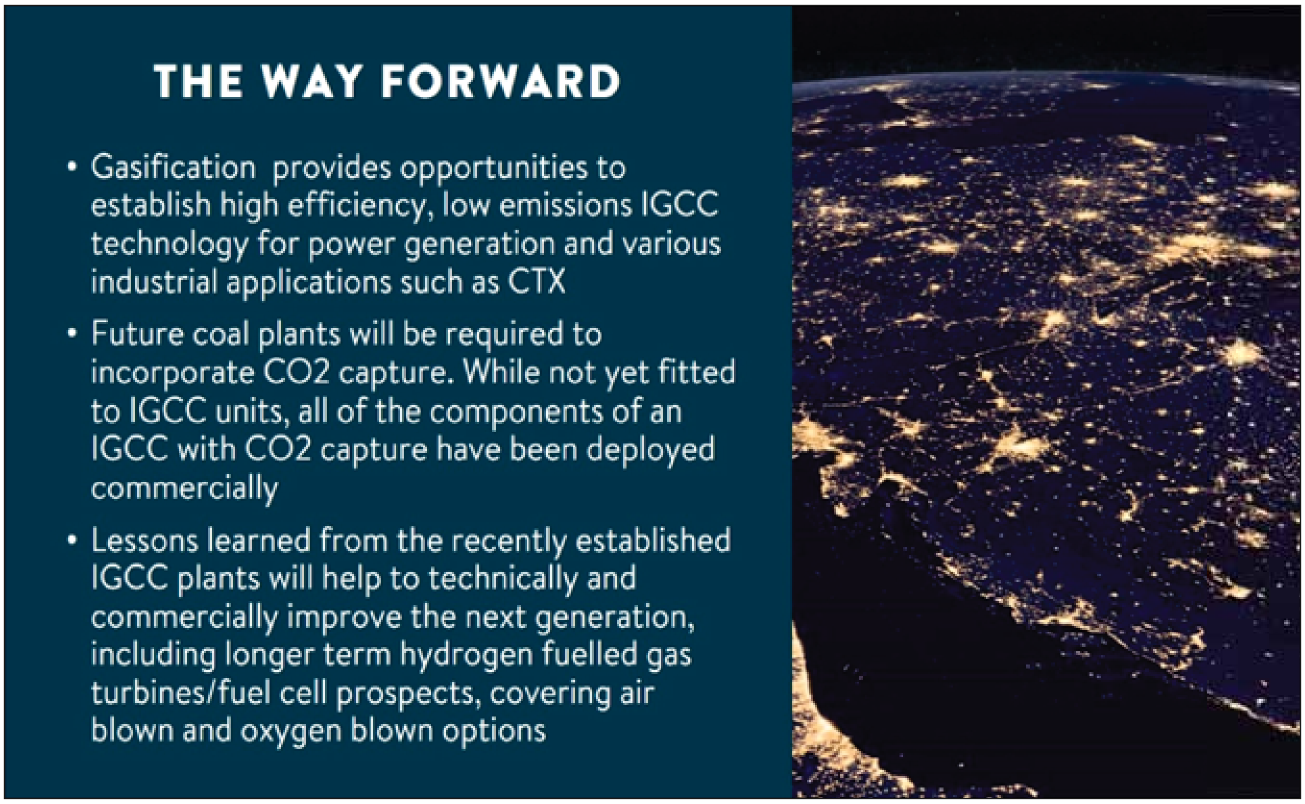
- Although capital investment for a coal gasification plant is higher than for a coal combustion system, when the need for carbon mitigation is required CO_2 capture for the coal gasification system is technically easier and lower cost than alternatives

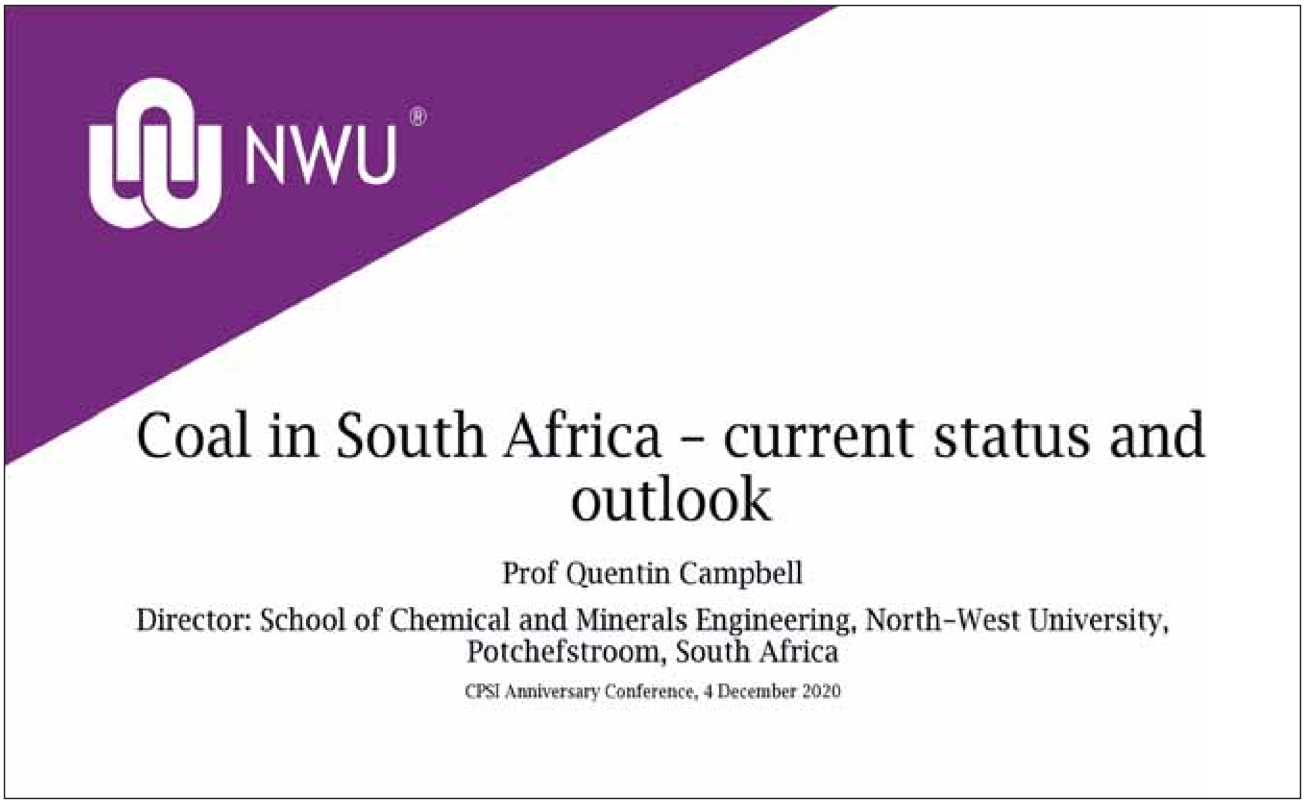


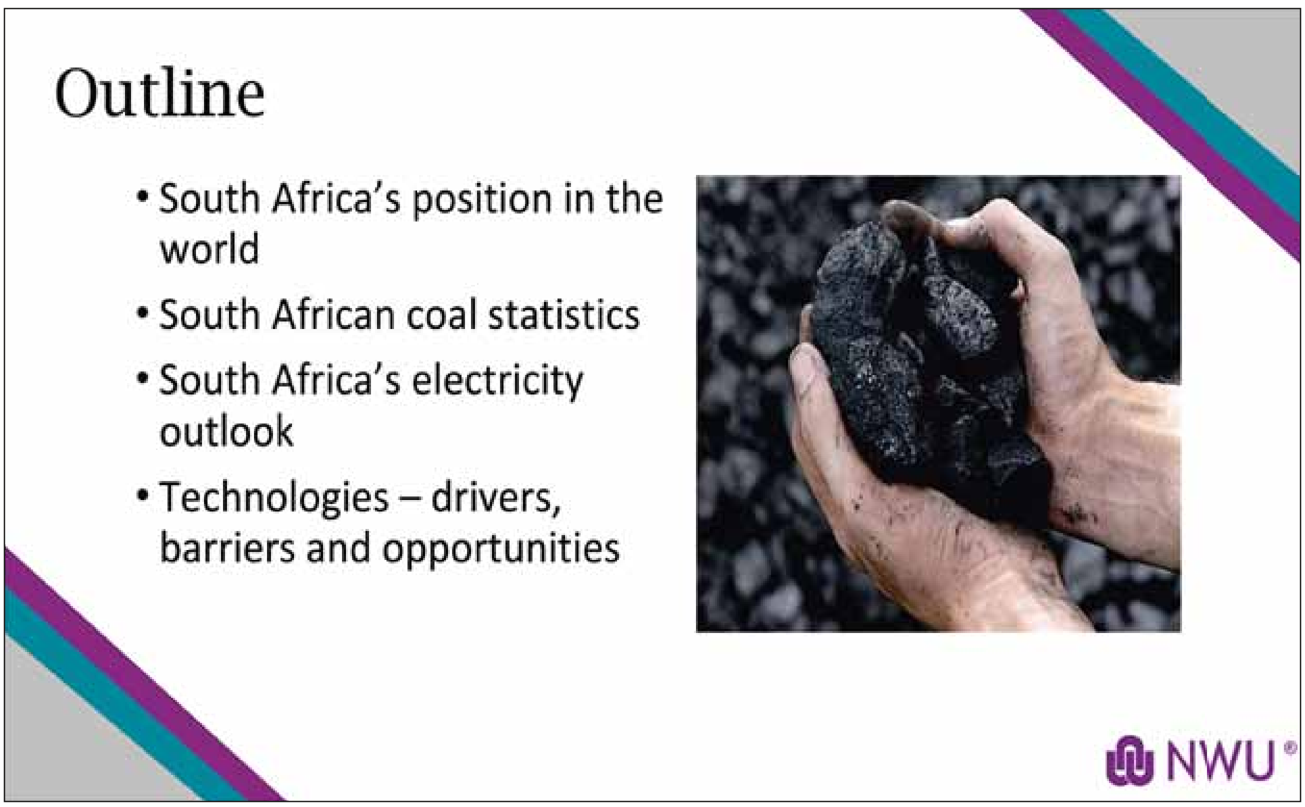
OSAKI Coolgen project (Aoki 2018)

OTHER GLOBAL PROSPECTS

- Tentative approach to establishing coal to methanol in India
- Australia-Japan cooperation for brown coal to hydrogen project
- Some work in Europe via RWE


THE WAY FORWARD
• Gasification provides opportunities to establish high efficiency, low emissions IGCC technology for power generation and various industrial applications such as CTX
• Future coal plants will be required to incorporate CO2 capture. While not yet fitted to IGCC units, all of the components of an IGCC with CO2 capture have been deployed commercially
• Lessons learned from the recently established IGCC plants will help to technically and commercially improve the next generation, including longer term hydrogen fuelled gas turbines/fuel cell prospects, covering air blown and oxygen blown options


NWU
Coal in South Africa – current status and outlook
Prof Quentin Campbell
Director: School of Chemical and Minerals Engineering, North-West University, Potchefstroom, South Africa
CPSI Anniversary Conference, 4 December 2020


Outline
• South Africa's position in the world
• South African coal statistics
• South Africa's electricity outlook
• Technologies – drivers, barriers and opportunities
NWU

World reserves (2017)

1	USA	24.2%
2	Russia	15.5%
3	Australia	14.0%
4	China	13.4%
5	India	9.4%
6	South Africa	6.4%
7	Ukraine	3.3%
8	Poland	2.5%

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World production (2017)

1	China	44.7%
2	India	9.7%
3	USA	9.3%
4	Australia	6.6%
5	Indonesia	6.5%
6	Russia	5.1%
7	South Africa	3.4%
8	Poland	1.7%

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World exports (2017)

1	Indonesia	28.5%
2	Australia	27.7%
3	Russia	13.8%
4	USA	6.4%
5	Colombia	6.3%
6	South Africa	5.8%
7	Canada	2.3%
8	Kazakhstan	2.0%

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South Africa: reserves, production and export (2017)

Reserves	67 Gt (6.4%)
Production	260 Mt p.a. (3.4%)
Exports	80 Mt p.a. (5.8%)

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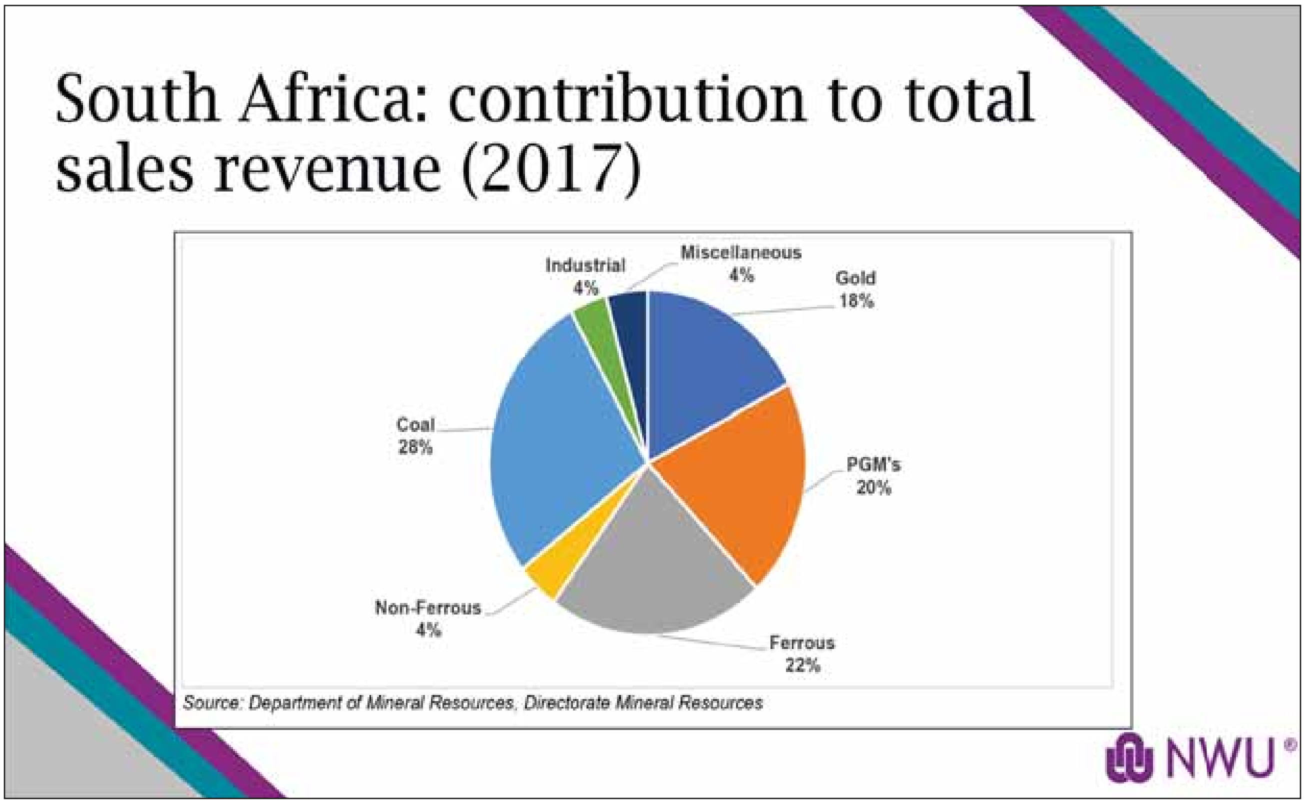
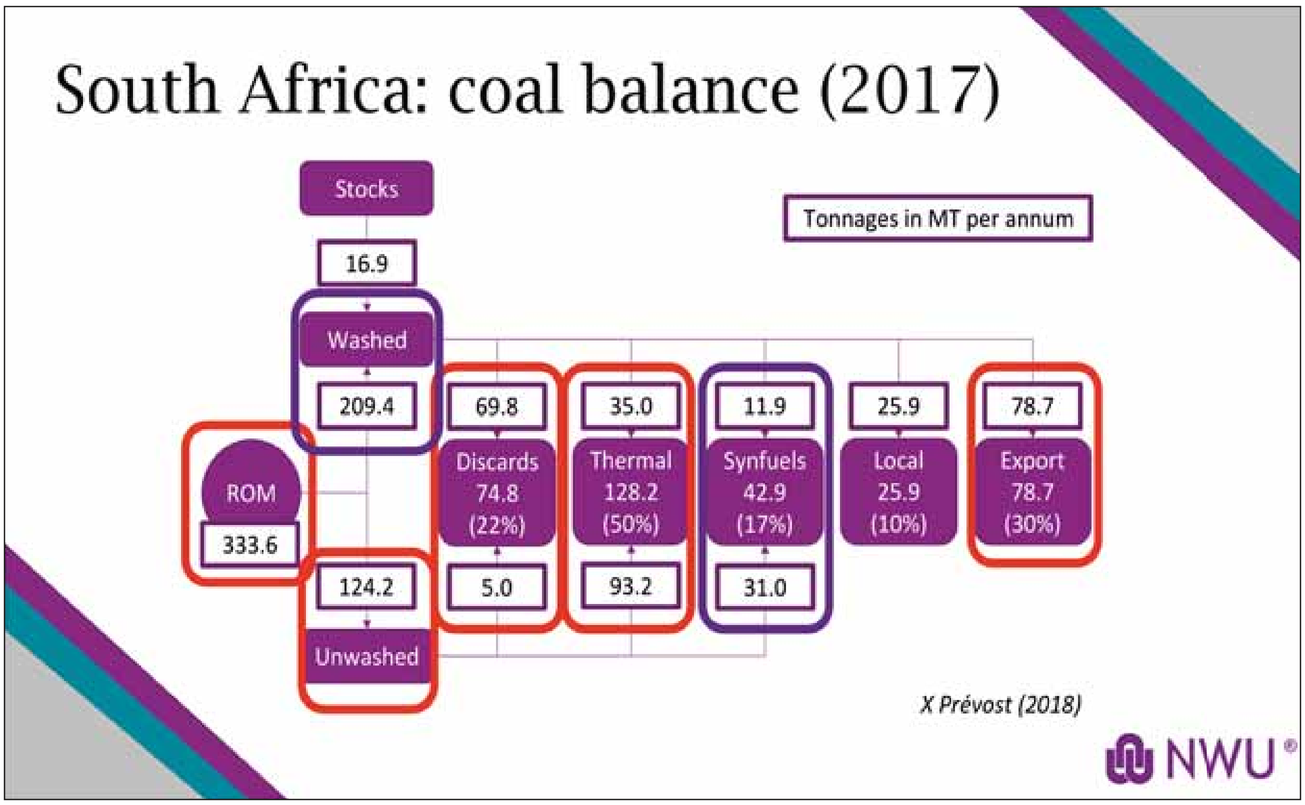
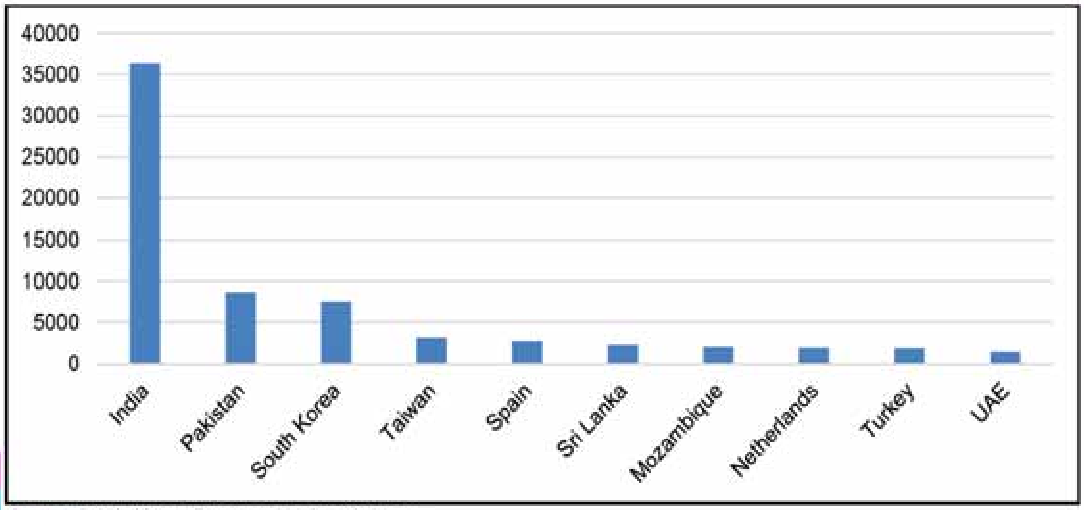

South Africa: contribution to total sales revenue (2017)
Industrial 4%
Miscellaneous 4%
Gold 18%
Coal 28%
PGM's 20%
Non-Ferrous 4%
Ferrous 22%
Source: Department of Mineral Resources, Directorate Mineral Resources
NWU


South Africa: coal balance (2017)
Stocks
16.9
Tonnages in MT per annum
Washed
209.4
69.8
35.0
11.9
25.9
78.7
ROM
333.6
Discards 74.8 (22%)
Thermal 128.2 (50%)
Synfuels 42.9 (17%)
Local 25.9 (10%)
Export 78.7 (30%)
124.2
5.0
93.2
31.0
Unwashed
X Prévost (2018)
NWU

South Africa: coal exports (2017)



Source: South African Revenue Services Customs

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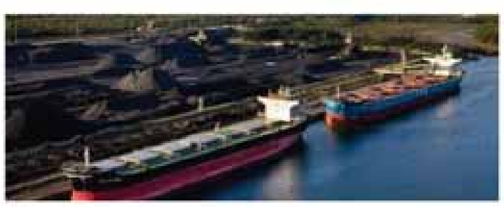
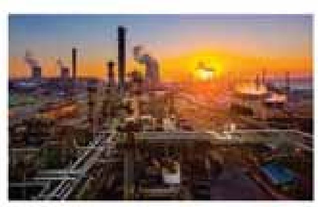
Coal facts: South Africa (2017)

- 70% consumed domestically
- 30% exported mainly through Richards Bay Coal Terminal
- 71% of electricity from coal
- 30% of domestic liquid fuel produced from coal



www.rbct.co.za



www.miningweekly.com

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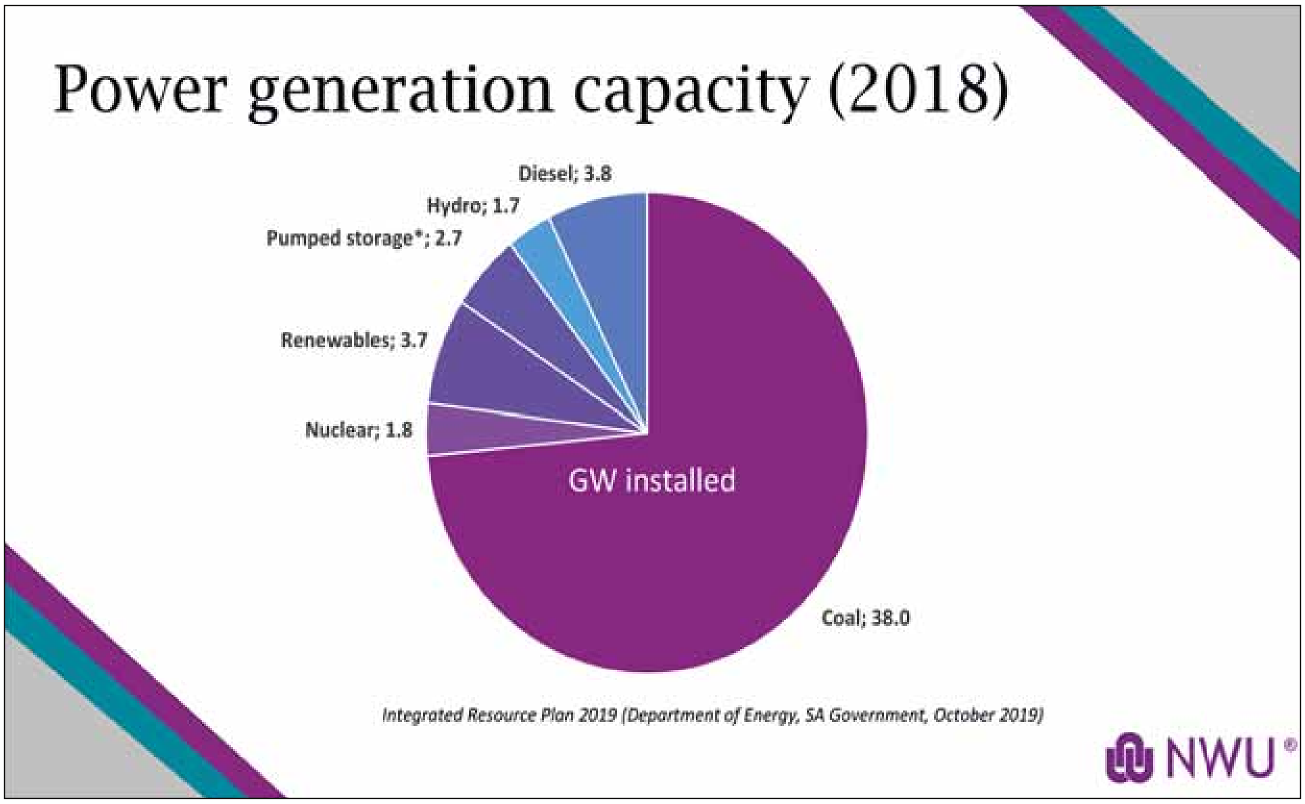

Coal outlook to 2030: South Africa

- Integrated Resource Plan 2019 (Department of Energy, October 2019)
  - Revision of IRP 2010-2030
- Energy growth assumed to be 4% pa
  - SA population ±60 million
  - 2018: 37 GW (71%) from coal
  - 2030: 33 GW (43%) from coal
- To be replaced mainly by wind and solar
- Despite this, coal is still very much part of the mix in the next century

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Technologies used

- 62% of ROM is washed
  - Average yield 64%
- DMS (Cyclones, Baths)
- Gravity (Spirals, TBS, RC)
- Very little flotation
- Very little dry processing
- Fines processing sections now common

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Technology drivers

- Improved efficiency and yield
  - Declining ROM qualities
  - Cyclone and spiral technologies
- Dry Processing
  - South Africa is a water scarce country
- Fines processing
  - Dewatering issues
- Environmental

www.sacoalprep.co.za

www.pixabay.com

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Recent game changers

- 3 product cyclone
- Dry technologies
  - FGX
  - X-ray sorters
  - Sep-air
- Reflux classifier, TBS
- Improvement in pressure filters
- Fines DMS (Coaltech)
  - Only SA development




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Technology barriers in SA

- Two decades ago: less than a dozen major mining companies
  - Large investment in research
  - Large investment in education
- Today: artisanal/junior/emerging miners
  - 46 companies involved in coal (2018)
  - Limited means to support research
- Aversion to fossil fuel research by government/private sector

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Some positives

- Coaltech
  - Cooperative research agreement, Collaboration with Universities
  - Funding limited by number of member companies
- New SA initiatives
  - Yield improvement - Magnetic cyclones
  - Dry processing - Wind sifting, winnowing, dry DMS (FB)
  - Dewatering - Ceramic adsorbents, ambient air drying

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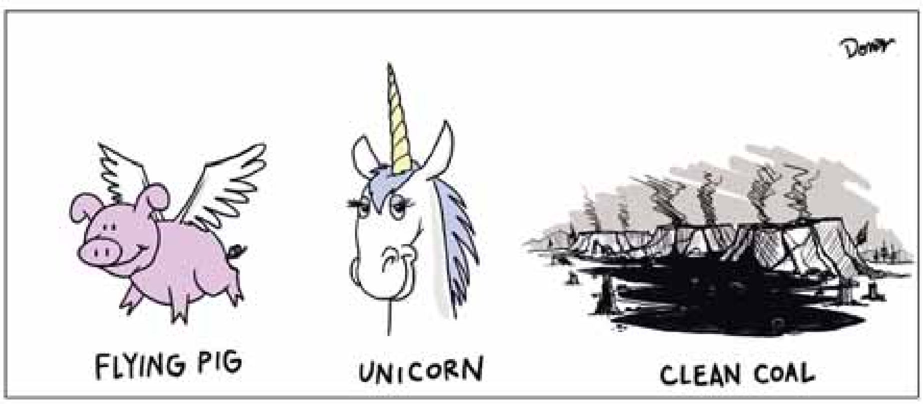
The real problem: fake populist messaging...



Coal Preparation Society of India

Website : www.cpsi-india.org.in

Webinar on *"Coal : Sampling and Analysis"*

Tuesday, 22nd December 2020

Chairman

Shri Alok Perti

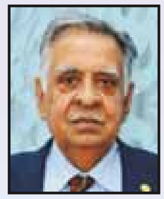
Ex Coal Secretary & Chairman, CPSI

Keynote Speaker

Dr. Ravi P Singh

Secretary General, Quality Council of India

Moderator



Shri R K Sachdev

President, CPSI

Panel of Subject Experts

Dr. A K Singh

Head of Group, RQA, CIMFR

Shri S K Gomasta

Director C&RD, CMPDIL

Shri Mehar Kuchimanchi

Director, Mineral Services, SGS India Pvt. Ltd.

Dr. Durgesh Sharma

Business Director, Metals & Minerals, Cotecna (India)

Shri Ratnesh Rai

MD, QA Laboratories (P) Ltd.

Shri Pankaj Rai

MD, Quality Austria Central Asia (P) Ltd.

Shri Shivam Dwivedi

Scientist (PCD), Bureau of Indian Standards (BIS)

Dr. Tarit Bhattacharya

Head (C&M), Inspectorate Griffith India

Registration for participation:

There is no joining Fee. Those interested in participating in the Webinar are requested to send an email request to:

rksachdev01@gmail.com, chem.divya@gmail.com

For any assistance & Registration, contact : : +91 98103 02360, 99906 02039

A view of Webinar on *"Coal : Sampling and Analysis"*

Gist of discussions held in the Webinar on Coal Sampling and Analysis

held on 22nd December, 2020 on virtual platform.

As a part of its service to the industry and all stakeholders and also as a fall out of the concerns expressed by various speakers during the twentieth anniversary webinar held on 4th December 2020, CPSI had organised a virtual Webinar on 22nd December 2020 on an important and topical theme: 'Coal: sampling and analysis'.

Welcoming the keynote speaker, Dr. R P Singh, Quality Council of India (QCI) and expert panelists and the participants, Shri Alok Perti, IAS (Retd), Former Coal Secretary and Chairman, CPSI, stressed upon the importance of sampling and analysis in the coal production and supply chain. He also gave a brief background about third-party sampling and testing of coal supplied to power plants.

Shri R K Sachdev, President, CPSI also welcomed the keynote speaker, panelists and the participants. He further observed that coal being a heterogeneous naturally occurring material, its quality parameters namely ash content, moisture content, sulphur etc. vary widely. Proximate Analysis is the standard method by which these parameters are determined. The coal producers and suppliers are required to ensure that the quality of coal is maintained as per agreed coal supply agreement.

Shri Sachdev further noted that the focus of the deliberations in the Webinar would be on various technical aspects of sampling and analysis of coal produced and marketed in India. Some important quality related aspects of imported coal will also be addressed by the panelists.

Dr. R P Singh, Secretary General,) delivered the Keynote address in which, besides describing the role of the Quality Council of India, he addressed upon the need for honest sampling and analysis of coal, covered various important technical, procedural and infrastructural aspects of sampling and analysis of coal at the loading points as well at the delivery points at the power plants and other major consumers. He also dwelt upon the issues and challenges being faced by sampling teams deputed by QCI and also by other private agencies who have been tasked with collection of samples at the loading points of Coal India Ltd and Singareni Collieries Company Ltd.

Dr. R P Singh further mentioned that the Standards of Sampling as laid down by the Bureau of Indian Standards were originally prescribed in early fifties and these need up-dation on urgent basis.

Dr. R P Singh made a comprehensive presentation highlighting the methodologies of sampling and testing of coal. He also made a very pertinent point regarding obsolete standards being followed by the agencies in absence of any updated versions. He strongly emphasized upon the need for revisiting IS : 436 (Part 1/Set 1) - 1964 by the Bureau of Indian Standards (BIS) on an urgent basis. Standards for analysis of samples also need to be reviewed and updated in the light of changed scenarios of mining methods etc.

While summing up his presentation, he stressed upon the need to address the following challenges:

- Huge amount of paperwork is involved in manual systems being practiced. This is to be replaced by IT tools and techniques;
- Infrastructure and Enabling Conditions must be improved by implementing the automated sampling using mechanical sampling facilities;
- Local and political issues need to be addressed by the coal companies by ensuring the human resource and mine safety measures are strictly followed.

Panel Discussions:

The expert panel comprised of the following subject experts:

i. Dr. A K Singh, Head Resource Quality Assessment Group, CIMFR.

ii. Shri Mehar Kuchimanchi, Director, SGS, India.

iii. Dr. Durgesh Sharma, Business Director, Cotecna, India.

iv. Shri Ratnesh Rai, Managing Director, QA Testing laboratories.

v. Shri Pankaj Rai, Managing Director, Quality Austria Central Asia (India).

vi. Dr. Tarit Kumar Bhattacharya, Head (C & M), Inspectorate Griffith (India).

vii. Shri Shivam Dwivedi, Scantiest PCD-7, Bureau of Indian Standard (BIS).

viii. Representative of CMPDIL

The discussions were moderated by Shri R K Sachdev, President CPSI. Shri Sachdev observed that in any commercial transaction of selling and buying of coal, transparency about the source, the quality and the quantity of coal is key in the coal supply chain. The determination of the quality of coal is an important subset of the commercial transaction. The panelists were requested to keep focus during their presentations on the following issue:

'Are the practices being followed in India for Sampling and Analysis in the Production-Preparation-Supply chain of coal adequate? If not how to make them at par with the global standards?'

The Panelists made presentations covering inter alia, methods of sampling and sample preparation, division, packaging and transportation of samples, standard laboratory testing procedures, analytical techniques and compilation of test results etc. They also dwelt upon various methods of collection of coal samples from stockpiles, conveyors, trucks and wagons etc. The advantages and shortcomings of each method were deliberated at length.

They also outlined the coal properties, such as calorific value, volatile matter, moisture, sulphur, chlorine and ash (elemental composition) content which largely form the basis of sale contracts. These properties are all measured at samples taken during loading/unloading of the coal. Payment for the coal is based on the analytical results.

A consensus was reached on the following critical aspects of the subject under discussions:

i. It is an accepted fact that 80% errors happen during sampling, 15% during sample preparation and only 5% in lab testing.

ii. Accuracy of sampling is dependent upon size and nature of coal to be sampled, method of sampling and equipment available, the quantity to be represented by the sample mass and the degree of precision required.

iii. The accessibility and site conditions, weather conditions, technical constraints, skill level of manpower deployed are among various influencing factors that affect the accuracy and the integrity of the sampling process.

iv. Mechanical sampling from moving streams is the preferred method for sampling coals, while manual sampling should be avoided whenever possible.

v. The best location for sampling from a moving stream is at the discharge point of a conveyor belt or where the complete stream can be intercepted at regular intervals.

vi. Coal samples can also be taken from a moving conveyor belt, but 'stop belt' method is accurate and preferred for sampling of coal.

vii. Sampling from stationary coal lots, such as coal stockpiles, loaded wagons or trucks, is sometimes necessary, but it is problematic and difficult to collect representative samples.

viii. Manual coal sampling methods from loaded wagons has its limitations such as, segregation due to large coal, impractical to collect samples from full depth, and possible bias due to manual operations, etc.

ix. Automated mechanical sampling (AMS) systems are being preferred globally, as these can be standardised to include preliminary preparation of the coal sample and are designed as per prescribed protocols.

x. Auto Mechanical sampling Augers are most preferred sampling systems for stationary coal lots, such as stockpiles, loaded wagons and trucks. Augers are available in various designs and are made to fit as per the requirements and nature of sampling.

Laboratory analysis:

i. The type of analysis normally requested by the thermal coal suppliers and coal consumers are proximate analysis and an ultimate analysis, together with one or more of the miscellaneous analyses or tests i.e. Ash Chemistry, Ash Fusion Temperature, Highgrove Grindability Index (HGI), etc. In the case of coking a different regimen of tests and analysis is prescribed by the steel industry.

ii. Coal has the tendency to gain or lose moisture and to undergo oxidation when exposed to the atmosphere; it is therefore necessary that all coal analyses follow standard procedural guidelines in order to obtain reliable and reproducible results.

iii. The analyses need to be sufficiently accurate so as to preclude any technical and/or economic consequences. Hence, strict adherence to the standard procedures is necessary to obtain repeatable and reproducible results.

iv. There are many relatively new approaches, usually based on modern sophisticated instrumentation, that have been shown to have wide applicability to coal analysis. Several such instruments are fast and can simultaneously determine IM, Ash, VM and carbon, hydrogen & nitrogen and/or other elements in various samples.

v. Instrumental analytical techniques enable tests of coal be carried out where the coal is mined, processed, transported, or utilized.

Recommendations

i. Sampling on crushed coal below 100mm or preferably at 50mm, because lower the size of coal, better is the sampling precision and less discrepancies in results.

ii. Implementation of Auto Mechanical Sampling (AMS) system at all sampling points.

iii. Urgent need of revisiting IS : 436 (Part l/Set 1) – 1964 to include Auto Mechanical Augers sampling for sampling of coal from loaded wagons & trucks and its implementation on ground.

iv. Huge amount of paperwork is involved in manual systems being practiced. This is to be replaced by IT tools and techniques.

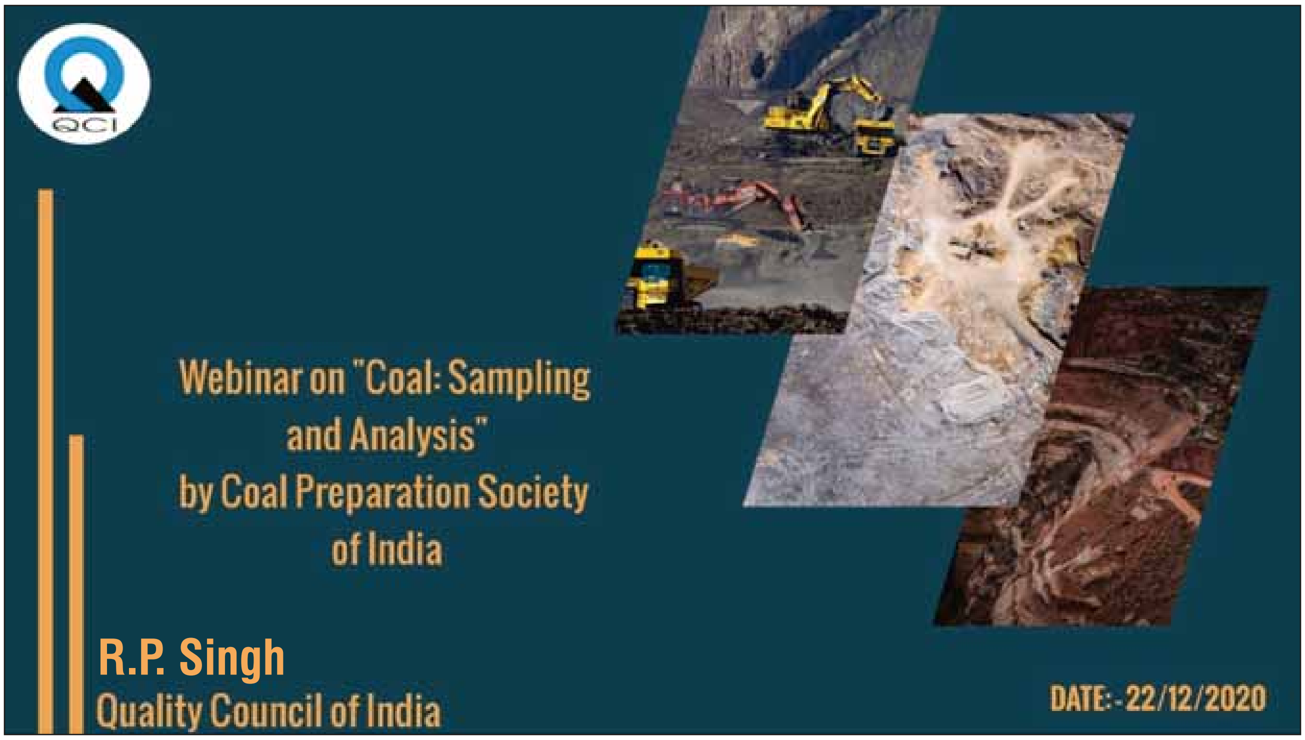
v. Infrastructure and enabling conditions must be improved by implementing the automated sampling using mechanical sampling facilities.

vi. Local and political issues need to be addressed by the coal companies by ensuring the human resource and mine safety measures are strictly followed.

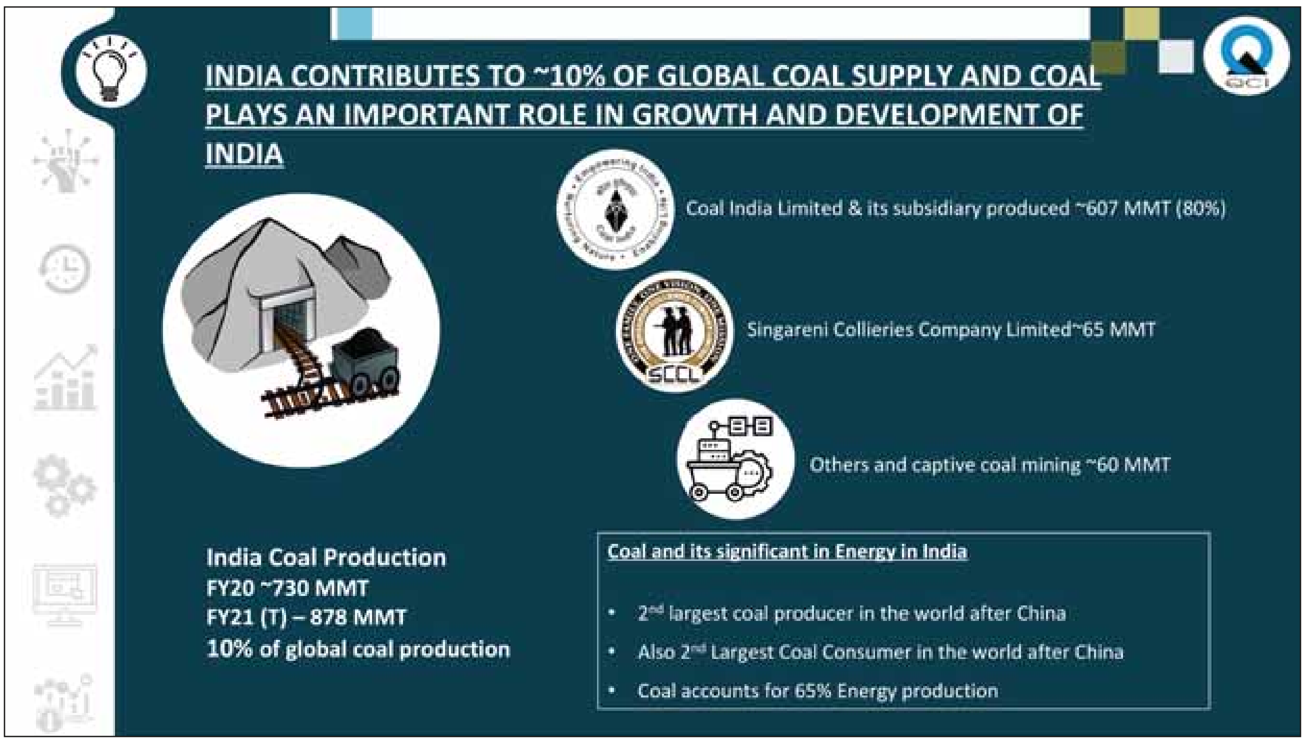
In order to instill confidence with the users of coal it is necessary that sampling and testing of coal is done with technically modern methods where the possibility of error is minimized. This can be achieved in implementing the recommendations stated above in a time bound manner.

It was suggested that the Ministry of Coal in consultation with NITI Aayog, set up a committee of representatives of Coal India, SCCL, CIMFR, Quality Council of India and Bureau of Indian Standards (MIS) to suggest a time-bound plan of action for implementing the suggestions and recommendations stated above.

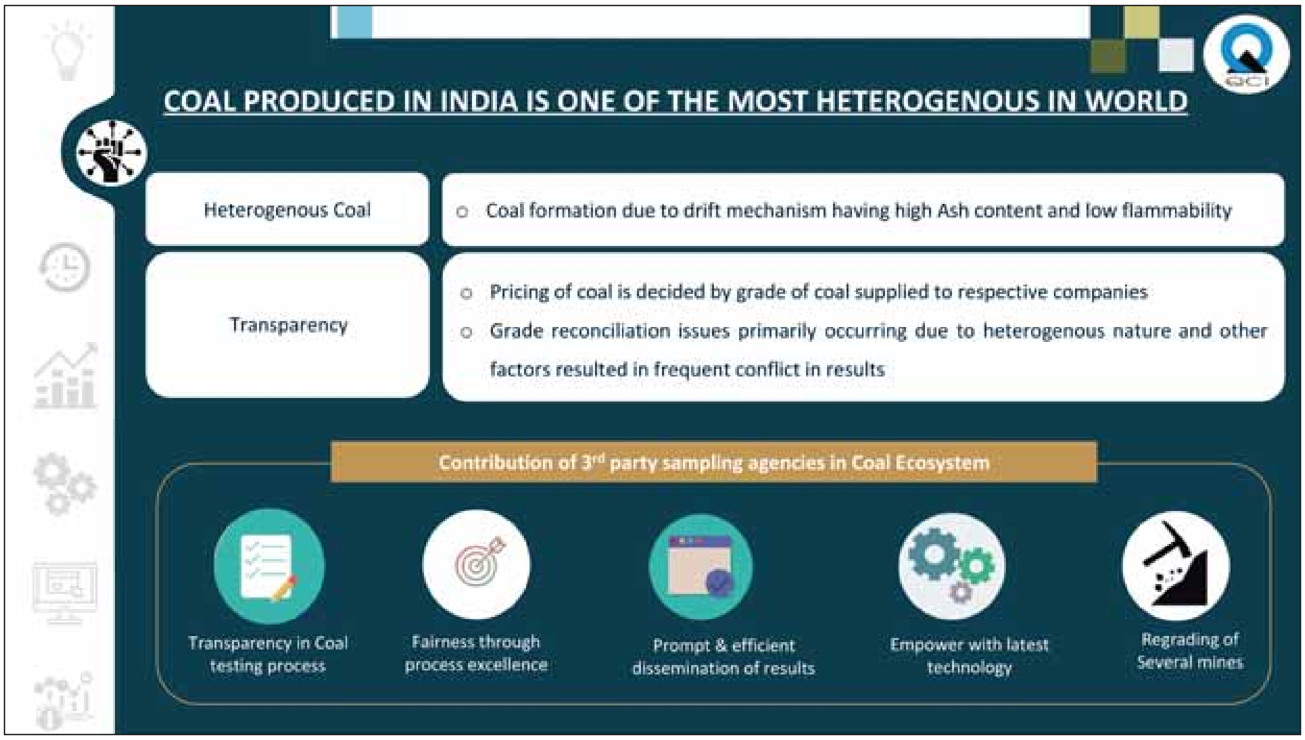
In order to facilitate and ensure acceptance of its recommendations by all stakeholders; the committee should be headed by the Quality Council of India (QCI).

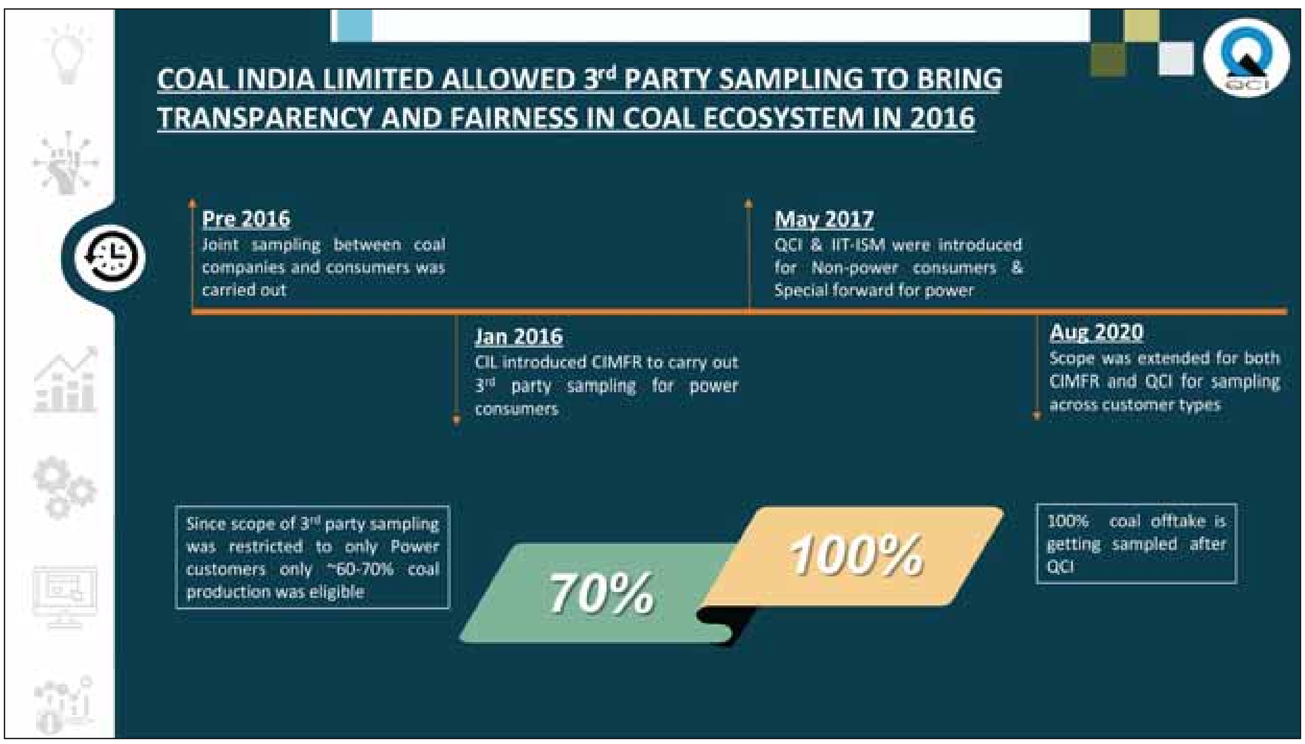


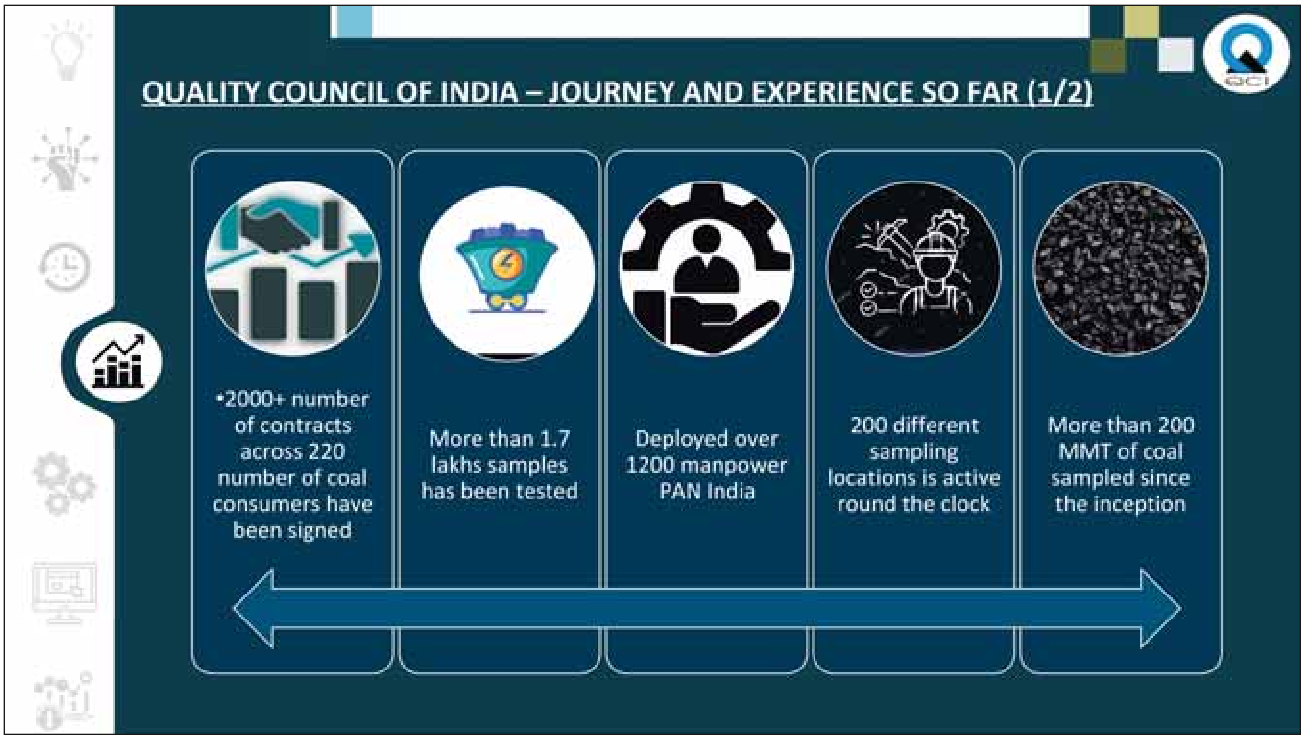
Webinar on "Coal: Sampling and Analysis" by Coal Preparation Society of India
R.P. Singh
Quality Council of India
DATE:- 22/12/2020

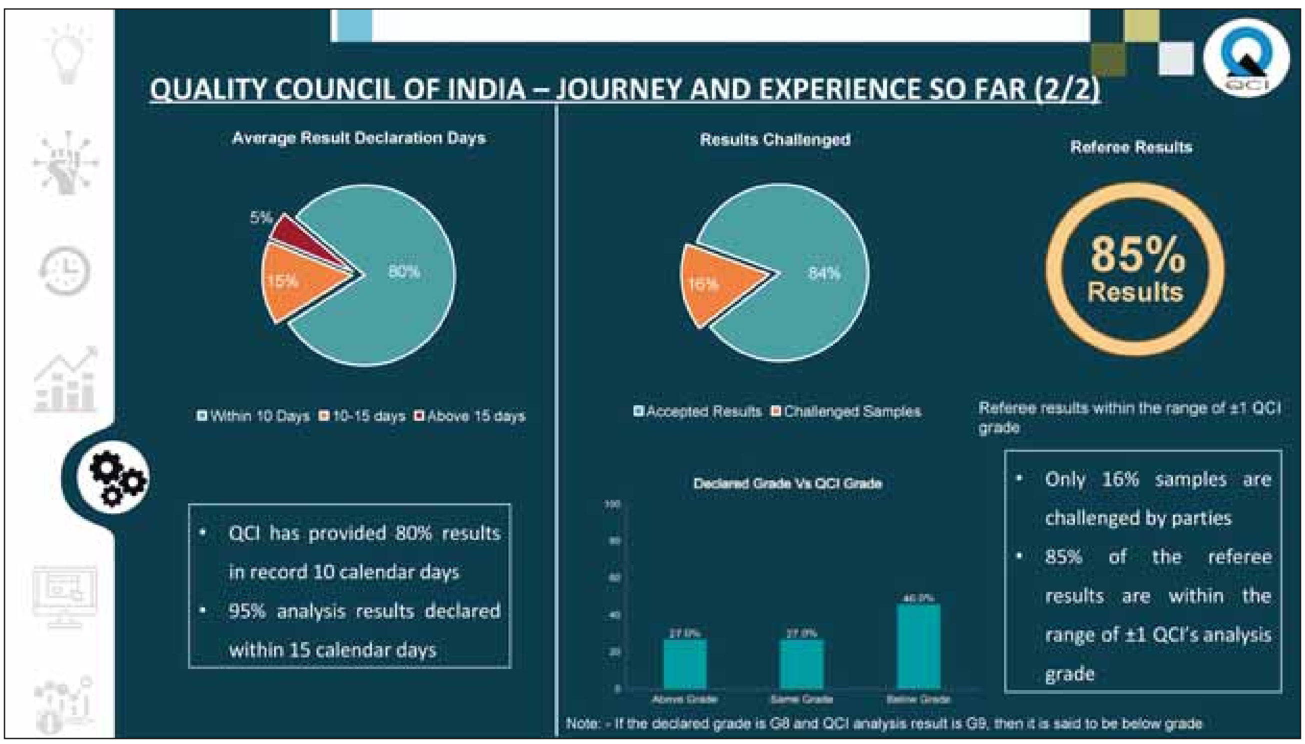


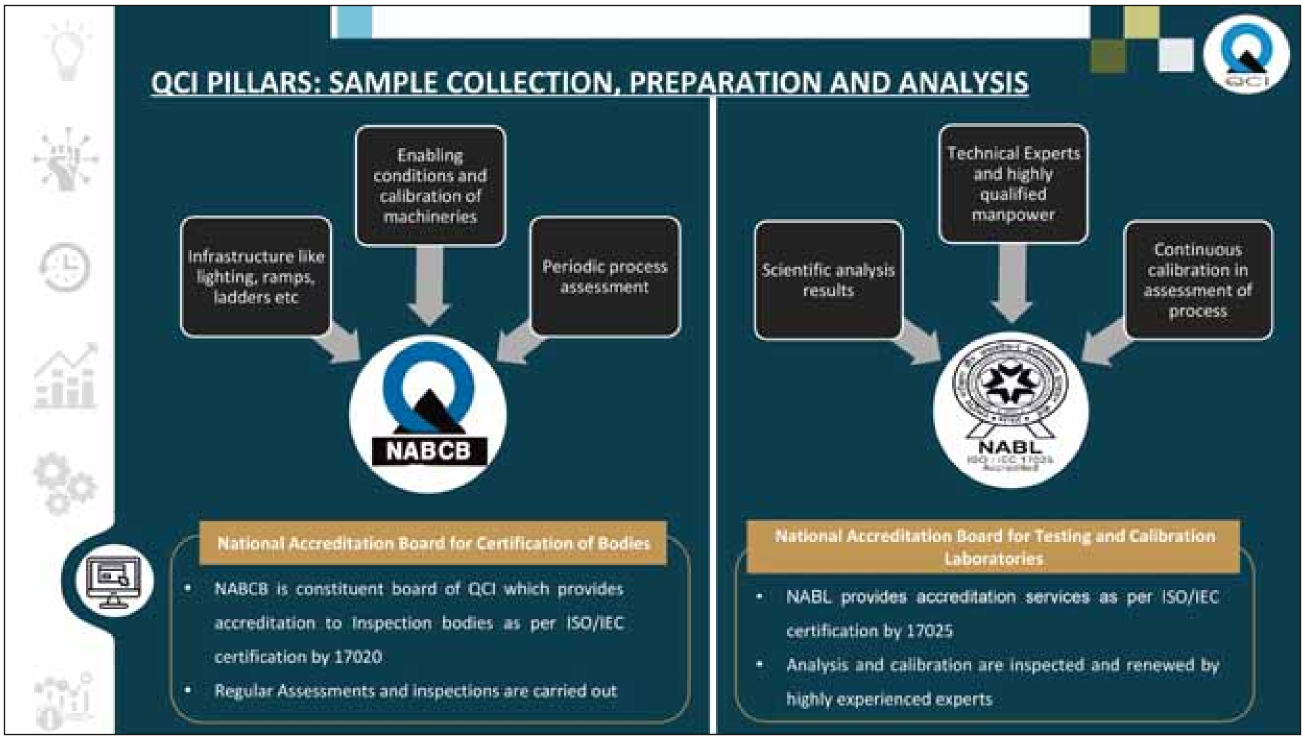
INDIA CONTRIBUTES TO ~10% OF GLOBAL COAL SUPPLY AND COAL PLAYS AN IMPORTANT ROLE IN GROWTH AND DEVELOPMENT OF INDIA
Coal India Limited & its subsidiary produced ~607 MMT (80%)
Singareni Collieries Company Limited~65 MMT
Others and captive coal mining ~60 MMT
India Coal Production
FY20 ~730 MMT
FY21 (T) – 878 MMT
10% of global coal production
Coal and its significant in Energy in India
2nd largest coal producer in the world after China
Also 2nd Largest Coal Consumer in the world after China
Coal accounts for 65% Energy production

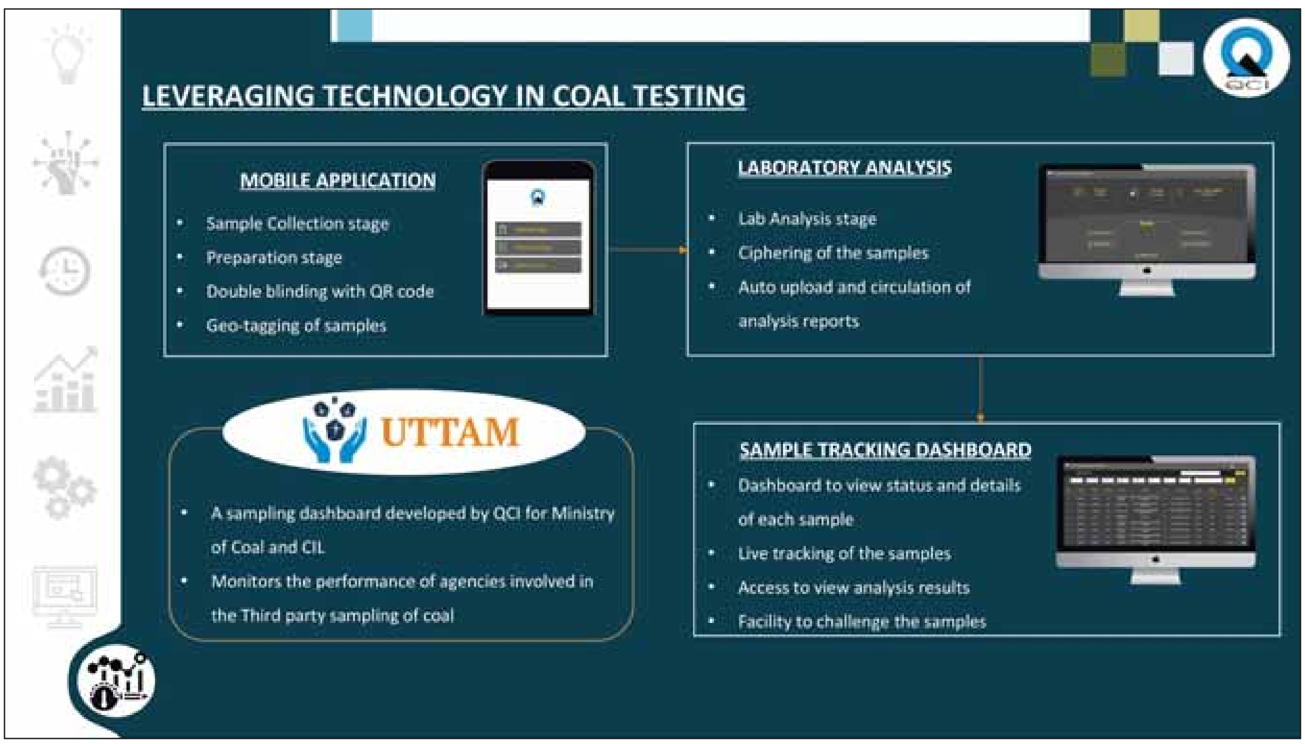

COAL PRODUCED IN INDIA IS ONE OF THE MOST HETEROGENOUS IN WORLD
Heterogenous Coal
Coal formation due to drift mechanism having high Ash content and low flammability
Transparency
Pricing of coal is decided by grade of coal supplied to respective companies
Grade reconciliation issues primarily occurring due to heterogenous nature and other factors resulted in frequent conflict in results
Contribution of 3rd party sampling agencies in Coal Ecosystem
Transparency in Coal testing process
Fairness through process excellence
Prompt & efficient dissemination of results
Empower with latest technology
Regrading of Several mines


COAL INDIA LIMITED ALLOWED 3rd PARTY SAMPLING TO BRING TRANSPARENCY AND FAIRNESS IN COAL ECOSYSTEM IN 2016
Pre 2016
Joint sampling between coal companies and consumers was carried out
May 2017
QCI & IIT-ISM were introduced for Non-power consumers & Special forward for power
Jan 2016
CIL introduced CIMFR to carry out 3rd party sampling for power consumers
Aug 2020
Scope was extended for both CIMFR and QCI for sampling across customer types
Since scope of 3rd party sampling was restricted to only Power customers only ~60-70% coal production was eligible
70%
100%
100% coal offtake is getting sampled after QCI


QUALITY COUNCIL OF INDIA – JOURNEY AND EXPERIENCE SO FAR (1/2)
•2000+ number of contracts across 220 number of coal consumers have been signed
More than 1.7 lakhs samples has been tested
Deployed over 1200 manpower PAN India
200 different sampling locations is active round the clock
More than 200 MMT of coal sampled since the inception


QUALITY COUNCIL OF INDIA – JOURNEY AND EXPERIENCE SO FAR (2/2)
Average Result Declaration Days
5%
15%
80%
Within 10 Days 10-15 days Above 15 days
• QCI has provided 80% results in record 10 calendar days
• 95% analysis results declared within 15 calendar days
Results Challenged
16%
84%
Accepted Results Challenged Samples
Referee Results
85% Results
Referee results within the range of ±1 QCI grade
Declared Grade Vs QCI Grade
Above Grade
Same Grade
Below Grade
• Only 16% samples are challenged by parties
• 85% of the referee results are within the range of ±1 QCI's analysis grade
Note: - If the declared grade is G8 and QCI analysis result is G9, then it is said to be below grade


QCI PILLARS: SAMPLE COLLECTION, PREPARATION AND ANALYSIS
Enabling conditions and calibration of machineries
Infrastructure like lighting, ramps, ladders etc
Periodic process assessment
NABCB
National Accreditation Board for Certification of Bodies
• NABCB is constituent board of QCI which provides accreditation to Inspection bodies as per ISO/IEC certification by 17020
• Regular Assessments and inspections are carried out
Technical Experts and highly qualified manpower
Scientific analysis results
Continuous calibration in assessment of process
NABL
National Accreditation Board for Testing and Calibration Laboratories
• NABL provides accreditation services as per ISO/IEC certification by 17025
• Analysis and calibration are inspected and renewed by highly experienced experts


LEVERAGING TECHNOLOGY IN COAL TESTING
MOBILE APPLICATION
• Sample Collection stage
• Preparation stage
• Double blinding with QR code
• Geo-tagging of samples
LABORATORY ANALYSIS
• Lab Analysis stage
• Ciphering of the samples
• Auto upload and circulation of analysis reports
UTTAM
• A sampling dashboard developed by QCI for Ministry of Coal and CIL
• Monitors the performance of agencies involved in the Third party sampling of coal
SAMPLE TRACKING DASHBOARD
• Dashboard to view status and details of each sample
• Live tracking of the samples
• Access to view analysis results
• Facility to challenge the samples


KEY CHALLENGES AND WAY FORWARD
Endless Paper Trail
Infrastructure and Enabling Conditions
Local and Political Issues
Challenges
Way Forward
Pen-paper model to Tech-driven process
To implement the automated sampling using mechanical sampling
Human resource and mine safety measures should be strictly followed

COTECNA
Trust for a moving world

Coal Sampling

(Manual & Mechanical)

Dr. Durgesh Sharma
Business Director – Metals & Minerals

Cotecna Inspection India Pvt Ltd.

Date Déc. 21, 2020

Why sampling???

> Why do we do sampling???

> The simple act of taking a sample that someone will use the information contained in the **analytical results to make a decision**.

- **Huge capital/operational commitments**
- **Design of coal washing operations**
- **Producing the right specifications**

> Sampling is among the most primary activities in a mining and processing operation, and this ppt aims to understand the applicability & limitations of Manual & Mechanical means, which have **major impacts on cost and decision making**.

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Why is it important?

> **Commercial Importance**
- Commercial transaction – between consumer and producer
- Bonus and Penalty – based on contractual specifications

> **Technical Importance**
- Plant design
- Process control
- Plant performance
- Producing right specifications

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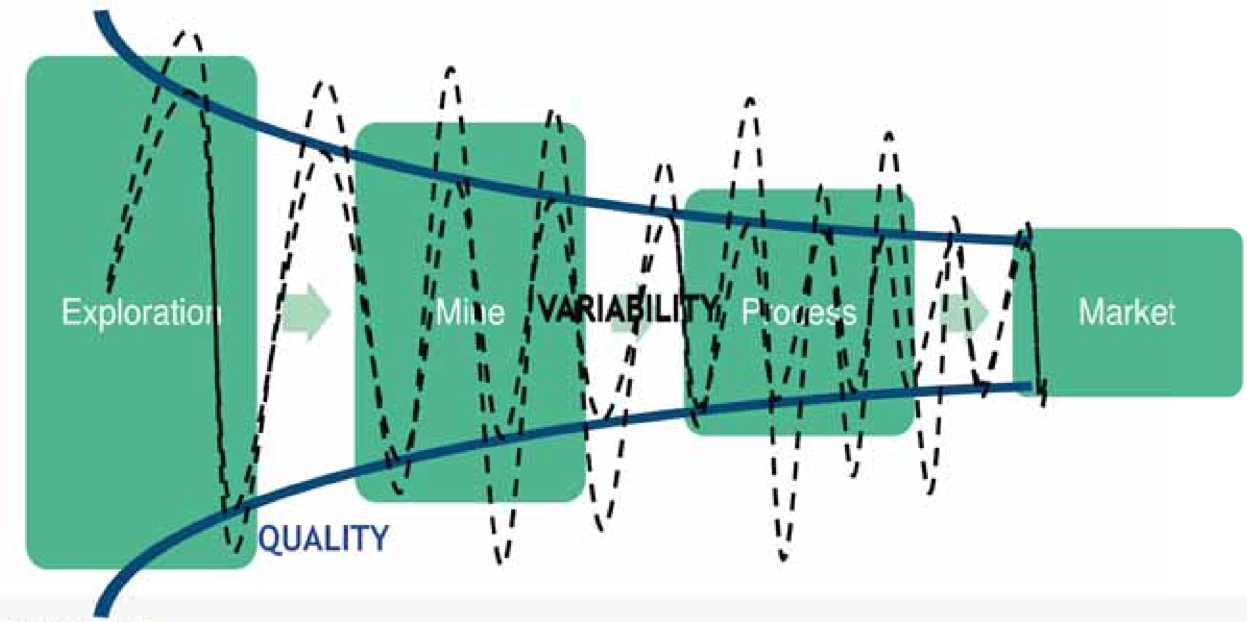
COAL QUALITY VALUE CHAIN - QUALITY VARIABILITY

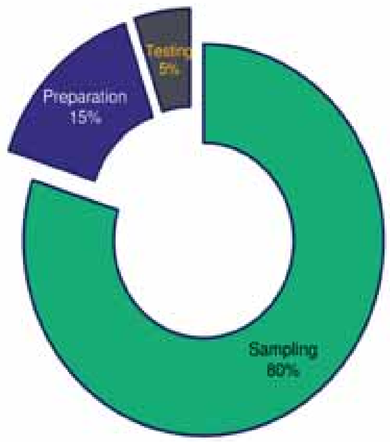


COTECNA 4

How is it achieved?

> **Quality monitoring requires proper implementation of**

- Standard Sampling scheme / procedures
- Correct Preparation techniques
- Valid National/Intl. Testing procedures



- Coal is heterogeneous material.
- Very difficult to achieve highest level of sampling precision
- Overall precision is influenced primarily due to sampling
- Utmost importance need to be given for sampling

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Sampling

> **Criteria of Sampling -** Must ensure...

- the sample is a **true representative**
- free from **Bias**
- reduce the **sampling variance**
- sample does **not undergo any chemical or physical changes**

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Sampling methods

> **Method of sampling -** depends on the nature of sample collection

- from moving stream or stopped belt,
- from stationary lots like loaded wagons / trucks, stockpiles, etc.
- **Manual** and **Mechanical** Method

> **Manual sampling from stationary lots is difficult, because**

- segregation occurs due of large size
- impractical to collect sample from the full depth
- introduces bias due to manual operation

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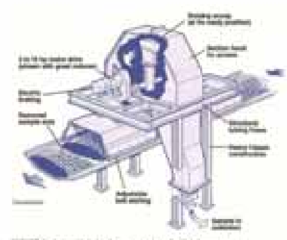
Sampling methods... Contd.



> **Auto-mechanical sampling (AMS) system**

> **AMS system at moving stream and belt conveyors**

- Size of coal for AMS – Not a proper choice for x200mm or above

> **Auto-mechanical Augers from the loaded wagons / trucks**

- To collect the sample from full depth of the wagons

NOTE: AMS & Auger should meet the requirements as per Intl. practice and Standards.

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Suggestions

> **Suggestion**
- Sampling on crushed coal below 100mm or preferably at 50mm
- Lower the size of coal, better the precision / discrepancies in results

> **Long term Alternatives**
- Auto mechanical sampling system at sampling points
- Auto mechanical augers from loaded wagons & trucks

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Coal Preparation Society of India
Webinar on
coal sampling and analysis

Mehar Kuchimanchi, Director, SGS India Private Limited

December 22, 2020

WHEN YOU NEED TO BE SURE

SGS

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TOPIC SUMMARY

- Sampling – Importance
- Sampling – Manual vs Mechanical
- Sample Preparation
- Laboratory Analysis
- Practical Constraints in India

2

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SAMPLING – WHY IS IT IMPORTANT?

- Analysis of the sample determines the product value
- Sample data allows process control
- Contract compliance and specifications are verified

3

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SAMPLING – IMPORTANCE - BENEFICIARY

- Producers want to be paid a fair price for the quality of coal produced
- Traders want the analysis to agree each time a shipment is sampled
- Consumers want to pay for the energy in the coal that was actually delivered

4

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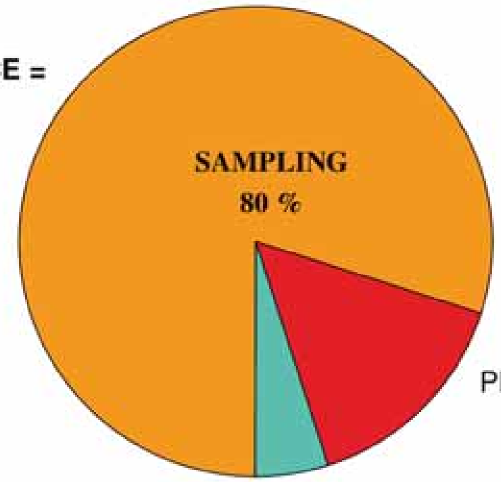
CONCEPTS ABOUT SAMPLING ERROR

80% OF SAMPLE ERROR OCCURS AS SAMPLE COLLECTION.

TOTAL VARIANCE =



Based on testing done using Manual Sampling!

5

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SAMPLING

- It is critical that the quality of the coal is measured accurately. It is used to determine the value of the cargo and the power plant needs accurate quality information to manage the power plant operation.
- In case of Import coal, the sampling was done multiple times, at the mine, on loading into the vessel and on unloading from the vessel in India. It will likely be sampled a fourth time at the power plant at a minimum when it is feed to the bunkers.
- Any one of these sampling locations in the example could be the "pay" sample.
- Unfortunately, for the most part sampling is done manually. This is a problem and causes problems through the whole process.

6

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CRITERIA FOR SOURCING COALS FOR INDIA

- Example – typical Indonesian coal journey from mine to the power plant in India;
  - Coal is manually sampled at the mine or jetty where it is loaded into barges.
  - The barges than travel down river and out into the ocean
    - It often rains on the barges and can results in moisture levels increasing by as much as 5% from the time it is loaded into the barge until the time the barge is unloaded onto a ship.
  - Barges are unloaded and the coal is transferred onto a ship by a transloader.
    - The barges are unloaded in no particular order.
    - Barges can come from a mix of mines and have a wide quality range. This is not blending!
    - Sampling is often done, manually but some transloaders are equipped with mechanical sampling systems (MSS).
  - The ships are unloaded in India often by grab.
    - Sampling is done manually from the grab or by sampling a pile a grab dumps on the pier.
    - It is impossible to tie individual sub-lots at DP to LP sub-lots.

7

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MANUAL SAMPLING

- Every international standard warns that manual sampling will **not** result in a representative sample. The standards notably state:
  - If manual sampling is to be used *the details of sampling procedure shall be* ***agreed upon in advance by all parties concerned***.
  - When manual sampling, *the user is cautioned that samples of this type* ***does not*** *satisfy the minimum requirements for probability sampling and as such cannot be used to obtain any meaningful statistical inferences such as sampling precision, standard error, or bias.* [the author added the bold type]
  - For coal sampled from a static source *the user is cautioned that the sample so obtained do not represent material beyond the point of penetration.*
  - ISO 11648 states that manual sampling of a stationary source; "*Such sampling from three-dimensional lots is prone to systematic errors because some parts of the lot usually have reduced or no chance of being collected for the gross sample.*" And goes on to state the standard is only trying to "*merely minimize some of the systematic sampling errors.*"

8

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GOOD PROBABILITY SAMPLING HAS THESE BASIC REQUIREMENTS THAT MUST BE MEET.

Manual Sampling

- The sampler or sample device shall have access to all of the material.
- All particles in the shipment shall have the same probability of being collected.
- Sampling shall be done in a manner that does not reject particles due to their size.
- Sampling shall be randomized – the best is randomized systematic.
- Sampling shall be done with material in flow taking a full cut of the stream.
- The size consist of the final sample shall be the same as the material being sampled.

9

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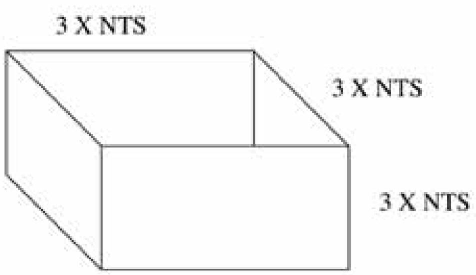
THE PROBLEMS LARGE NTS AND MANUAL SAMPLING



NTS (mm)	Sides (m)	Volume (m^3)	Density (kg/m^3)	Increment mass (kg)
50	0.15	0.0034	800.00	2.70
75	0.23	0.0114	800.00	9.11
100	0.30	0.0270	800.00	21.60
150	0.45	0.0911	800.00	72.90
300	0.90	0.7290	800.00	583.20

10

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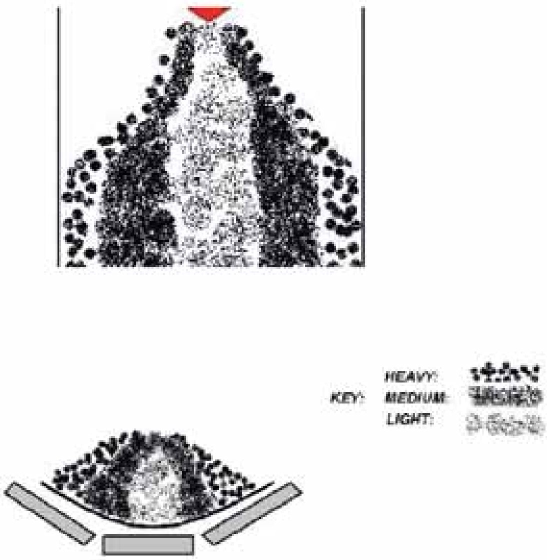
MANUAL SAMPLING LOCATIONS ARE A PROBLEM DUE TO SEGREGATION



- Manual samples are collected:
  - From the sides of piles
  - Tops of trucks, wagons, holds or grabs
  - Sides of a flowing stream on a conveyor belt
- The second problem is all the material the sampler has access to is segregated by size based on how it was loaded.
- This means the sample size analysis is bias – most often to the coarser fractions.

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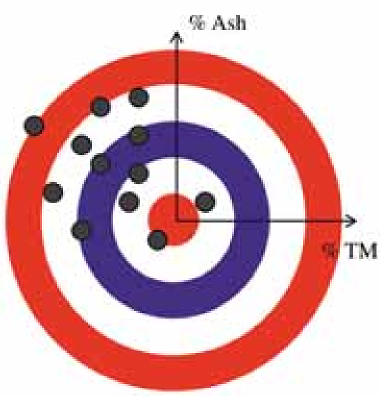
MANUAL SAMPLING – PROBLEM WITH SEGREGATION AT SAMPLING LOCATION

- Manual sampling is often bias and not precise.



Bias and not precise

Indian Coal		Sampled from side of pile			
Size Fractrion (mm)		In sub-lot		As Sampled	
Passing	Retained	% Wt.	% Dry Ash	% Wt.	% Dry Ash
plus	150.0	5.0	58.45	8.9	58.45
150.0	100.0	14.5	54.76	21.5	54.76
100.0	50.0	16.5	39.11	20.3	39.11
50.0	25.0	14.0	36.80	19.6	36.80
25.0	13.0	16.0	36.44	17.5	36.44
13.0	6.0	10.0	34.84	7.6	34.84
6.0	3.0	8.5	32.75	2.2	32.75
3.0	1.0	6.3	29.41	1.1	29.41
1.0	0.5	3.9	25.62	1.0	25.62
0.5	pan	5.3	27.12	0.3	27.12
		100.0	38.86	100.0	42.53
				Delta Ash	3.68

Segregation at the sampling location could result in the sample size consist being finer and the bias in the other direction.

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MECHANICAL SAMPLING

- ISO and ASTM standards recognize that Mechanical Sampling of Coal generates the most representative and repeatable sampling results.
- Both state that a MSS shall be bias tested.
- The standards also state the MSS should be monitored after testing using control charts to monitor the MSS extraction ratio (kg sample/ton sampled) to insure the MSS continues to operate as tested.

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MECHANICAL SAMPLING

- Only a properly designed Mechanical Sampling System (MSS) should be used to determine the quality of the coal for contract purposes.
  - Designed to meet the specified standard ASTM or ISO.
  - Inspected and certified that the MSS is designed properly and set up to operate properly per the standards.
  - The MSS is bias tested and found to be bias free – yearly or every two years.
  - The MSS is monitored on a sub-lot by sub-lot bases using extraction ratio monitoring as defined by the standards, to ensure the MSS continues to operate as bias tested.
  - Highly recommended – test the precision of the MSS. Precision is a function of the Coal Variability, MSS and the laboratory sample preparation and analysis.
- Should be time based!

14

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SAMPLE PREPARATION

- How the sample is to be prepared should be part of the sales contract.
  - Crushing and sample sub-divided.
    - crushed NTS
    - minimum sample masses required
  - Specify at what stage the total moisture is to be determined.
  - Require maintains of records on how each sample was prepared.
  - Require the precision of laboratory preparation to be known.

15

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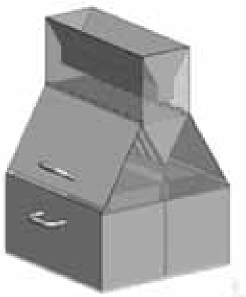
MINIMUM SAMPLE MASS

Nominal Top Size (mm)	General Analysis (kg)	Total Moisture Determination (kg)
150.0	2,600	500
125.0	1,700	350
100.0	1,700	350
90.0	750	125
80.0	750	125
75.0	470	95
70.0	470	95
63.0	300	60
60.0	300	60
50.0	170	35
45.0	125	25
38.0	85	17
31.5	55	10
30.0	55	10
25.0	55	10
22.4	32	7
20.0	32	7
16.0	20	4
12.5	20	4
11.2	13	3
10.0	10	2
8.0	6.0	1.5
5.6	5.00	1.2
4.75	4.00	1.2
4.0	1.50	1.00
2.8	1.00	0.65
2.36	1.00	0.65
2.0	0.65	0.65
1.0	0.65	0.65
0.85	0.65	0.65
0.6	0.65	0.65
0.5	0.65	0.65
0.25	0.65	0.65

- At each stage of sample collection and preparation it is critical that the divided samples are not smaller than the minimum stated by the ISO and ASTM standards.
- If insufficient mass is maintained for the NTS of the material, there are too few particles in the sample and the result is excessive split errors. The two splits, say the analysis sample and the referee sample, will have substantially different qualities.
- Proper sample crushing and division is critical. Errors that occur in sample preparation can never be corrected.

16

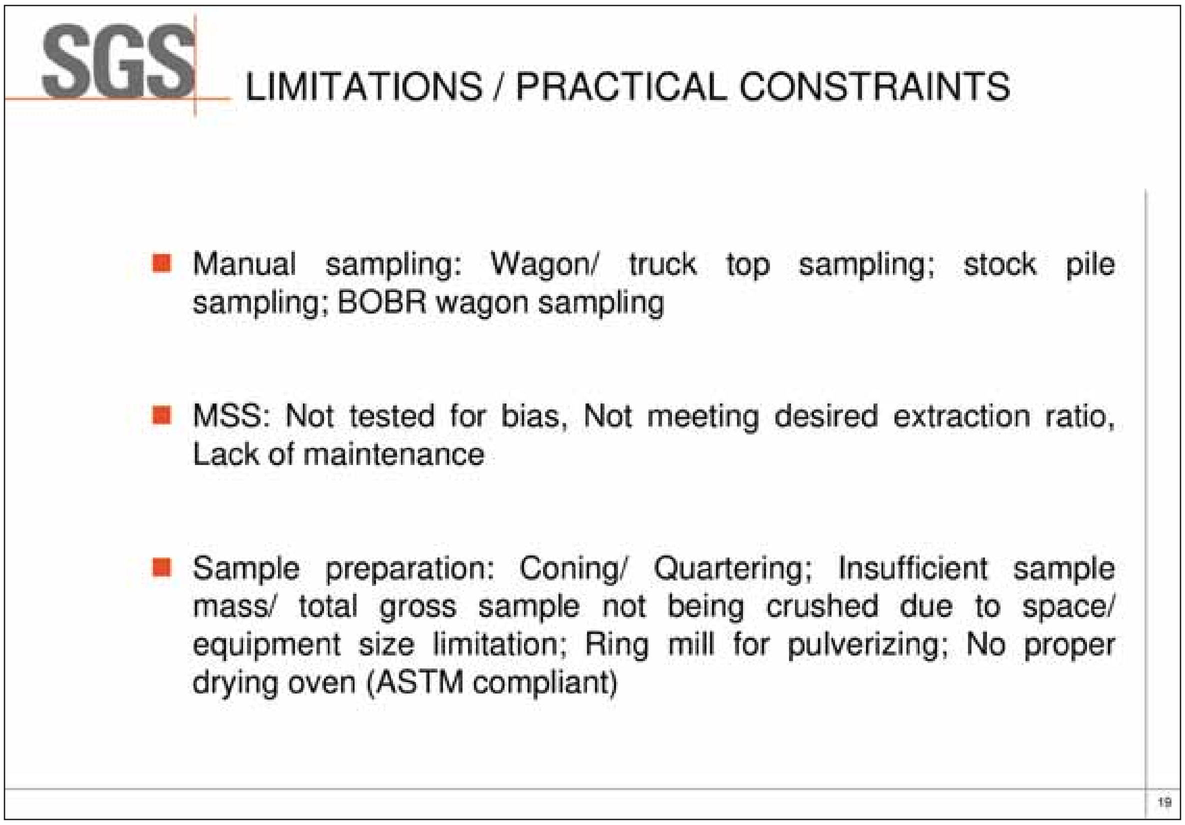
SAMPLE PREPARATION

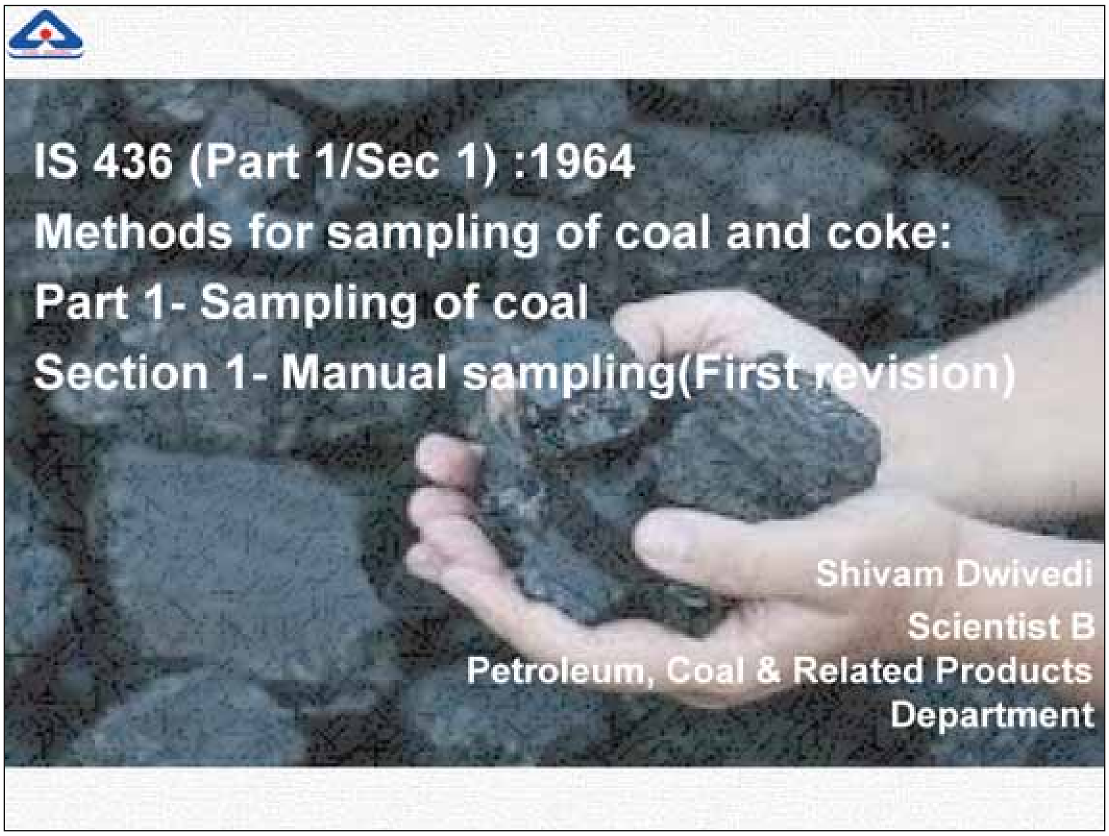


- Sample division should only be done in properly sized Riffles or Rotary Sample Dividers.
- Sample mixing before division is highly recommended.
- Sample crushing must be done in a manner that does not cause moisture loss.
- Drying ovens need to be properly designed with good temperature control and the proper air exchanges.
- Ring mills should never be used to pulverize coal.
- Dust collection systems

LABORATORY ANALYSIS

- Contracts cannot ignore the lab analysis work.
- Labs should be monitored to ensure performance (Laboratory Information Management Systems – LIMS for better control).
- Precision of lab work should be determined.
- Participation in round robin programs and other QC activities needs to be encouraged and used to validate lab performance.
- Labs must use appropriate Certified Reference Materials and Standard Reference Materials to check and ensure analysis instruments are working properly and are not bias.


SGS
LIMITATIONS / PRACTICAL CONSTRAINTS
Manual sampling: Wagon/ truck top sampling; stock pile sampling; BOBR wagon sampling
MSS: Not tested for bias, Not meeting desired extraction ratio, Lack of maintenance
Sample preparation: Coning/ Quartering; Insufficient sample mass/ total gross sample not being crushed due to space/ equipment size limitation; Ring mill for pulverizing; No proper drying oven (ASTM compliant)
19



Overview of BIS

- The Indian Standards Institution (ISI) was set up in 1947 as a registered society, under a Government of India resolution.
- Bureau of Indian Standards (BIS) Act 1986 gave statutory status to BIS on 1 April 1987.
- The BIS Act of 2016 enforced on 12 October 2017 makes BIS the National Standards Body of India.

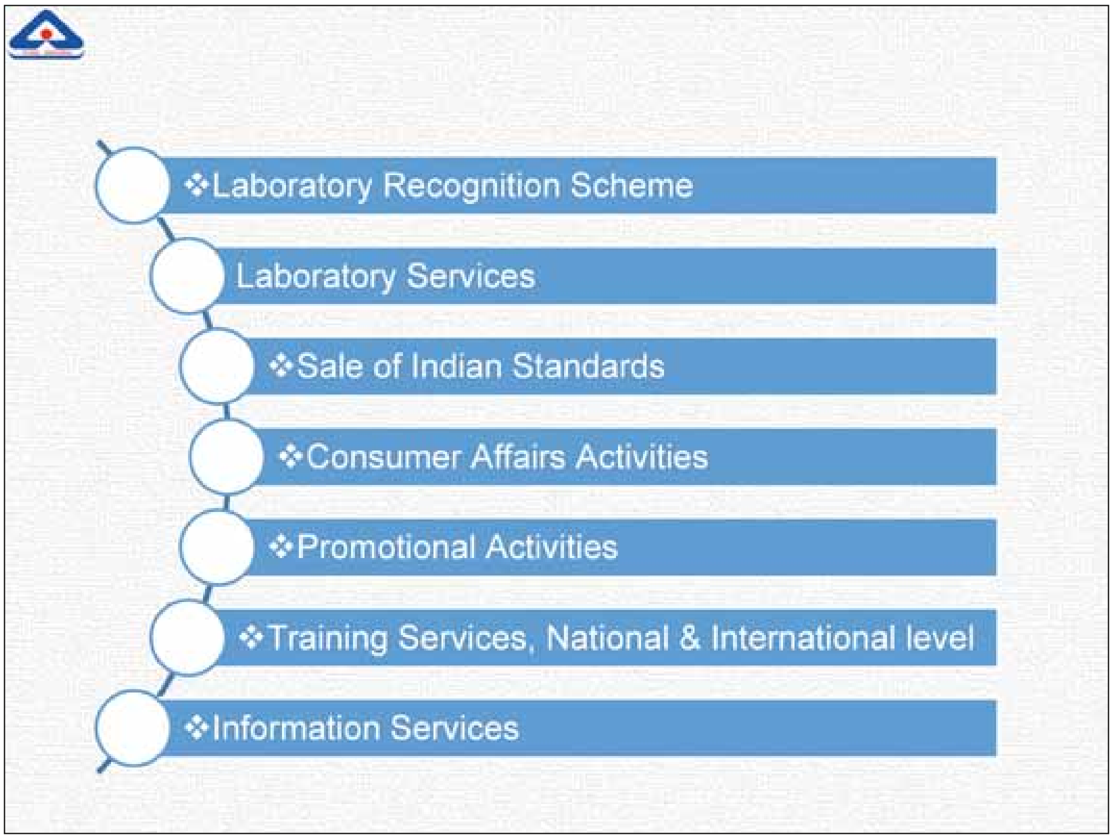
Benefits of BIS

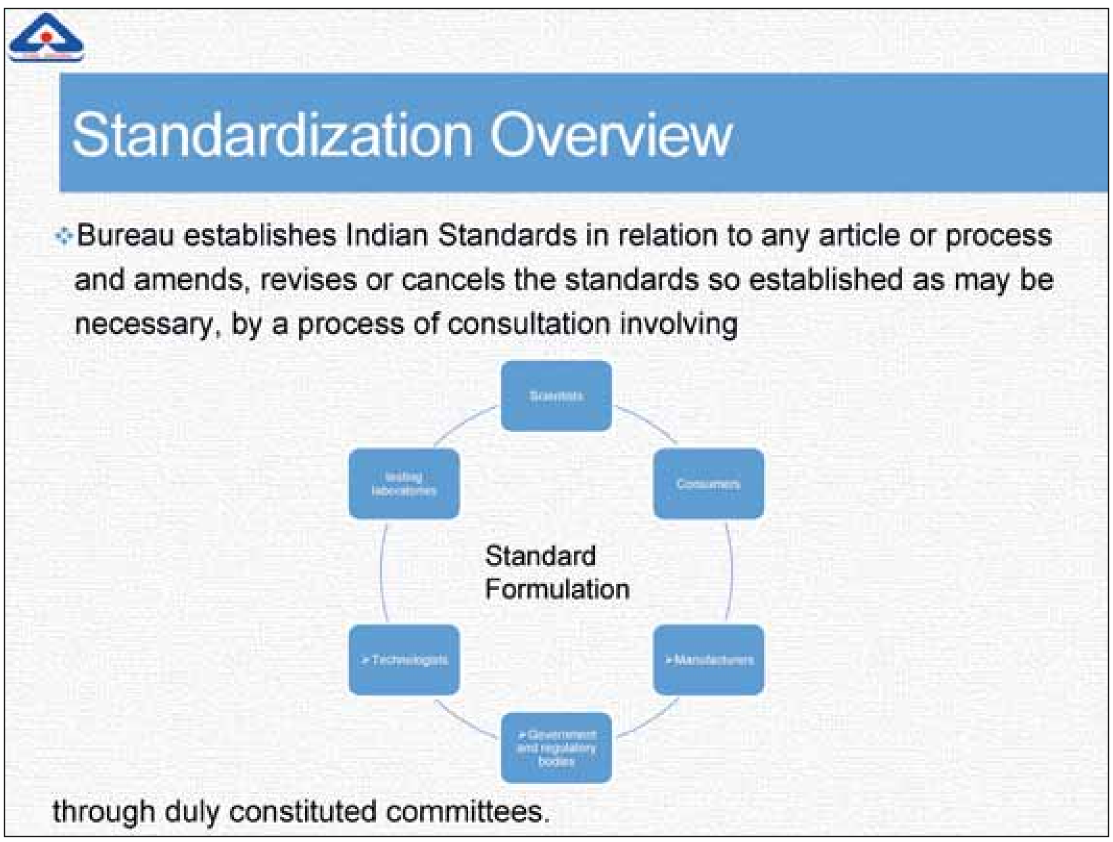
- BIS has been providing traceable and tangible benefits to the national economy by providing
  - safe reliable quality goods
  - minimizing health hazards to consumers
  - promoting exports and imports substitute
  - control over proliferation of varieties

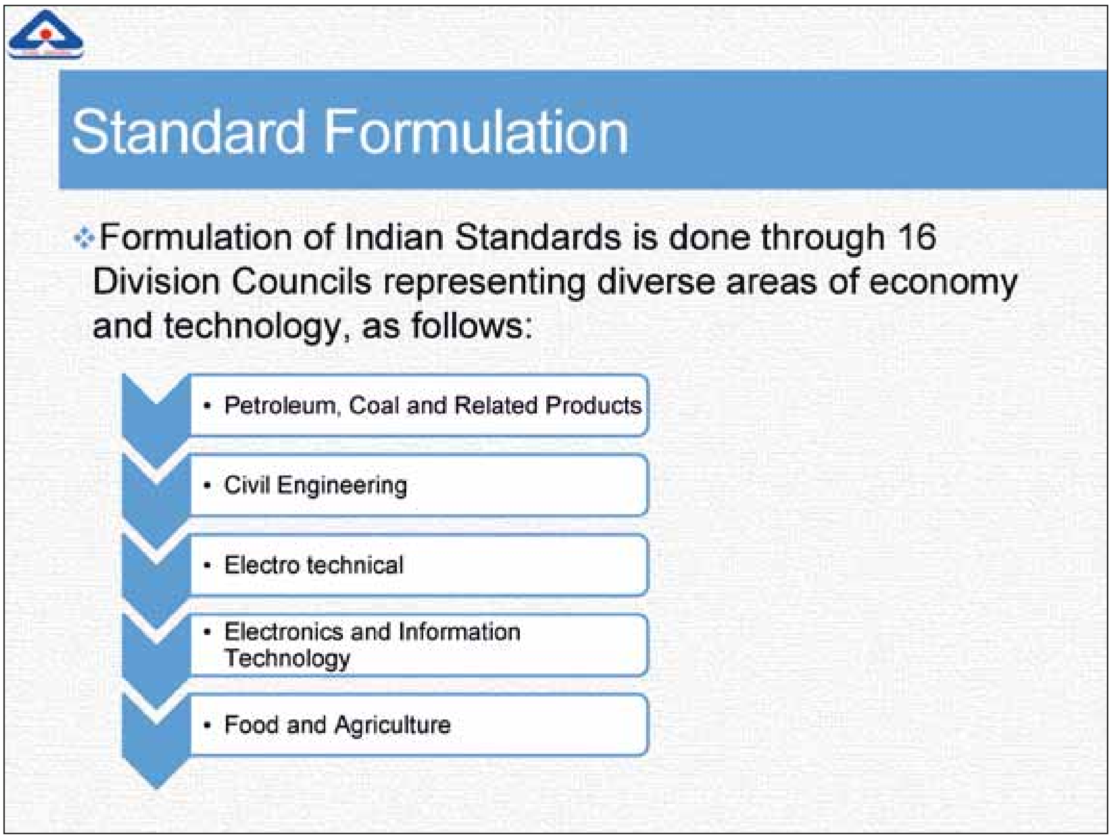
through Standardization, certification and testing.

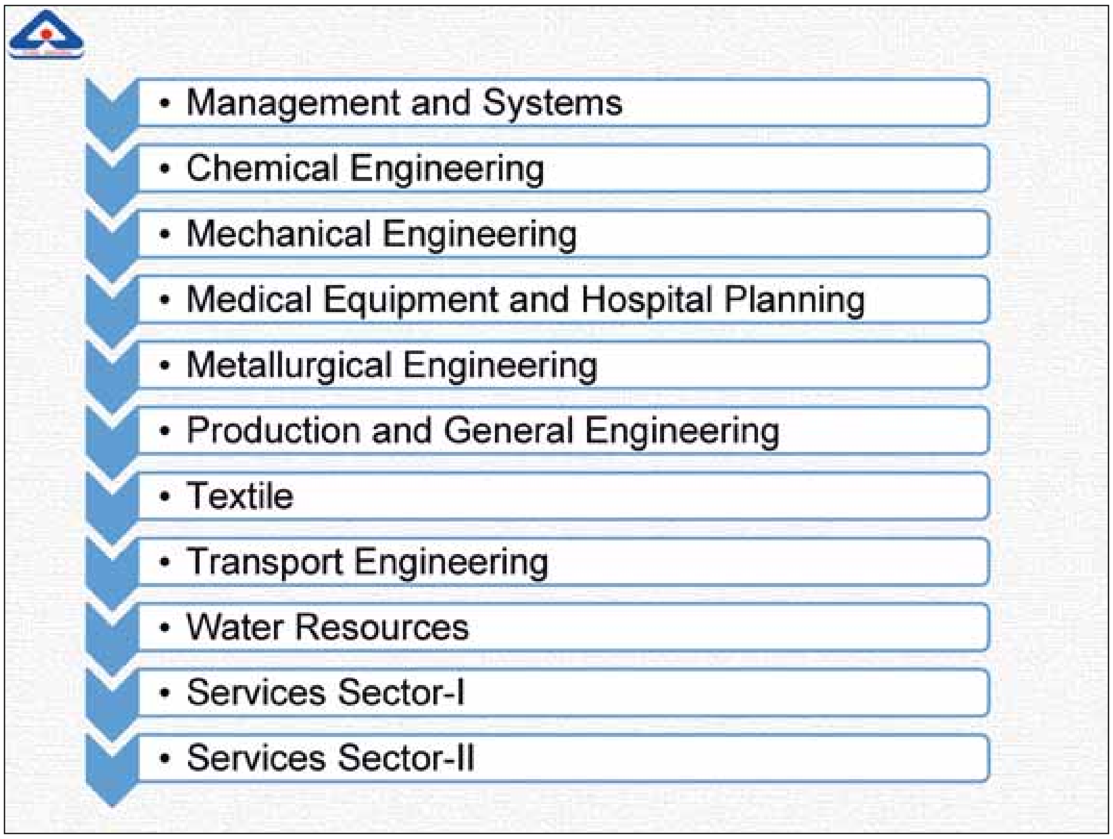
Activities of BIS

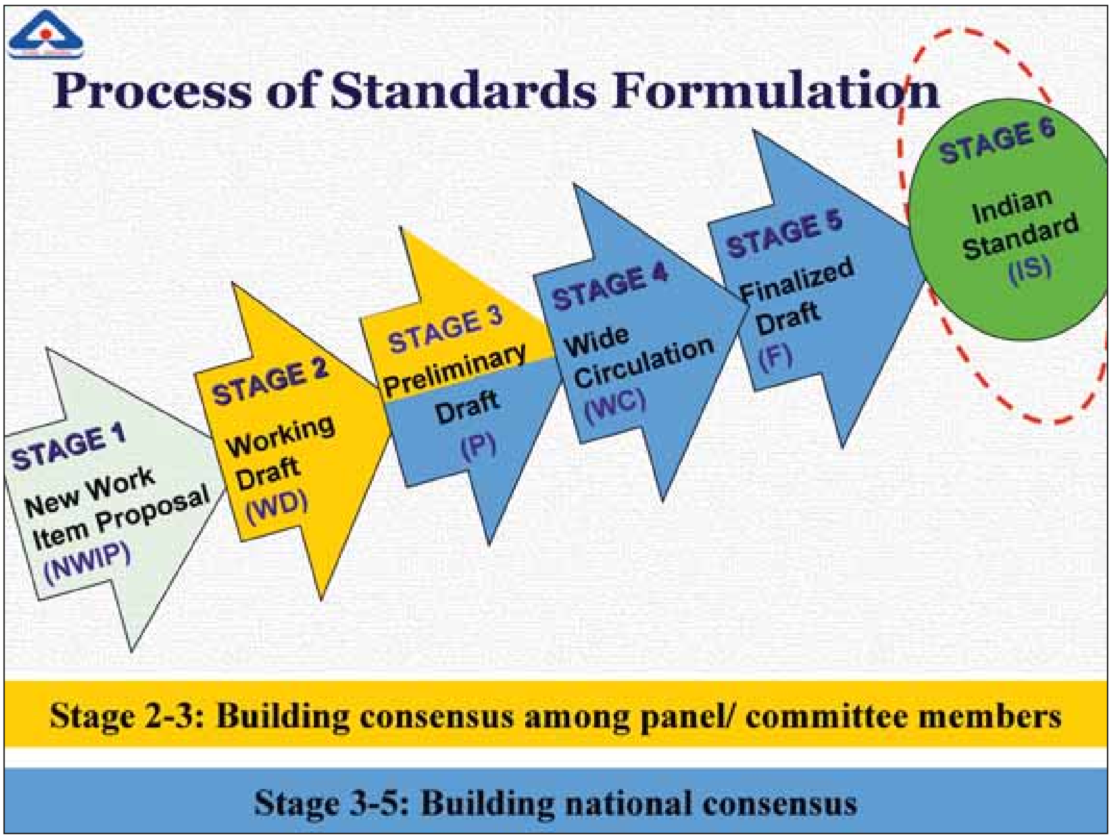
- **Keeping in view, the interest of consumers as well as the industry, BIS is involved in various activities like**
  - Standards Formulation
  - Product Certification Scheme
  - Compulsory Registration Scheme
  - Foreign Manufacturers Certification Scheme
  - Hall Marking Scheme

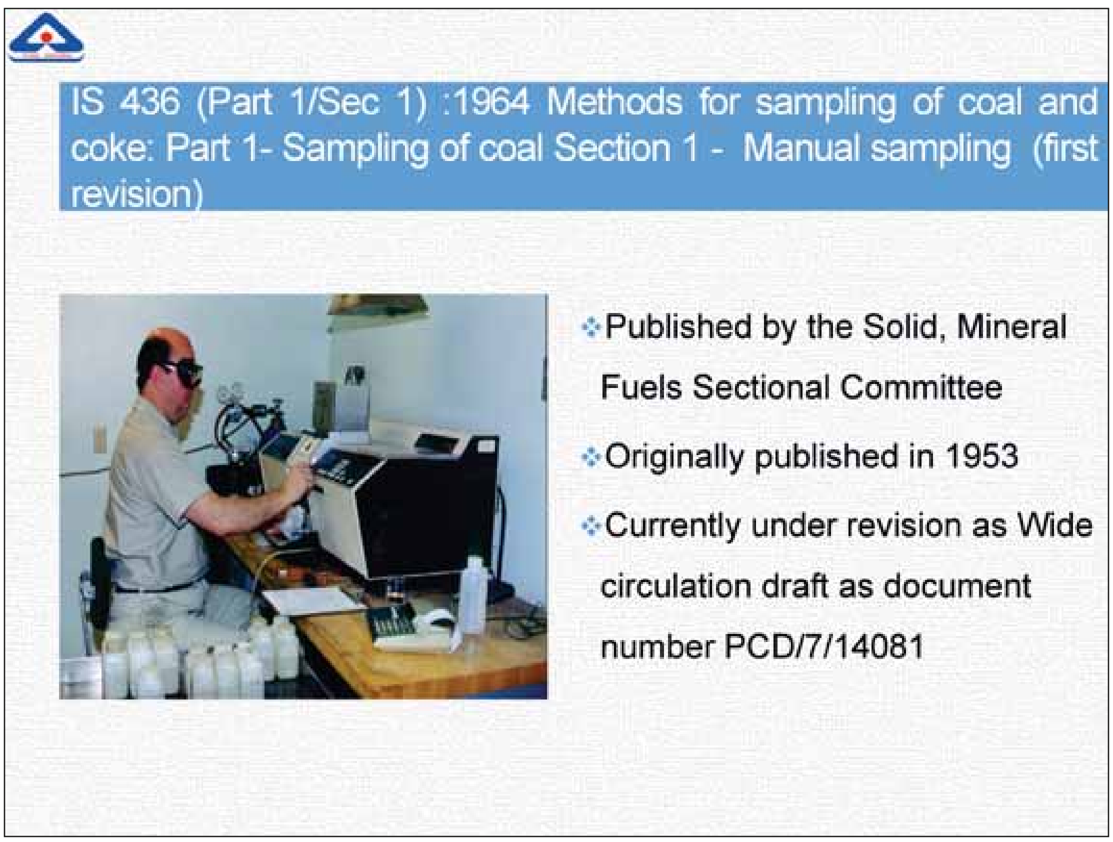

❖Laboratory Recognition Scheme
Laboratory Services
❖Sale of Indian Standards
❖Consumer Affairs Activities
❖Promotional Activities
❖Training Services, National & International level
❖Information Services

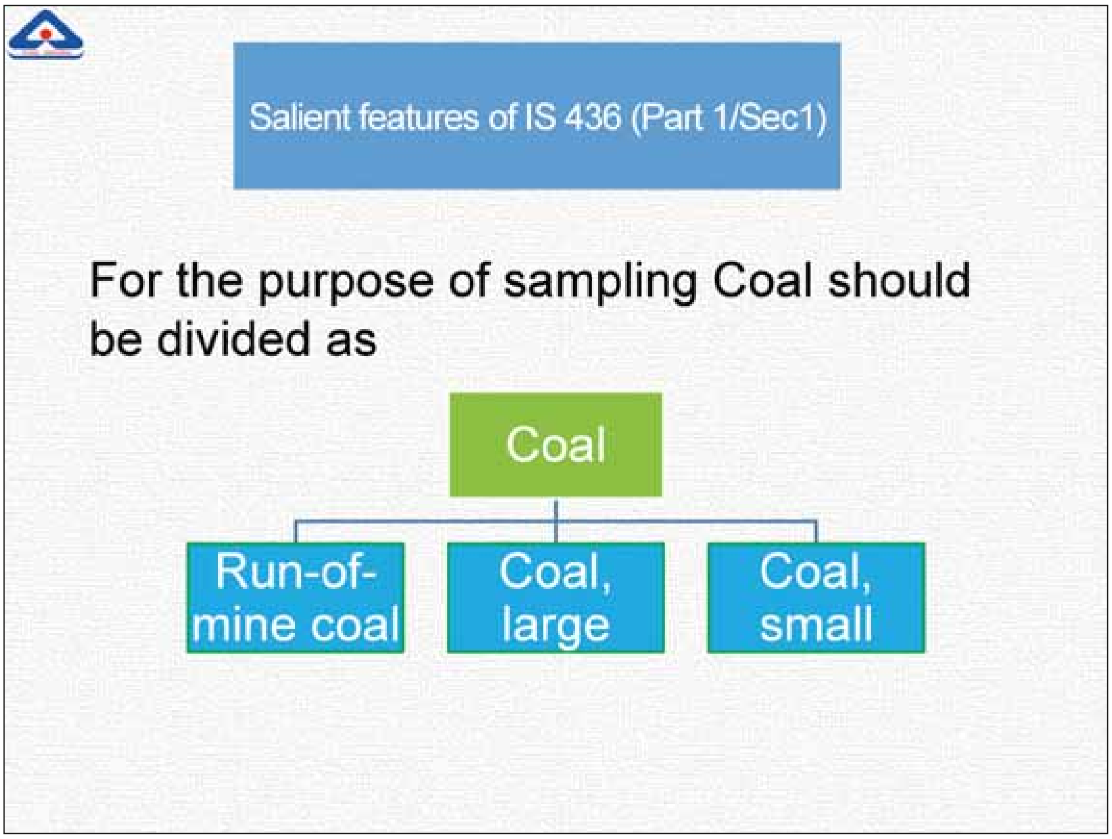

Standardization Overview
Bureau establishes Indian Standards in relation to any article or process and amends, revises or cancels the standards so established as may be necessary, by a process of consultation involving
Scientists
Consumers
Manufacturers
Government and regulatory bodies
Technologists
testing laboratories
Standard Formulation
through duly constituted committees.

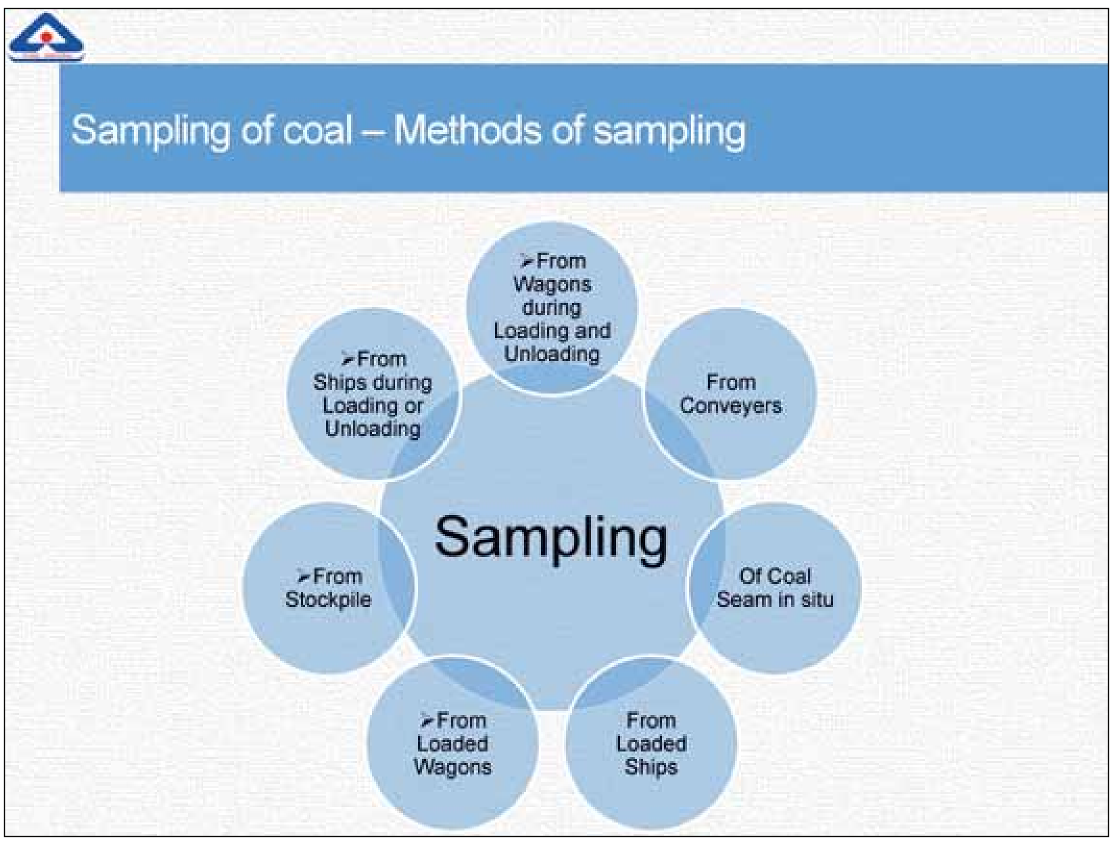

Standard Formulation
Formulation of Indian Standards is done through 16 Division Councils representing diverse areas of economy and technology, as follows:
• Petroleum, Coal and Related Products
• Civil Engineering
• Electro technical
• Electronics and Information Technology
• Food and Agriculture

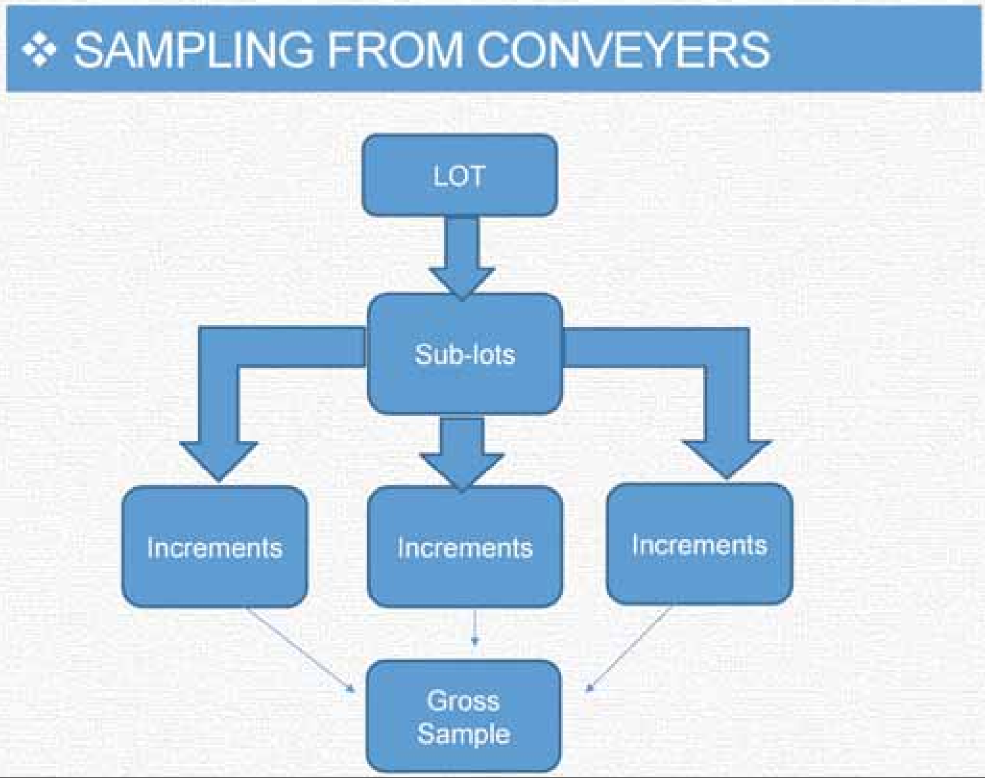

• Management and Systems
• Chemical Engineering
• Mechanical Engineering
• Medical Equipment and Hospital Planning
• Metallurgical Engineering
• Production and General Engineering
• Textile
• Transport Engineering
• Water Resources
• Services Sector-I
• Services Sector-II


Process of Standards Formulation
STAGE 1
New Work Item Proposal
(NWIP)
STAGE 2
Working Draft
(WD)
STAGE 3
Preliminary Draft
(P)
STAGE 4
Wide Circulation
(WC)
STAGE 5
Finalized Draft
(F)
STAGE 6
Indian Standard
(IS)
Stage 2-3: Building consensus among panel/ committee members
Stage 3-5: Building national consensus


IS 436 (Part 1/Sec 1) :1964 Methods for sampling of coal and coke: Part 1- Sampling of coal Section 1 - Manual sampling (first revision)
Published by the Solid, Mineral Fuels Sectional Committee
Originally published in 1953
Currently under revision as Wide circulation draft as document number PCD/7/14081


Salient features of IS 436 (Part 1/Sec1)
For the purpose of sampling Coal should be divided as
Coal
Run-of-mine coal
Coal, large
Coal, small


Sampling of coal – Methods of sampling
Sampling
➢From Wagons during Loading and Unloading
From Conveyers
Of Coal Seam in situ
From Loaded Ships
➢From Loaded Wagons
➢From Stockpile
➢From Ships during Loading or Unloading



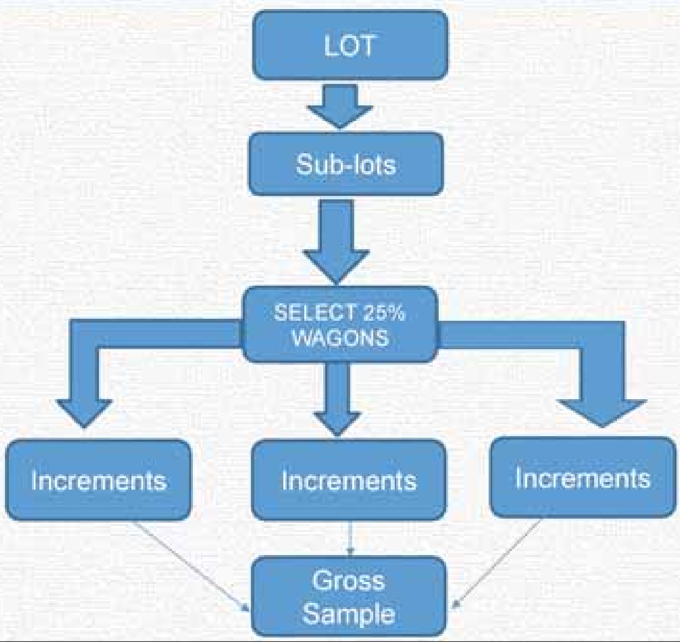
NUMBER OF SUB-LOTS/GROSS SAMPLE

Weight of the lot(Metric tonnes)	No. of Sub-lots/Gross Samples
Up to 500	2
501 to 1000	3
1001 to 2000	4
2001 to 3000	5
Over 3000	6

WEIGHT OF GROSS SAMPLE AND NUMBER
OF INCREMENTS FOR CONVEYERS

SI NO.	Sample	Run of Mine Coal	Coal, Large	Coal, Small
(1)	(2)	(3)	(4)	(5)
i)	Weight of Gross Sample, Min	350kg	175kg	75kg
ii)	Weight of Increment (Approx.)	5kg	5kg	5kg
ii)	Number of Increment	70	35	15

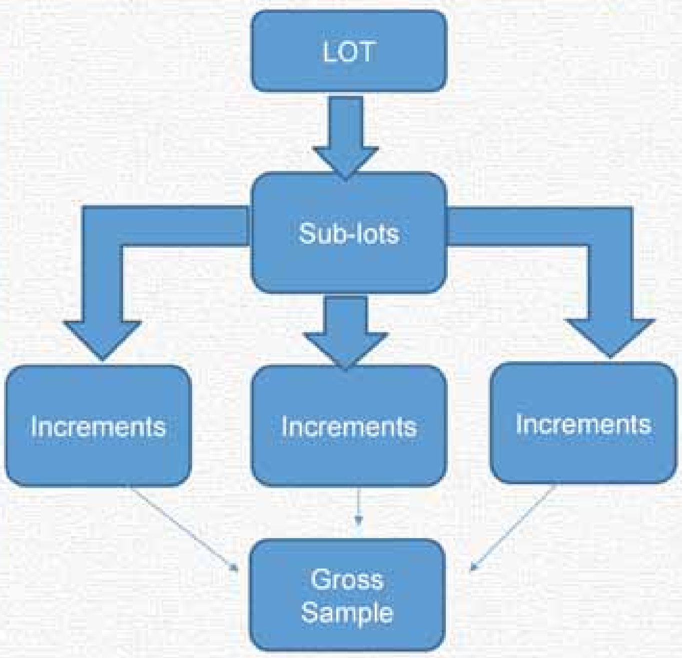
❖ Sampling from Wagons during Loading or Unloading



WEIGHT OF GROSS SAMPLE AND NUMBER OF INCREMENTS FOR WAGONS

SI NO.	Sample	Run of Mine Coal	Coal, Large	Coal, Small
(1)	(2)	(3)	(4)	(5)
i)	Weight of Gross Sample, Min	350kg	175kg	75kg
ii)	Weight of Increment (Approx.)	7kg	7kg	5kg
iii)	Number of Increment	50	25	15

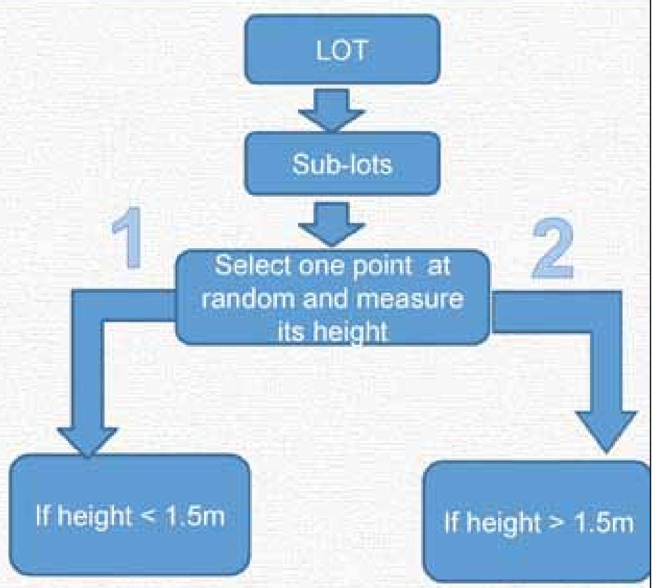
❖ SAMPLING FROM SHIPS DURING LOADING OR UNLOADING



WEIGHT OF GROSS SAMPLE AND NUMBER OF INCREMENTS FOR WAGONS

SI NO.	Sample	Run of Mine Coal	Coal, Large	Coal, Small
(1)	(2)	(3)	(4)	(5)
i)	Weight of Gross Sample, Min	350kg	175kg	75kg
ii)	Weight of Increment (Approx.)	7kg	7kg	5kg
iii)	Number of Increment	50	25	15

❖ SAMPLING FROM STOCK PILE



Case 1

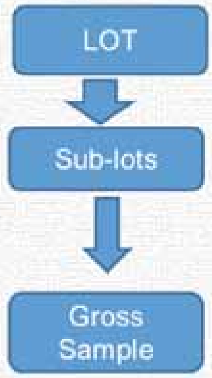
- Sample collected at every selected point from whole section of coal over a circular area of 30 cm -diameter.
- First collection from surface upto 50 cm below
- Hole formed to be covered by a plate
- Coal lying on the sides shall be removed up to that plate
- Process is repeated till bottom is reached.

Case 2

- Sample collected at every selected point from whole section of coal over a circular area of 30 cm -diameter.
- Up to a depth of 1.5 m
- Procedure same as Case 1.

❖ SAMPLING FROM LOADED WAGONS

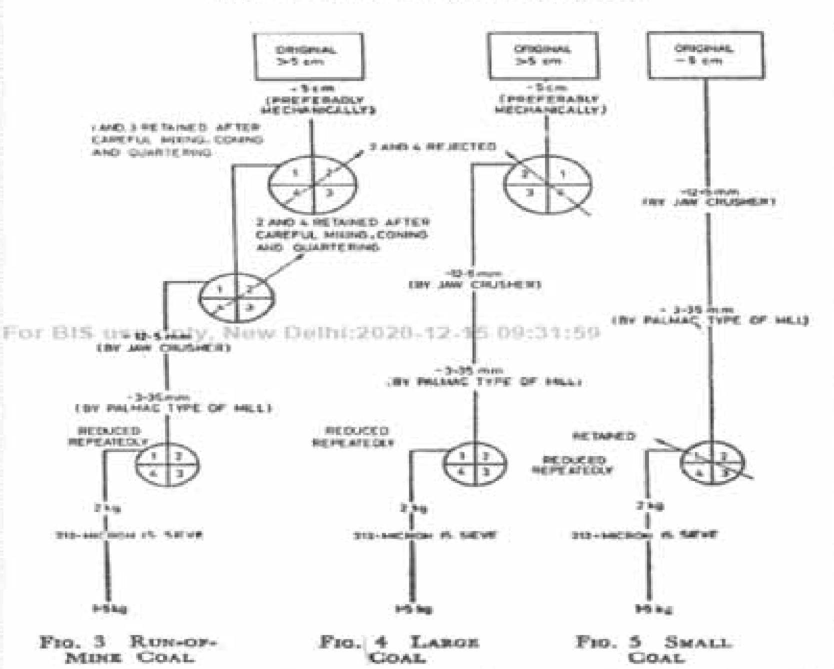
❖ SAMPLING FROM LOADED SHIPS



❖ SAMPLING OF COAL SEAM *(in situ)*

- Sampling of coal in situ gives a measure of the quality of coal to be mined.
- Sampled section of seam shall be exposed from the roof to the floor.
- Exposed surface shall be as smooth as possible.
- Seam sample shall be taken in a channel representing the entire cross-section of the seam (30 x 10 cm dimensions)
- Two parallel lines, 30 cm apart and at right angles to the bedding planes of the seam shall be marked on the freshly exposed surface of the seam.
- Channel marked shall be cut to a depth of 10 cm.
- Height of the channel shall be measured and noted.

REDUCTION OF GROSS SAMPLE



IS 436 (Part 1/Sec 1) :1964
Sampling of Coal - Manual Sampling

How important the role of independent coal testing agencies? free from the influence, guidance or control of interested parties

Presented By -
Ratnesh Rai
Managing Director
QA Testing Laboratories Private Limited

QA Testing Laboratories Private Limited 1

Index

QA Testing Laboratories Private Limited 2

Coal Analysis (A crucial data for Industries)

- Once the coal has been mined, it is usually processed to separate the inorganic, ash-forming components and to produce appropriately sized particles.
- The degree of preparation depends on the intended use of the coal, which is decided by coal analysis.
- Coal analysis/testing are the most important data for coal producers and users.
- The accuracy of coal testing results helps in maximizing recovery, utilization aspect and optimization of coal preparation plants.
- The coals to be used for metallurgical purposes has the most stringent requirements like low ash and sulphur content, and bituminous rank coal.
- However, the thermal plants can utilize high ash coals, but the composition of ash plays a significant role in deciding the boiler and operating parameters.

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Testing of Coal and Its Importance

- Identification of the chemical composition of coal has a strong influence on its combustibility.
- Testing results in a variety of improvements to plant operations, which directly affect the profitability of a coal plant, its ability to meet environmental requirements and to avoid future economic risks.
- One of the major issues that are faced while designing a boiler is the behavior of ash during the combustion process and management of coal ash. This can be curbed by testing a batch of coal and determining its properties.
- The coal analysis results provided by us, helps coal producers and processing industries in deciding the cleaning equipment, parameters, and probable amount of by-products.

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QA
Quality Assurance

Impact Of Coal Analysis

QA Testing Laboratories Private Limited 5

QA
Quality Assurance

Methods of Coal Analysis

There are different methods in following standard for the analysis of coal :

- ISO (International Standards Organization) Standard
- ASTM (American Society for Testing and Materials) International Standard
- Chinese Coal Standard
- Australian Standard
- South African National Standard
- Indian Standard

Standard Number	Title
IS 1350:Part 1	Method of test for Coal and Coke: Part 1 Proximate Analysis
IS 1350:Part 2	Method of test for Coal and Coke: Part 2 Determination of Calorific Value
IS 1350:Part 3	Method of test for Coal and Coke: Part 3 Determination of Sulphur
IS 1350:Part 4	Method of test for Coal and Coke: Part 4 Ultimate Analysis
IS 4433	Method for Determination of hard grove Grind ability index of coal
IS 9127	Method for the petrographic analysis of coal

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Classification of Coal Analysis

Broadly there are three types of coal analysis conducted for commercial purposes:

Proximate Analysis	Ultimate Analysis	Calorific Value
• Moisture Content • Ash Content • Volatile Matter • Fixed Carbon	• Carbon • Hydrogen • Nitrogen • Sulphur • Oxygen	• Gross Calorific Value • Heating Value • Net Calorific Value

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8

High Ash Content In Indian Coal and Its Impact

Ash content of coal produced in India is generally 25 to 45 % whereas average ash content of imported coal varies from 10 to 20 %.

Impact of High Ash

- Ash is an impurity which will not burn.
- Ash content is important in design of furnace grate, combustion volume, pollution control equipment (ESP) and ash handling plant.
- Ash increases transportation, handling, storage cost.
- Ash affects combustion efficiency and boiler efficiency.
- Ash causes clinkering and slagging problems in boiler.

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Role Of Independent Testing Agencies

The independent, off-site testing laboratory focuses on its testing procedures to ensure accurate results. Companies often use the terms "third-party testing" or "tested by an independent laboratory" in advertising claims that guarantee that their test results are objective and free from the **influence, guidance or control of interested parties**.

The independent laboratory focus on only one purpose to provide objective, analytical data on the quality of a product. Testing laboratories invests considerable time, money and effort to ensure this objectivity. In keeping with this agenda, testing labs usually keep considerable documentation on the internal processes that they follow to ensure objectivity and accuracy.

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Quality is not what happens when what you do matches your intentions. It is what happens when you do matches your customers expectations.

Therefore, Quality plays a very crucial role in Coal Production-Supply Chain.

Role of independent coal testing agency becomes very pronounced and very impacting particularly in India, because nearly 80% coal is supplied as crushed ROM(Run of Mine).

Independent coal testing agencies plays a vital role in coal and coke industries for selecting appropriate market and industry for the given coal. With the increasing stringent environmental policies, the accuracy of coal analysis results helps in optimizing disposal and storages of reject coal, coal slurries, fly ash and slag.

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Blockchain Application in Mining Industry

Blockchain Technology is one type of distributed ledger technology; it is a time-stamped series of immutable record of data, managed by a cluster of computers not owned by a single entity." Blockchain digitally sends information from a starting point to an end point in an automated, safe manner with negligible transaction costs.

Functional Application of Blockchain in Mining Industry

1 Supply chain traceability of minerals

- ✓ Blockchain will track the mineral / ore at each stage of this supply chain, from when it is mined to when it is beneficiated to when it is put in smelters and when & where the finish product is put to final use
- ✓ Blockchain can also be used to develop comprehensive end-to-end tracking of ores and minerals
- ✓ The process would require sealed bags or containers of concentrates and ore to be stamped with a unique identifying ID that will subsequently be logged on the blockchain
- ✓ The ID will contain information on the quality and quantity of each parcel of ore or concentrate, as well as being continually updated with an ongoing timeline tracking and logging movements
- ✓ This will bring in compliance, transparency and accountability in the entire process

2 Sustainability in mining operation

- ✓ Spare part traceability for limiting the equipment downtime. Regularity of servicing, registration of faults, scheduled overhaul
- ✓ With blockchain immutable database that shows full, time-stamped life of a piece of equipment, signed off by network participants makes the auditing process and liability straight forward and irrefutable
- ✓ Contract management like maintenance contract, equipment contract, labour contract. Blockchain technology automates the contractual executions to keep the process on track and objections to minimum, and improves the trust between the stakeholders
- ✓ Blockchain can be a secure platform for M&A due-diligence procedure and regulatory auditing compliances. It could also be used to track high-value samples from exploration activity, or monitor samples to potentially ensure market-sensitive results are not manipulative

Abhinav Sengupta | MBA in Energy & Infrastructure & B.Tech in Mining & Executive Diploma in Business Valuation

Ethanol Blended Petrol Programme for building Ethanol Economy

Ethanol Blended Petrol Programme (EBP) ?

It seeks to achieve blending of ethanol with motor sprit (gasoline/petrol) with a view to

- ✓ Reducing pollution
- ✓ Conserve foreign exchange
- ✓ Increase value addition in the sugar industry
- ✓ Enabling clear cane price arrears of farmers

What is Ethanol & why it has been chosen?

- *Ethanol is produced from sugarcane, maize, wheat, etc. which are high in starch content*
- *It can be mixed with gasoline to form different blends*
- *As the ethanol molecule contains oxygen, it allows the engine to more completely combust the fuel, resulting in fewer emissions and thereby reducing the occurrence of environmental pollution*
- *Since ethanol is produced from plants that harness the power of the sun, ethanol is also considered as renewable fuel*

Misery of Sugarcane Producers

In years of surplus production of sugarcane, when prices are depressed, the sugar industry is unable to make timely payment of cane price to farmers

- ✓ India's current Ethanol blending as on FY 2019-20 is only ~5%
- ✓ India's Ethanol procurement has jumped to 195 Cr. Litre in FY 2019-20 from 38 Cr. Litre in 2013-14
- ✓ ~ 465 Cr. Litre of ethanol will be required for 10% blending target
- ✓ CCEA approved higher prices of ethanol produced from various sources that will help clear pending of payments of Rs. ~ 13000 Cr. to cane farmers
- ✓ Rs. ~50000 Cr. Ethanol economy opportunity if scaled up

National Policy on Biofuels – 2018

Govt. target of ethanol blending with petrol by 2022 is 10% and 20% by 2030

Govt has widened the feedstock options for Ethanol Blended Petrol (EBP) through

- ✓ 100% sugarcane juice/sugar syrup/sugar
- ✓ B-heavy molasses (which is sweeter)
- ✓ C-heavy molasses (which is mild sweet)
- ✓ Damaged food grain like wheat, broken rice
- ✓ Surplus rice from Food Corporation of India
- ✓ Surplus maize (latest addition by Govt)

Policy for feedstock improvement

The national policy on biofuels 2018 envisages that during an agriculture crop year if there is projected over-supply, then surplus quantity of food grains can be converted into ethanol

Price regulation & capacity augmentation

Govt. plans to enhance the ethanol production capacity to 9 billion liters from 3.55 billion liters in next 2 years. This will help meeting 20% blending target with petrol and thus save ~ 1 $ billion in oil import bill. Government has fixed remunerative ex-mill price of ethanol derived from molasses and sugar/sugarcane

Abhinav Sengupta | MBA in Energy & Infrastructure & B.Tech in Mining & Executive Diploma in Business Valuation

Financing Trend for India's Energy Sector

Financial closure is one of the key milestone for any energy sector projects due highly leveraged nature of these projects. Therefore, project financing is one of major KPI in order to determine the sector growth as it is not only reflects the risk appetite of the investor but also gives projection towards investor confidence. In overall the market sentiment towards a sector can be gauged by observing the financing trend.

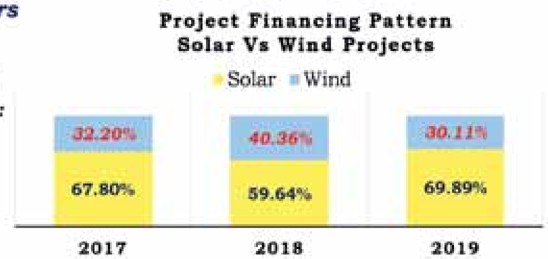
CAGR 3 Years

Coal : -86.55%

Renewables : 0.13%

Solar : 1.65%

Wind : -3.17%



Data Source: CFA Coal Vs Renewables Report Nov 2019

Key Highlights of the Report – Financing Pattern for Energy Projects

- ✓ Year 2019; Renewables energy projects have received 95% of loans as compared to 5% for coal fired energy projects and share of solar remains highest
- ✓ From last two consecutive years coal project financing has been decreasing; in 2018 by ~90% and in 2019 by ~86% and result in negative CAGR
- ✓ 81% of loans to renewable energy projects were to finance new generation facilities while for coal fired projects 67% loans were used for new projects
- ✓ 79% of renewable lending were for the states Karnataka, Rajasthan, Andhra Pradesh, Madhya Pradesh and Gujarat
- ✓ In Year 2019 only commercial banks are providing loans to the coal fired energy projects & contribution from state owned financial banks remains nil
- ✓ Refinancing continued to be accounting for coal fired energy projects in Year 2019
- ✓ State-owned financial institutions have been increasing loans for renewable energy projects (~24 of loans for renewable energy funding)

Abhinav Sengupta | MBA in Energy & Infrastructure & B.Tech in Mining & Executive Diploma in Business Valuation

How Shipping Logistics Impacting the Minerals & Metals Supply Chain

- *Only 8% of India's total freight volume is handled through water mode as compared to China (55%)*
- *Indian coastline is ~7517 kms stretched and has 12 Major Ports and 200 Non-Major Ports*
- *95% of India's trade by volume & 68% of India's trade by value is moved through maritime transport*
- *Cumulative cargo handling capacity in India's major & non-major ports is ~ 2500 MTPA*
- *Commodities are Coal, POL, Iron Ore, Fertilizers comprises ~60% of total freight volume handled by Indian ports*
- *FY 2019-20 capacity utilization of Indian port was 46% (i.e. throughput capacity was 704 MT only*
- *Water transportation is the cheapest mode of transport compared to road & rail*

Key Issues related to Coastal / Waterways

1. *Port handling mechanization*

- ✓ Mechanization of handling system at old ports for import of raw material like coking coal i.e. from vessel unloading to wagon loading with rapid loading system (RLS)
- ✓ For export of steel specialized heavy duty steel handling equipment, vehicles to be made available at ports to reduce material damage / handling cost

2. *Handling of 3rd party cargo in captive jetties movement on conditional basis*

- ✓ In Maharashtra 3rd party cargo handled by jetty should not exceed 25% of the total annual capacity of captive jetty
- ✓ There is no such restriction in states like Gujarat & Tamilnadu

3. *Coastal / Inland waterways Utilization*

- ✓ Remote inland specific location of imported raw material consumption centre like steel plants causes coastal/inland waterways movement uneconomical due to multiple handling

4. *Development of deep-water ports at strategic locations*

- ✓ Developing ports at strategic locations (i.e. along eastern coast where most mining activity, material handling movement happens will boost water transportation

Indian Major Ports

Source : *Annual Report 2019-20 (Ministry of Ports, Shipping & Waterways)*

Major Port Authorities Bill 2020 has been passed on September 2020 by GoI

Bill aims at decentralizing the decision making and will infuse professionalism in governance of Indian major ports. It will reorient the governance model (which is globally followed) in central ports to landlord model, on the other hand port infrastructure will be leased to private operators

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Notified Coal Price Analysis

Power Prices

ROM Prices	Notified Price 30-05-2016 Power	Notified Price 08-01-2018 Power	Notified Price 27-11-2020 Power	RP Prices 31-03-2020 NCI	Notified Price 30-05-2016 Power	Notified Price 08-01-2018 Power	Notified Price 27-11-2020 Power	RP Prices 31-03-2020 NCI
G1	5,020	3,388	3,398	8,568		↓ -32.51%	↑ 0.30%	↑ 152.15%
G2	4,870	3,288	3,298	4,549		↓ -32.48%	↑ 0.30%	↑ 37.93%
G3	3,890	3,144	3,154	4,350		↓ -19.18%	↑ 0.32%	↑ 37.92%
G4	3,490	3,000	3,010	4,401		↓ -14.04%	↑ 0.33%	↑ 46.21%
G5	2,800	2,737	2,747	4,042		↓ -2.25%	↑ 0.37%	↑ 47.14%
G6	1,600	2,317	2,327	3,651		↑ 44.81%	↑ 0.43%	↑ 56.90%
G7	1,400	1,926	1,936	2,619		↑ 37.57%	↑ 0.52%	↑ 35.28%
G8	1,250	1,465	1,475	2,485		↑ 17.20%	↑ 0.68%	↑ 68.47%
G9	970	1,140	1,150	2,154		↑ 17.53%	↑ 0.88%	↑ 87.30%
G10	860	1,024	1,034	1,975		↑ 19.07%	↑ 0.98%	↑ 91.01%
G11	700	955	965	1,474		↑ 36.43%	↑ 1.05%	↑ 52.75%
G12	660	886	896	1,369		↑ 34.24%	↑ 1.13%	↑ 52.79%
G13	610	817	827	1,270		↑ 33.93%	↑ 1.22%	↑ 53.57%
G14	550	748	758	1,098		↑ 36.00%	↑ 1.34%	↑ 44.85%
G15	510	590	600	830		↑ 15.69%	↑ 1.69%	↑ 38.33%
G16	450	504	514	723		↑ 12.00%	↑ 1.98%	↑ 40.56%
G17	400	447	457	535		↑ 11.75%	↑ 2.24%	↑ 17.07%

- ✓ CIL accounts for 82% of domestic coal production. The notified prices for CIL (thermal coal) has been revised once in two years
- ✓ In year Jan 2018 the CIL has revised prices where for higher coal grade i.e. G1 to G5 prices were reduced significantly whereas for grade G6 to G17; the prices were increase significantly
- ✓ CIL notified prices released on Nov 2020 where the prices for all grades is increased by Rs. 10 per tonne only from Jan 2018
- ✓ The CIL notified price trend reflects the actual domestic market scenario of Indian Coal (as only 10% of CIL mined coal is sold through spot auctions rest 90% is through CIL linkage)
- ✓ On the contrary RP (NCI) prices for March 2020 are very high as compared to CIL notified prices

Abhinav Sengupta | MBA in Energy & Infrastructure & B.Tech in Mining & Executive Diploma in Business Valuation

Notified Coal Price Analysis

Non Power Prices

ROM Prices	Notified Price 30-05-2016 Non Power	Notified Price 08-01-2018 Non Power	Notified Price 27-11-2020 Non Power	RP Prices 31-03-2020 NCI	Notified Price 30-05-2016 Non Power	Notified Price 08-01-2018 Non Power	Notified Price 27-11-2020 Non Power	RP Prices 31-03-2020 NCI
G1	5,020	3,388	3,398	8,568		↓ -32.51%	↑ 0.30%	↑ 152.15%
G2	4,870	3,288	3,298	4,549		↓ -32.48%	↑ 0.30%	↑ 37.93%
G3	3,890	3,144	3,154	4,350		↓ -19.18%	↑ 0.32%	↑ 37.92%
G4	3,490	3,000	3,010	4,401		↓ -14.04%	↑ 0.33%	↑ 46.21%
G5	2,800	2,737	2,747	4,042		↓ -2.25%	↑ 0.37%	↑ 47.14%
G6	2,150	2,524	2,534	3,651		↑ 17.40%	↑ 0.40%	↑ 44.08%
G7	1,890	2,311	2,321	2,619		↑ 22.28%	↑ 0.43%	↑ 12.84%
G8	1,690	1,757	1,767	2,485		↑ 3.96%	↑ 0.57%	↑ 40.63%
G9	1,310	1,368	1,378	2,154		↑ 4.43%	↑ 0.73%	↑ 56.31%
G10	1,160	1,228	1,238	1,975		↑ 5.86%	↑ 0.81%	↑ 59.53%
G11	950	1,145	1,155	1,474		↑ 20.53%	↑ 0.87%	↑ 27.62%
G12	890	1,063	1,073	1,369		↑ 19.44%	↑ 0.94%	↑ 27.59%
G13	820	980	990	1,270		↑ 19.51%	↑ 1.02%	↑ 28.28%
G14	740	897	907	1,098		↑ 21.22%	↑ 1.11%	↑ 21.06%
G15	680	708	718	830		↑ 4.12%	↑ 1.41%	↑ 15.60%
G16	610	604	614	723		↓ -0.98%	↑ 1.66%	↑ 17.75%
G17	540	536	546	535		↓ -0.74%	↑ 1.87%	↓ -2.01%

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What is the benefit of new coal-fired power stations in the 'age of renewables'?

Hugh M. Lee

hugh.lee@btinternet.com

Coaltrans Virtual World Coal Leaders Network

Monday 26th October 2020

Hugh Lee

Coal v. Renewables (1)

- There are many reports saying that wind and solar are lower cost than coal
- Wind and solar have been bid at lower prices in tenders and reverse auctions
- However, these look at the lifetime costs of a particular plant, rather than at the total cost for the whole electricity system/grid
- And there are various other considerations

Hugh Lee

Coal v. Renewables (2)

What is the benefit of new coal-fired power Stations in the 'age of renewables'?

or

Why are so many new coal-fired power stations being built and ordered when renewable appear to be cheaper?

Hugh Lee

Acknowledgment

I am very grateful for the help of several organizations especially the **IEA Clean Coal Centre www.iea-coal.org**

Hugh Lee

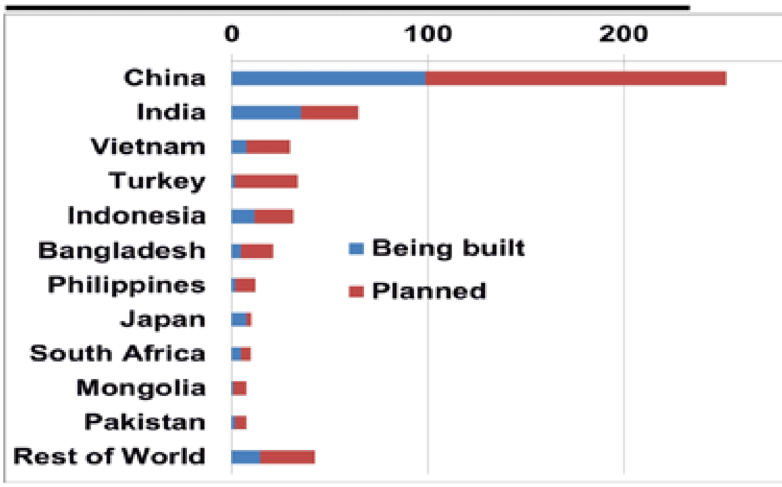
Coal plants being built & planned

In July 2020, around the world:

- **190 GW** of coal-fired power stations were under construction
- A further 332 GW were planned (Announced & Pre-permit & Permitted)

Hugh Lee

Coal plants being built & planned (GW)



Possible reasons (1)

1. Lower capital cost
2. Local employment
3. Expertise/experience of the decision makers
4. The coal lobby
5. Construction & finance packages offered

Possible reasons (2)

6. Project economies of scale
7. Transmission constraints
8. The structure of the electricity market
9. Coal needed when there is no sun or wind
10. Replacing old inefficient coal plant with HELE coal plant, CCS ready

Hugh Lee

1 Lower capital cost

- In some situations, the capital cost of a coal-fired power station (per MW) is lower than for renewables
- So there are lower up-front costs, i.e. less initial finance is needed
- Also coal can often borrow at 5% but renewables pay 6.5-12%

Hugh Lee

Capital costs

There are widely varying estimates

Some figures from the IEA (2017$/kW):

	China	India	Japan
Coal	700	1200	2400
Solar	1120	1120	1900
Wind	1200	1080	3260

Hugh Lee

2 Local Employment

- Differing views on whether coal or renewables employ more people
- Renewables may be in a different location from the planned coal plant
- When the coal mining is local, for coal will certainly be higher than renewables
- Skills required for renewables may be different and unfamiliar

Hugh Lee

3 Decision makers' experience/expertise

- Decision makers often have more experience and expertise in coal than in renewables
- Decision makers go for the fuel with which they are familiar and comfortable
- USA & EU have had >2 decades of renewables subsidies boosting them; SE Asia etc have not had this experience
- Technical education may not have yet caught up with providing sufficient know-how in renewables

Hugh Lee

4 The coal lobby

- In the past, the coal lobby was very strong in countries that mined coal; this still persists in a number of places
- People employed in coal mines & plants and their families can be significant part of the electorate
- Political leaders used to wish to be seen to be looking after coal people
- But there is now a negative view of coal in many places, as it seen to be the major cause of climate change and a health hazard

Hugh Lee

5 Construction & finance packages

- With the reducing number of coal plants being built in China, Korea & Japan, their companies and banks have got together to offer attractive packages to finance and build coal pants in other countries.
- Export Credit Agencies (ECAs) have played an increasing role With an ECA the risk can be with the home country

Hugh Lee

Packages offered by China

- China's BRI is dominated by power plant & grid investment
- BRI is theoretically fuel neutral
- Chinese government & state banks are helping coal plant builders move abroad
- 2.8 GW of the 18.5 GW of coal plant construction starts outside China in 2019 are being supported by the Export-Import Bank of China

Hugh Lee

6 Project economies of scale

- Solar & wind farms are usually much smaller in MW than a coal plant
- Several solar & wind farms may be needed instead of one coal plant
- Several renewables projects therefore need to be financed and managed
- This requires more time and people including bankers, lawyers, project mangers etc

Hugh Lee

7 Transmission constraints

- Large scale solar or wind generation projects have to be sited where there is enough land or offshore
- In many countries there is insufficient grid capacity in this locations
- Whereas a coal plant can usually be sited near good grid connections
- IEA WEO: "Electricity grids could prove to be the weak link in the transformation of the power sector"

Hugh Lee

8 Structure of the electricity market

Nowhere has implemented an electricity market that adequately takes account of its varied characteristics that include

- Limited and relatively expensive storage
- Renewable generation is almost zero marginal cost but intermittent
- The need for adequate capacity to prevent 'the lights going out'

Hugh Lee

Electricity markets

- Some electricity markets are favourable to plants that can provide 'base load' generation like coal
- Some electricity markets give long-term contacts to proposed new coal plants
- When all the generation and all the grid is owned by one monopoly, that is well–run and well-regulated, the whole system can be optimised

Hugh Lee

9 Coal needed when no renewables

- When VRE is >80% of total system capacity and power demand is rising, the cost to the system of further VRE may be more than the cost to the system of a new coal plant, because there can be several days with very little sun or wind but coal is relatively slow to ramp up
- The IEA Clean Coal Centre suggests this is the major reason for new coal plants

(VRE = variable renewable energy)

Hugh Lee

Coal provides key grid services

- Coal plant also provide key grid services including inertia, frequency control & reactive power these are not easily provided by VRE plant

Hugh Lee

10 Replacing old inefficient coal

- Some new coal plants are built to replace old coal plants that are inefficient, polluting & costly
- If at the same site, it can use existing transmission, labour etc.
- New plant can be HELE (=high efficiency, low emissions)
- And can be CCS (= carbon capture & storage) ready

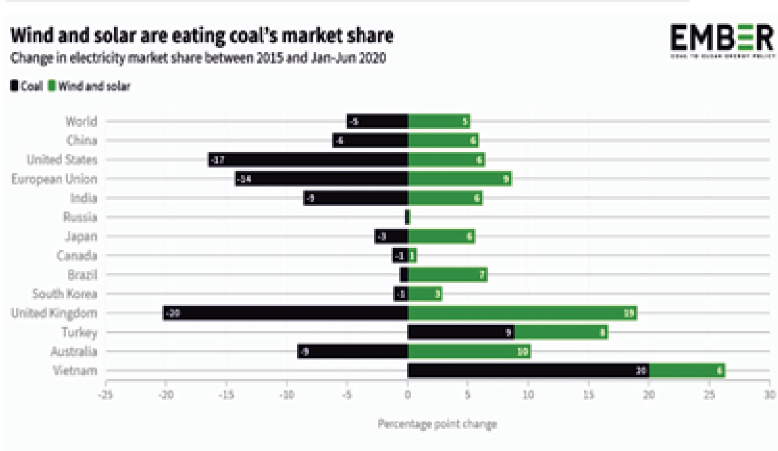
Hugh Lee

The benefit of new coal plants?

- I have shown above that there at least 10 possible benefits, some of which may be valid in some situations
- This explains why many coal plants are still being built and ordered
- But the tide has changed to renewables because of economics & climate change policies
- Now economic to replace many <u>existing</u> coal plants with renewables

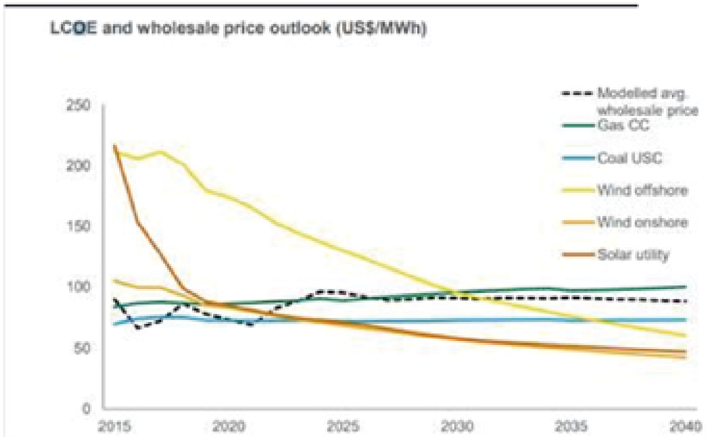
Hugh Lee

Switch from coal to renewables



Levelised Cost of Electricity

S. Korea **(Source: Wood Mackenzie)**



Do new plants help coal?

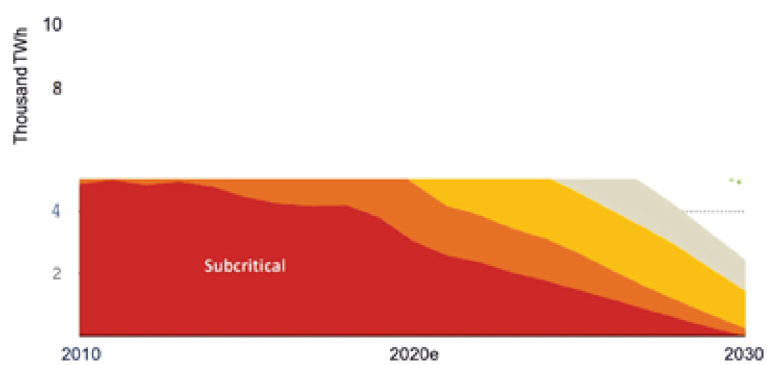
- New plants may mean extra demand for coal in that location for the next few years
- But climate change & cheap renewables mean the world demand for coal will continue to fall

China's President Xi Jinping at UN 22Sep20: "China will reach carbon neutrality before 2060 and ensure its greenhouse gas emissions peak in the next decade"

Hugh Lee

IEA WEO Oct20 Net zero 2050 scenario

Figure 4.7 > Cool-fired eleckicity generation by echnology in the NIE2050



The‹e .'S 0 mayor reduc l on in cool-fired ¿lenercfion and related CO› end ss.'ons n the NZE2P5P with the vse of the least eft c.'enf coo/ po'•zei ,c/ants fa//.'n;; fo Ze/o 4y 1030

Met coal demand may also fall

- Steel making with blast furnaces may be replaced by direct reduction with hydrogen

Or

- Carbon capture & storage (CCS) or carbon capture and utilization may installed at steel plants so that coal is still used

Hugh Lee

Conclusions / Take Aways

- There may be number of benefits in building a coal-fired power station rather than renewables
- Lasting benefit is to meet rising demand when there is no sun or wind, in the unusual situation that VRE capacity is >80%
- But coal demand will fall rapidly, so coal companies need to reposition as **net-zero carbon mining/energy companies** and/or **invest in CCS**

hugh.lee@btinternet.com

Hugh Lee

COAL INDIA LIMITED कोल इण्डिया लिमिटेड
A Maharatna Company एक महारत्न कंपनी
(A Govt. of India Enterprise)

COAL BHAWAN
Marketing & Sales & Division
Ground Floor, Premises No. 04 MAR, Plot No. AF-III, Action Area -1A
Rajarhat, New Town, Kolkata - 700156
Phone: 033-23246617, Fax: 033-23244229, Website: www.coalindia.In
CIN: L23109WB1973GOI028844

PRICE NOTIFICATION NO CIL /M&S /Pricing: 194 dated 27.11.2020

In supersession of the Price Notification no. CIL:M&S:GM(F)/Pricing 2018/07 dated 08th January 2018, the Pit head Run of Mine (ROM) prices of all grades of non-coking coal produced by Coal companies of Coal India Limited including North Eastern Coalfields limited are being revised with effect from 00:00 Hours of 1st December 2020.

The revised Pithead ROM prices have been given in Table I and II as annexures.
However all elements of other Charges and respective add-on prices as are presently applicable shall continue to remain applicable.

This issues with the approval of the competent authority.

GM (M & S) / QC
Coal India Limited
Kolkata

Enclosed: Table I and II as Annexure

1

ANNEXURE TO THE PRICE NOTIFICATION NO CIL /M&S /Pricing: 194 dated 27.11.2020

Table I

Pit head run of mine price (ROM) of non-coking coal applicable for all coal producing subsidiary companies including NEC but excluding WCL

Grade	GCV Range	Pithead Run of mine price for Non-Coking coal	
		Power Utilities (including IPPs), Fertilizer & Defence sector	Sectors other than Power Utilities (including IPPs), Fertilizer & Defence
	(Kcal/Kg)	(Rs./Te)	(Rs./Te)
G1	Exceeding 7000	*	*
G2	Exceeding 6700 and not exceeding 7000	3298	3298
G3	Exceeding 6400 and not exceeding 6700	3154	3154
G4	Exceeding 6100 and not exceeding 6400	3010	3010
G5	Exceeding 5800 and not exceeding 6100	2747	2747
G6	Exceeding 5500 and not exceeding 5800	2327	2534
G7	Exceeding 5200 and not exceeding 5500	1936	2321
G8	Exceeding 4900 and not exceeding 5200	1475	1767
G9	Exceeding 4600 and not exceeding 4900	1150	1378
G10	Exceeding 4300 and not exceeding 4600	1034	1238
G11	Exceeding 4000 and not exceeding 4300	965	1155
G12	Exceeding 3700 and not exceeding 4000	896	1073
G13	Exceeding 3400 and not exceeding 3700	827	990
G14	Exceeding 3100 and not exceeding 3400	758	907
G15	Exceeding 2800 and not exceeding 3100	600	718
G16	Exceeding 2500 and not exceeding 2800	514	614
G17	Exceeding 2200 and not exceeding 2500	457	546

*** For GCV exceeding 7000 Kcal/Kg, the price shall be increased by Rs. 100/- per tonne over and above the price applicable for GCV band exceeding 6700 but not exceeding 7000 Kcal/Kg, for increase in GCV by every 100 Kcal/Kg or part thereof.**

An additional amount of Rs. 450.00 per tonne (as per the existing practice) to be charged over and above the notified price in respect of the coal produced from Rajmahal mine of Eastern coalfields Limited.

2

ANNEXURE TO THE PRICE NOTIFICATION NO CIL /M&S /Pricing: 194 dated 27.11.2020

Table II

Pit head run of mine (ROM) price of non-coking coal applicable for WCL.

Grade	GCV Range	Pithead Run of mine price for Non-Coking coal	
		Power Utilities (including IPPs), Fertilizer & Defence sector	Sectors other than Power Utilities (including IPPs), Fertilizer & Defence
	(Kcal/Kg)	(Rs./Te)	(Rs./Te)
G1	Exceeding 7000	*	*
G2	Exceeding 6700 and not exceeding 7000	3298	3298
G3	Exceeding 6400 and not exceeding 6700	3154	3154
G4	Exceeding 6100 and not exceeding 6400	3010	3010
G5	Exceeding 5800 and not exceeding 6100	2747	2747
G6	Exceeding 5500 and not exceeding 5800	2534	2590
G7	Exceeding 5200 and not exceeding 5500	2321	2433
G8	Exceeding 4900 and not exceeding 5200	1767	2119
G9	Exceeding 4600 and not exceeding 4900	1378	1652
G10	Exceeding 4300 and not exceeding 4600	1238	1484
G11	Exceeding 4000 and not exceeding 4300	1155	1384
G12	Exceeding 3700 and not exceeding 4000	1073	1285
G13	Exceeding 3400 and not exceeding 3700	990	1186
G14	Exceeding 3100 and not exceeding 3400	907	1086
G15	Exceeding 2800 and not exceeding 3100	718	860
G16	Exceeding 2500 and not exceeding 2800	614	735
G17	Exceeding 2200 and not exceeding 2500	546	653

*** For GCV exceeding 7000 Kcal/Kg, the price shall be increased by Rs. 100/- per tonne over and above the price applicable for GCV band exceeding 6700 but not exceeding 7000 Kcal/Kg, for increase in GCV by every 100 Kcal/Kg or part thereof.**

3

WORLD COAL ASSOCIATION

Zanny Minton Beddoes, Editor-in-Chief
The Adelphi
1-11 John Adam Street
London
WC2N 6HT

7th December 2020

In response to the following coverage in *The Economist*:

- '*Killing coal: time to make coal history*' published 3rd December 2020
- '*The dirtiest fossil fuel is on the back foot*' published 3rd December 2020

Dear Ms Minton Beddoes,

As I approach 18 months as Chief Executive of the World Coal Association, it does not surprise me to see negative headlines dismissing coal, but I did pause when I saw last week's coverage in *The Economist*. It wasn't so much the sensationalist headlines but that *The Economist* would publish a piece with little attempt to reflect a balanced discussion or consider real-world facts about coal. Not only were we, the global coal organisation, not approached for comment, but seemingly neither were any coal industry stakeholders in Asia.

As my Head of Communications sent me this alert, I was delivering a speech to the Indian Government and industrialist stakeholders. This forum reinforced that coal will continue to be significant in India's energy mix and proactively discussed the preparations that will need to happen for responsible usage. Last month, similar themes were reinforced by Southeast Asian Energy Ministers in their annual meetings, which I also participated in. The discussions at this session in no way reflected the way that *The Economist* characterised the future of coal in Asia.

In fact, these sorts of headlines are often disregarded by the coal growth regions because dismissing coal is dismissing the rights of developing and emerging economies to choose their own energy mix to support economic development. Statements around European and American politicians needing to 'work harder to depress coal elsewhere' are patronising. Asian economies have the right to choose whatever energy mix and technologies work for them – aligned with the G20 and International Energy Agency's (IEA) message on the importance of '*all fuels and all technologies*'.

There is not one government minister and/or adviser in the key coal markets that I have spoken to that wants to make the same mistakes as the developed markets. Equally, they do not wish to promote an uneconomical and unsustainable vision that is not realistic. Hence why so many countries continue to use coal – with coal still forecast to be the single biggest source of electricity in 2040. Since 2010, 40 nations that have not used coal for power in the past have added coal to their energy portfolios, including countries in the Middle East and Africa.

20 St Andrew Street
Holborn Circus
London
EC4A 3AG
United Kingdom

Registered office
as above.

Registered in
England and Wales
No 1947623

T +44 (0)20 7851 0052

info@worldcoal.org
worldcoal.org

Although *The Economist* was dismissive of the role that can be played by clean coal technologies, the emissions reduction potential is significant and multiple countries have included a role for coal and clean coal technologies in their Paris Agreement pledges.

Globally, the average efficiency of coal-fuelled power plants is 37.5%. If this was raised to 47.5% – which is possible with today's technology – this would reduce global emissions by 2 Gigatonnes, the equivalent of eliminating the ASEAN region's 2017 carbon emissions from all fossil fuels; or almost equivalent to India's 2018 emissions from fuel combustion.

The IEA has also made clear that carbon capture, use and storage (CCUS) is vital to our climate efforts – with CCUS contributing nearly 15% of the cumulative reduction in emissions necessary in its net-zero scenario.

The reason these technologies are important is not only because of the continued role of coal across Asia but also because the IEA, the Intergovernmental Panel on Climate Change and the US Energy Information Administration have all concluded, there isn't a credible scenario which includes 100% renewables.

These articles distract and misinform stakeholders who are capable of deploying the very real clean coal technologies that are making a dent in all emissions.

A more informed question would have been 'should' we make coal history; not 'how'. If countries across Asia are continuing to use coal – and technologies exist to ensure this coal can be clean – then shouldn't the focus be on widening the responsible deployment of technology rather than penalising energy choices?

We need all fuels and all technologies.

Yours sincerely

Michelle Manook
Chief Executive
World Coal Association

WORLD COAL ASSOCIATION

Authors' Profile

G Durga Prasad

G Durga Prasad graduated in Chemical Engineering from RVR&JC College of engineering, Guntur, Andhra Pradesh in 2006 and has been awarded M Tech in Chemical Engineering from Indian Institute of Technology (IIT), Bombay in 2009. Currently, he is working as Manager (Coal Preparation) in Coal & Mineral preparation division at Central Mine Planning & Design Institute Limited (CMPDI), Ranchi since September 2009. After joining to CMPDI, he has undergone training for one year in different areas/sections like Coal & Mineral Preparation (CMP) division, Coal Technology, Coal petrography, Coal Bed Methane etc. and finally posted in CMP division of CMPDI. Since then, he is actively involved in R&D projects in monitoring of project construction, commissioning, trial operation & PGT, contract management etc. He is also actively involved in planning &design of washery consisting of conceptual report, preliminary feasibility study, preparation of tender document etc. During service, he has taken up other jobs like study of existing washeries of BCCL, CCL for their improvement.

Bill Sullivan

Bill Sullivan, Senior Foreign Counsel with Christian Teo & Partners, a Jakarta based, Indonesian law firm & Senior Advisor to Stephenson Harwood LLP.

Christian Teo

Christian Teo is a partner of Christian Teo & Partners, a Jakarta based, Indonesian law firm.

Claudius Novabianto

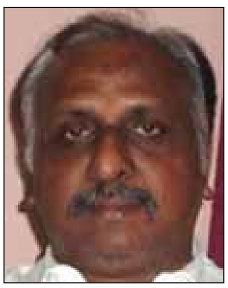
Claudius Novabianto is a partner of Christian Teo & Partners, a Jakarta based, Indonesian law firm.

Dr. G.V. Ramana

Dr. G.V. Ramana is Managing Director in Ardee Hi-Tech Pvt Ltd. He completed his doctorate from Jawaharlal Nehru University and worked with Bureau of Industrial Costs & Prices, Government of India, Indira Gandhi National Open University and Economic Times, New Delhi.

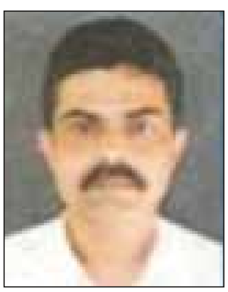
He has worked on in-line coal quality, coal dry beneficiation and other environment-friendly technologies. Under his leadership, the company executed four coal dry beneficiation projects at Talcher, Madhuban and for lignite in GHCL & GMDC in Bhavnagar, Gujarat. Ardee has developed gamma ray sorting systems as well as Dual Energy XRT technology. A research project to develop On-Line Coal Washability Analyser with with CSIR-CIMFR, Dhanbad funded by Ministry of Coal is completed.

Under his leadership, Ardee has developed a number of products and processes with the overall philosophy of promoting environment-friendly technologies. Dr. Ramana has presented a number of papers at different fora.



Dr. T. Gouri Charan

Dr. T. Gouri Charan, is presently working as a Senior Principal Scientist and Head of the Research Group, Coal Preparation and Coal Carbonization Division, CSIR-Central Institute of Mining & Fuel Research (CIMFR), Dhanbad. His main research interests are in the areas of Coal Washability, Development of flow sheets for Beneficiation of Coking and Non-coking coals, Fine Coal Beneficiation etc. He has published more than 100 papers in international journals and conferences and over sixty technical reports. He had published a book "Coal Processing & Utilization" printed by Taylor & Francis, Netherlands. Dr. Charan is a recipient of Coal Preparation Innovation Award, conferred by CPSI, R.P. Bhatnagar Award conferred by MGMI and Coal Preparation Award conferred by IIME.



U.S. Chattopadhyay

U.S. Chattopadhyay passed M.Tech in Mineral Engineering from Indian School of Mines, Dhanbad Joined Central Institute of Mining and Fuel Research, Dhanbad in the year 1997 and since then continuing to carry out R & D work primarily in the areas of Coal Preparation especially Washability and Fine Coal Separation. Presently, he is holding the rank of Principal Scientist and in charge of Coal Washability. He is a life member of Indian Institute of Mineral Engineers and Mining, Geological, Metallurgical Institute of India, Indian Institute of Metals and Associate Member of Institute of Engineers.

David Woodruff

David Woodruff has over 45 years' experience in the Minerals Industry. He graduated from the University of Leeds in the 1970's and worked for many years in the process design of Coal Preparation Plants in many major Coal producing Countries, including India. In the 1990's David Joined EIMCO Process equipment and eventually became President of Dorr-Oliver EIMCO, which was purchased by FLSmidth in 2007. He now works for F L Smidth as a part – time Coal Preparation Consultant and is the UK representative on the organizing committee of the ICPC.

Quentin Peter Campbell

Professor Quentin Campbell is the Director: School of Chemical and Minerals Engineering, North-West University, South Africa, and holds a PhD (Chemical Engineering). He has over 35 years' experience in both industry and academia. In 2017 he was awarded the "Coal Person of the Year" award in recognition of his service to the South African coal industry.

Shivam Dwivedi

Shivam Dwivedi is presently working as a Scientist (PCD) in Bureau of Indian Standards (BIS).

Ratnesh Rai

Ratnesh Rai is Managing Director of QA Testing Laboratories Private Limited. He is a Bachelor in Technology and Masters in Business Administration, he has six years of work experience in distinct fields of inception, testing and analysis such Coal, Food, Water, Environment and Building Material and many more. Back in 2018 he started QA Testing Laboratory to enhance and improve the Quality of the products by testing activities and to reduce its hazardous impact on Environmental. He is also a Qualified Lead Auditor for ISO 9001 quality management system (QMS), ISO 14001 Environmental management systems (EMS) & ISO 45001 occupational health and safety (OH&S) management system"

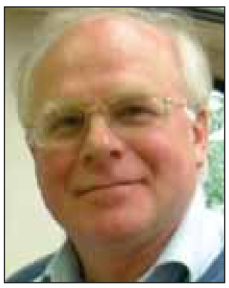
Abhinav Sengupta

Abhinav Sengupta is an MBA in Energy & Infrastructure & B.Tech in mining engineering having over 9 years of experience in Coal, Power & Infrastructure Sector has acquired strong industry exposure in areas of Strategic/Risk Advisory, Due-Diligence, Financial Appraisal, Feasibility Studies, Business Process Consulting and Strategic Procurement.

With strong domain knowledge of Energy & Infrastructure; brings in skills of Techno-Economic Studies, Financial Modelling, Business Development, Data-analytics, Market Research, Business Intelligence, ERP Implementation and Report Writing.

He is currently working with PwC India in their advisory division of Mining & Metals and has worked in organizations like TATA Consulting Engineers, Wipro Technologies, aXYkno Caps and Dilip Buildcon Ltd.

On February 2020, Abhinav has completed an Executive Diploma in Business Valuation from the Institute of Cost Accountant of India (ICMAI)



Hugh Lee

HUGH LEE has over forty years' experience in the international coal industry. From 1976 to 1984, he led the worldwide work on coal supply, transport and trade for the International Energy Agency (IEA) Coal Research office. Then he was Deputy Head of British Coal's Strategic Planning Unit, where his responsibilities included assessing the competition from gas and imported coal during the time when the electricity and coal industries in Britain were being privatised. In 1991, he joined the WEFA Group (now IHS Markit) to manage and develop their international coal and electricity consultancy work.

Since 1996, he has been an independent energy consultant in the coal and electricity industries worldwide, specialising in forecasting international coal trade and prices in the short and long term, and analysing how coal production and consumption needs to change to align with the Paris Agreement.

From 2004 to 2016 Hugh was also Chairman of Ebico Ltd, the not-for-profit UK energy supplier whose purpose is to help the fuel poor. He has been a speaker and a lecturer at many international coal and energy conferences and courses, and he directed the well-respected Coaltrans 'School of Coal' courses on negotiating international coal supply contracts and transport logistics for over twenty years. Hugh has master's degrees in mathematics, theology and operational research from Cambridge and Brunel Universities.

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Coal Preparation Society of India (CPSI)

www.cpsi-india.org.in

Representing India's commitment to Clean Coal to the world, **Coal Preparation Society of India (CPSI)** is a non-profit, non-government professional body having members from coal, power, iron and steel sectors and their allied industries. CPSI has been dedicatedly promoting washing of high ash domestic coal to improve quality and enhance the calorific value, making it more suitable for use in **High Efficiency Low Emission (HELE)** power generating Systems. Such efforts will lead to more environment friendly usage of coal as a source of energy. It will therefore be a step which will facilitate fulfilling the country's commitment to decisions taken in **COP 21**.

Main Objectives of **CPSI** inter alia are;

- To act as a facilitator in policy formulation in coal beneficiation and preparation.
- To provide an effective network amongst coal producers, consumers, coal washery operators, technical and research organizations, venture capitalists both domestic and international.
- To provide an independent platform for deliberating important issues pertaining to technological, operational, financial, commercial and policy aspects of the Indian Coal Preparation Industry.
- To promote and encourage any new idea beneficial for India. Encourage international companies and professional global bodies to exchange information on demonstrated, prevalent state of art technologies relevant to Indian coal industry.
- India's commitment to environment.

CPSI is a member of the **International Organizing Committee (IOC)** of the **International Coal Preparation Congress (ICPC)** which is held once in three years. The **International Organizing Committee (IOC)** is a body on which so far 15 countries are represented through non-government organizations which deal in their respective countries with the issues relating to coal preparation. **CPSI** is a member of **IOC** representing India.

XIX International Coal Preparation Congress & Expo (ICPC) was organised under the aegis of CPSI from 13th to 15th November, 2019 at New Delhi was a great success. This prestigious global event on COAL was held in India after 37 years. The last one was the 9th ICPC held in 1982 in New Delhi.

The World Coal Association, UK, IEA Clean Coal Centre, UK, Federation of Indian Mineral Industries (FIMI), Sponge Iron Manufacturers Association (SIMA) and Association of Power Producers (APP) were associated with CPSI in organising the XIX ICPC.

CPSI is an Associate Member of the **World Coal Association** - a global industry association formed of major international coal producers and stakeholders and has bilateral relationship with IEA Clean Coal Centre, UK for promoting clean coal technologies for use in High Efficiency Low Emission (HELE) power generating Systems.

CPSI is a member of ASSOCHAM and Associate Member of the **PHD Chamber of Commerce and Industry**, and has over **75** large companies as the Corporate Members and a large number of individual members.

CPSI is registered under the Societies Registration Act, XXI of 1860 and its head office is located in New Delhi.

Contact Details :

E-mail : rksachdev01@gmail.com

Tel/Fax : +91 11 2613 6416

Mobile : +91 98103 02360

Web site : www.cpsi-india.org.in

CPSI joins the Nation in celebrating

158th Birth Anniversary

of

Swami Vivekananda

*which is also observed as **National Youth Day** in India*

Important quotes from Swami Vivekananda's historic speech delivered at the Parliament of the World's Religions on September 11, 1893 that are very relevant and thought provoking in today's context; specially for the Indian youth.

- ***"I am proud to belong to a religion which has taught the world both tolerance and universal acceptance. We believe not only in universal tolerance but we accept all religions as true."***
- ***"I am proud to belong to a nation which has sheltered the persecuted and the refugees of all religions and all nations of the earth."***
- ***"In a day, when you don't come across any problems - you can be sure that you are travelling in a wrong path".***