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CPSI JOURNAL

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Number - 36

SPECIAL ANNIVERSARY ISSUE

Celebrating 20 years of unblemished and dedicated service to Coal, Power, Steel, Cement and their allied industries.

'We are not merely launching commercial coal mining today, we are unshackling it from decades of lockdown, we want to turn the coronavirus crisis into an opportunity".

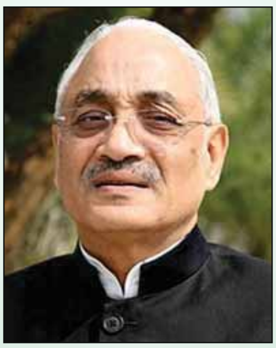
– Hon'ble Prime Minister Narendra Modi
at the launch of auctions of coal blocks for commercial mining 18th June, 2020

ANNIVERSARY CONFERENCE

on

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

Chief Guest



Justice Swatanter Kumar (Retd)
Former Chairperson, NGT

4th December, 2020

at Virtual Platform

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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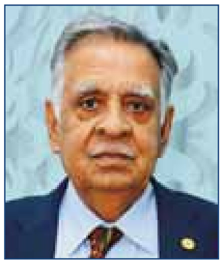
From the President



Coal will continue to dominate India's energy basket for many more years despite doomsayers' predictions. India is endowed with about 350 billion tonnes of coal resource, of which over 145 billion tonnes is of proven category. The only issue is its high ash content, which can easily be reduced to any desired level depending upon the end use, simply by washing. The redeeming feature of Indian coals is their very low sulphur content - around 05.0 %; a part of which can also be eliminated in the washing process. The quality of Indian coal has always been a matter of debate in various forums. This is a common concern for the producers as well as the consumers. This triggered the birth of Coal Preparation Society of India (CPSI) in the year 2000, when I got a telephone call from the Coal Preparation Society of America (CPSA), informing that unless Indian coal industry renews its active participation in the International Organising Committee of the International Coal Preparation Congress (ICPC), India stands to lose its membership of the elite forum. With the help and support of coal, power and allied professionals, CPSI was registered on 30th November 2000 at New Delhi. Thereafter, CPSI was represented at the 14th ICPC held in Johannesburg in 2002 with the support of its members. However, we missed participating in the 15th ICPC held in Beijing in 2006 due to lack of financial support, but our active participation started in the 16th ICPC held in Lexington, Ky, USA. This gave a big push and our membership gradually increased and today we have about 75 large companies as our esteemed Life Corporate Members and about the same number of individual members. Besides, its international affiliation with International Coal Preparation Congress (ICPC), CPSI also has Corporate Members from Australia, China, Indonesia, South Africa etc. The society itself is a Member of ASSOCHAM, PHD Chamber of Commerce & Industry: and also an Associate Member of the World Coal Association, UK and a Knowledge Partner of IEA Clean Coal Centre, UK.

We very successfully hosted 19th International Coal Preparation Congress & Expo (ICPC) in November 2019. 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. XIX ICPC witnessed a participation of about 450 including over 160 subject experts from more than 20 countries.

Over the years, CPSI has been actively and dedicatedly advocating and promoting washing of domestic thermal coal with a view to reducing its ash content and improving the heat value for its efficient burning in power plants with significantly lower emissions. Besides being in constant touch with coal, power and allied industries, the Society has been having periodic interaction with the government ministries of coal, power, steel and environment, forest and climate change and NITI Aayog etc.

We have been holding workshops, roundtables and conferences at regular intervals on topics of interest with particular focus on coal washing and clean coal technologies. Our monthly E- bulletin and quarterly magazine is widely circulated and very well received by the industry, academia and R & D institutions.

Over the last three decades, Indian coal industry has seen a series of policy reforms albeit in bits and pieces. The clarion of Atam Nirbharta (Self Sufficiency) given by the Hon'ble Prime Minister Shri Narendra Modi led to the launching of the first ever auction of coal blocks for commercial mining by the private investors on 18th June 2020. Since the Nationalisation of coal mines in 1973; the commercial mining auction by far has been the most important reform brought in by the government. The production of coal from these privately operated mines will further supplement CIL's projected production of one billion tonnes of coal by FY 2023-24, which will be a major boost to India's Atam Nirbharta in coal, barring some import of metallurgical coking coal for steel plants, which will continue beyond that too.

Hon'ble Prime Minister in his address to the recently held 4th India Energy Forum, mentioned about seven key drivers of India's energy plan including cleaner use of fossil fuels; which obviously meant use of washed coal. We therefore, presume that the government will very soon rescind the MoEFCC notification of 21st May 2020, by which the mandatory washing of coal for power plants was done away with. This indeed is surprising that the concerned government ministries forgot Hon'ble Prime Minister's own writing in his book 'CONVENIENT ACTION: Continuity for Change' where he said 'Due to the use of washed coal, the energy consumed in transportation, handling and milling has been optimised as the inert material from coal is eliminated. This helps in reducing the auxiliary consumption of equipments involved in coal processing because the use of improved coal ultimately results in reduction of GHG as compared to conventional coal."

Jai Hind,

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

For more details about CPSI & regarding membership please log on to www.cpsi-india.org.in or contact rksachdev01@gmail.com

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Chairman's Note

The government decided to do away with the need to mandatorily wash coal through the notification issued by MOEF&CC on 21st May 2020, thereby almost nullifying the thrust required to ensure improvement in quality of coal. It was presumably done on the basis of advice rendered by the Ministry of Power, Ministry of Coal and Niti Aayog. There was an impression created that washing results in an increase in cost of the fuel and hence the cost of power produced. Secondly it results in generating more pollution distributed in several places. Further, Niti Aayog has stated that there is no scientific evidence to indicate any environmental benefit in using washed coal. We in CPSI strongly felt that this was an unwarranted step and hence set-up an expert group to examine the issue and put forward evidence of known benefits of washing coal and improving its quality. The report of the expert committee which clearly enlisted the benefits along with scientific evidence was shared with all concerned segments of the government. Niti Aayog is the only organization which responded, but unfortunately stated that their conclusions were drawn on the information provided by the Ministry of Power. They of course did not share the information they had received from the Ministry of Power. Strangely enough a direction was issued by the Ministry of Power vide their letter dated 01.09.2020 to CEA to constitute a committee under the chairmanship of Chief Engineer (TPP&D) to do a detailed field level analysis of the impact of the decision to do away with then requirement of washing of coal and its impact on the cost of power.

One would have expected that these issues should have been resolved before the notification was issued by MOEF&CC on 21st May 2020. It is obvious that justifications are now being searched for the action already taken. Government is not expected to make decisions on unverified facts. This action of now seeking justification will definitely prompt people to believe that the real purpose for doing away with washing is something else. One can only hope that this should not lead to severe problems for the power plants and ultimately impact the economy as well the environment of the country.

Recently, the Ministry of Coal concluded some auctions of coal blocks for commercial mining. It may not have been a grand success as it was envisaged but the Ministry deserves to be complimented and congratulated for breaking the ice and initiating the process which was eagerly awaited. It is to be seen how this would impact the coal market in India, particularly the monopoly CIL.

CPSI completes 20 years of very fruitful existence. India has had the privilege of holding the International Congress on Coal Preparation (ICPC) twice. The first ICPC was in 1982 and the second in 2019. CPSI has been undeterred in its pursuit to promote the scientific and technical community in finding solutions to improving the quality of coal produced in the country, which due to high ash content has been a serious problem. Over the years almost without break CPSI has provided excellent forums to the scientific community to exchange knowledge and experiences in the area of Coal Preparation, through a series of international and national conferences and seminars. CPSI has also provided technical support and advice to the government and coal mining industry in establishing coal washing facilities and quality control measures. On this occasion of the 20th anniversary of the organization we are holding a conference on a currently very relevant subject: Coal to dominate India's Energy Mix: Preparing it for responsible usage is an imperative'.

Alok Perti, IAS (Retd.)

Opening of Coal Sector for Commercial Mining by Private Companies Legislative Amendments during the journey

— D.N. Prasad

Coal is the mainstay of India's Energy with its share of over 75% in electricity generation and 55% in primary energy supply and is envisaged to continue the trend for quite some time in to the future. Steel, cement, fertilisers, ceramics, paper etc. are other large consumers of coal in the country after power sector.

Resource wise, India ranks fifth in the world with about 156 billion tonnes of measured reserves and second in global coal production after China. India's coal production was about 730 mt in 2019-20 and consumption was about 970 mt including coal imports of about 230 mt (24% of consumption) during this period.

However, government of India is seriously thinking to reduce imports of thermal coals through increasing domestic coal production from PSU coal companies and through opening coal sector for commercial mining.

Despite the concerted efforts to transit to renewable energy, India is expected to be dependent on coal for significant part of its electricity generation even in 2040.

Pre independence era - Mining of coal in India began during the time of Warren Hastings in the year 1774 in Birbhum District of West Bengal. The advent of steam locomotives in 1853 gave a phillip to the development of coal industry and the production of coal reached over a million tonne per annum during this period. Sudden rise in coal production was witnessed at the end of the First World War and the production reached a level of about 22 million tonnes in 1919 and 29 million tonnes by 1942. Grant of PL/ML was on first cum first served (FCFS) basis.

Post- independence / planned development - By the end of the First Five Year Plan (1955-56) coal production went up to 38 million tonnes. The need for systematic and scientific development of coal industry was recognized from the inception of the process of national economic planning in the country. The thrust on development of coal was dictated by the needs of the consumer; initially it was the Railways followed by the Steel industry & now power sectors are the major consumers.

Coal was in both private and public sectors & PL/ML on FCFS basis continued. National Coal Development Corporation (NCDC) and Neyveli Lignite Corporation (NLC) were formed in 1956 and Singareni Collieries co. Ltd. (SCCL) was already a government company by then and government of India started participating in equity of the company from 1960 onwards.

Nationalisation of coal mines - However, to secure the supply of coking coal for steel sector, prevent unscientific coal mining by the private owners and up liftment of the conditions of safety and welfare of coal mine workers, need for Nationalisation of coal mines was felt by the government.

Coal mines were nationalised pursuant to the Coal Mines (Taking over of Management) Act, 1973 in two phases - Coking coal in May 1972 and non-coking coal in May 1973. The Coalmines (Nationalisation) Act, 1973 was enacted to permit only public sector participation in the sector. Coal India Ltd., was formed in November 1975 as a holding company with four coal producing subsidiaries namely Eastern Coal Fields Ltd. (ECL), Bharat Coking Coal Ltd. (BCCL), Central Coalfields Ltd. (CCL), Western Coalfields Ltd. (WCL) and Central Mine Planning and Design Ltd. (CMPDIL), a planning company. The Mines and Minerals (Development and Regulation) Act, 1957 along with the rules and regulations under it (MMDRA) read with the CMN Act, 1973 regulated the coal sector in India.

*Former Adviser, Ministry of Coal

Captive mining - In 1993 the CMN Act, 1973 was amended to allow private sector participation in coal mining restricted to captive purposes in certain industries like steel, power, cement, etc. Under the Nationalisation Act, the allotment of coal mines for captive use was based on the recommendations of a high-powered committee chaired by the Secretary, Ministry of Coal. Accordingly, some 216 coal blocks were allotted by the GoI from 1993 to 2010 through this committee.

In 2010, the process of allotment of coal mines to private parties was changed and MMDRA was amended. It required GoI to allot coal mines through auction by competitive bidding to companies recognised for private participation in coal mining, i.e., for captive use in iron and steel, power, washing of coal, etc.

CAG Report - In 2012, the Comptroller and Auditor General published its report on allotments of coal mines in India saying that the process lacked transparency and objectivity.

Legality of captive mining - The legality of the allotments was challenged before the Supreme Court in a common cause public interest litigation, which started hearing the matter in September 2012. The Central Bureau of Investigation (CBI), was directed to investigate the criminality of the allocation of coal blocks. Subsequently in September 2014, the Supreme Court held that all allotments of coal blocks made during 1993 to 2010, excepting (i) allotment for ultra-mega power plant which was by way of a public auction; and (ii) two allocations made to the GoI public sector undertaking not having any joint venture were illegal and cancelled them.

Aftermath of Supreme Court Judgement - Subsequent to the Supreme Court Judgement, the Coal Mines (Special Provisions) Act, 2015 (CMSPA) was enacted to deal with the cancelled coal blocks. Also MMDR Act was amended in 2015. The CMSPA amended the Coal Mines (Nationalisation) Act and the MMDRA and introduced three categories of coal mines specified in Schedule I, II and III. The CMSPA provided for allocation of coal mines to successful bidders and allottees through a transparent bidding process & paved the way to allow greater private participation in commercial coal mining.

Implementation of CMSP Act - Schedule I coal mines were all the 204 blocks that were cancelled by the Supreme Court. While Schedule II coal mines include the 42 producing and ready to produce coal mines forming part of the Schedule I coal mines, Schedule III coal mines include 32 coal mines of the Schedule I which were substantially developed. Schedule II and III mines were reserved for allocation only for specified end use (i.e., power, steel, cement, etc.). Since the enactment of CMSPA till the end of 2017, 84 coal mines (53 through allotment and 31 through auction) were allocated by the government. However, the subsequent response to auction of captive blocks was not encouraging due to different issues including sub-optimal utilization of resources when there was a need for increasing production and reduce imports.

CMSPA 2018 Order - The GoI approved the methodology for auction of coal mines under the CMSPA in 2018 (2018 Order) considering poor response to captive blocks auction. Prior to this, the GoI had also issued the methodology to fix the floor or reserve price for auction of coal mines in 2014. The 2018 Order provided for commercial coal mining for private sector with no restriction on the sale and/or utilization of coal from the coal mine. The auction of the coal mines was sought to be based on prescribed bidding parameters.

FDI Policy - In line with the 2018 Order, the foreign direct investment (FDI) policy was also amended. The FDI policy was amended earlier in 2006 to allow 100% FDI under the automatic route for coal and lignite mining but only for captive consumption by power projects, iron and steel, cement units and coal processing plants. It was further subject to the condition that processing units would not mine or sell coal in open markets.

GoI amended the FDI policy in 2019 and approved 100% FDI under automatic route for sale of coal, coal mining activities including associated processing infrastructure, which would include coal washery, crushing, coal handling and separation.

Mineral Laws Amendment Bill 2020 - The Bill was meant for amending the Mines and Minerals (Development and Regulation) Act, 1957 (MMDR Act) and the Coal Mines (Special Provisions) Act, 2015 (CMSPA). While the MMDR Act regulates the overall mining sector in India, the CMSP Act provides for the auction and allocation of mines whose allocation was cancelled by the Supreme Court in 2014.

Removal of restriction on end-use of coal - Currently, companies acquiring Schedule II and Schedule III coal mines through auctions can use the coal produced only for specified end-uses such as power generation and steel production. The Bill removes this restriction on the use of coal mined by such companies. Companies will be allowed to carry on coal mining operation for own consumption, sale or for any other purposes, as may be specified by the central government.

Eligibility for auction of coal and lignite blocks - The Bill clarifies that the companies need not possess any prior coal mining experience in India in order to participate in the auction of coal and lignite blocks. Further, the competitive bidding process for auction of coal and lignite blocks will not apply to mines considered for allotment to (i) a government company or its joint venture for own consumption, sale or any other specified purpose; and (ii) a company that has been awarded a power project on the basis of a competitive bid for tariff.

Composite license for prospecting and mining - Currently, separate licenses are provided for prospecting and mining of coal and lignite, called prospecting license, and mining lease, respectively. Prospecting includes exploring, locating, or finding mineral deposit. The Bill adds a new type of license, called prospecting license-cum-mining lease. This will be a composite license providing for both prospecting and mining activities.

Non-exclusive reconnaissance permit holders to get other licenses - Currently, the holders of non-exclusive reconnaissance permit for exploration of certain specified minerals are not entitled to obtain a prospecting license or mining lease. The Bill provides that the holders of such permits may apply for a prospecting license-cum-mining lease or mining lease. This will apply to certain licensees as prescribed in the Bill.

Transfer of statutory clearances to new bidders - Currently, upon expiry, mining leases for specified minerals (minerals other than coal, lignite, and atomic minerals) can be transferred to new persons through auction. This new lessee is required to obtain statutory clearances before starting mining operations. The Bill provides that the various approvals, licenses, and clearances given to the previous lessee will be extended to the successful bidder for a period of two years and during this period, the new lessee will be allowed to continue mining operations. However, the new lessee must obtain all the required clearances within this two-year period.

Reallocation after termination of the allocations - The CMSP Act provides for the termination of allotment orders of coal mines in certain cases. The Bill adds that such mines may be reallocated through auction or allotment as may be determined by the central government. The central government will appoint a designated custodian to manage these mines until they are reallocated.

Prior approval from the central government - Under the MMDR Act, state governments require prior approval of the central government for granting reconnaissance permit, prospecting license, or mining lease for coal and lignite. The Bill provides that prior approval of the central government will not be required in granting these licenses for coal and lignite, in certain cases. These include cases where: (i) the allocation has been done by the central government, and (ii) the mining block has been reserved to conserve a mineral.

Advance action for auction - Under the MMDR Act, mining leases for specified minerals (minerals other than coal, lignite, and atomic minerals) are auctioned on the expiry of the lease period. The Bill provides that state governments can take advance action for auction of a mining lease before its expiry.

The Bill was enacted on 13th March 2020 and Mineral Concession (Amendment) Rules, 2020, CM (SP) Amendment Rules, 2020 and Coal Block Allocation

(Amendment) Rules, 2020 have been notified. National Coal Index has been implemented to create a transparent market based pricing mechanism.

New Methodology for coal blocks auctioning :

Bid parameters

- The bidders to bid for revenue share (%) payable to the govt.;
- The floor price shall be 4% of the revenue share;
- Bids would be accepted in multiples of 0.5% of the revenue share till the percentage (%) of revenue share is up to 10%;
- Thereafter bids would be accepted in multiples of 0.25% of the revenue share;
- There shall be no restriction on sale and/or utilization of coal from the mine;
- A Bidder shall submit only 1 (one) bid for a particular coalmine;
- No affiliate of such Bidder shall submit bid for the said coalmine otherwise bids submitted by the Bidder and its Affiliate(s) will be rejected;
- Successful Bidder shall be required to make monthly payments which shall be determined as product of :

  Percentage (%) of:

  i. revenue share (final bid);

  ii. quantity of coal on which the statutory royalty is payable during the month; &

  iii. notional price or actual price whichever is higher;
- The Upfront Amount shall be 0.25% of the value of estimated geological reserves of the coal mine payable in 4 equal instalments;
- However, the upfront amount payable shall be as per actual calculation as per above method or as per ceiling mentioned below, whichever is lower:
  - Up to 200 million tonnes Rs. 100 Cr;
  - Above 200 million tonnes Rs. 500 Cr.
- Upfront Amount shall be adjusted in full against monthly payments to the State Govt.;
- Adjustments shall not exceed 50% of aggregate Monthly payments for the year;
- Bid Security in the form of an unconditional and irrevocable bank guarantee:
  - *For Fully Explored Mines:*
    - equal to 20% (twenty percent) of the Upfront Amount
    - For Partially Explored Mines:
    - Equal to 25% (twenty five percent) of the estimated exploration expenses based on Mandatory Work Program
- ***Validity:***
  - not less than 270 (two hundred and seventy) days from the Bid Due Date
- ***Eligibility criteria:***
  - A Government company or corporation or a joint venture company formed by such company or corporation or between the Central Government or the State Government, as the case may be, or any other company incorporated in India; or
  - a company or a joint venture company formed by two or more companies.
- ***Additional conditions:***
  - Incase bidder is a Prior Allottee -
  - Must have paid the additional levy within the time period
  - Should not be convicted of an offence relating to coal block allocation and not sentenced with imprisonment for more than 3 (three) years;
- ***Other Key Terms :***
  - *Flexibility in coal production -*
    - At least 65% of scheduled production each year;
    - At least 75% of scheduled production over a block of 3 years;

- *Right to exploit CBM and Other Minerals :*

  Exploitation of CBM and minor minerals present in the coalfield allowed in accordance with applicable policy;

- *Sale and/or utilisation of coal :*
  - No restriction on the sale and/or utilization of coal from the coalmine including:
  - Sale to affiliates and related parties, captive consumption, coal gasification, coal liquefaction and export of coal etc.

- *Incentives -*
  - 50% rebate in revenue share for early production;
  - 20% rebate on quantity of coal consumed and/or sold for coal gasification provided at least 10% of scheduled annual coal production is consumed and/or sold for gasification and liquefaction;
  - A certificate from CCO required;

- ***Relinquishment of partially explored mine –***

  After completing the prospecting operations as per the mandatory work program

- ***Financing –***
  - Security creation through mortgage over the coalmine has been allowed;
  - Change in control allowed;

Auction Process –

- 2-Stage Online Electronic Auction - Tender Document to be purchased upon payment of fee;
- Technical Bid - Compliance with Eligibility Conditions;
- Financial Bid - Comprises of 2 rounds;
- Initial Offer - To be submitted along with Technical Bid;
- Final Offer - To be submitted against Qualified Bids;
- Technical Bid is opened and bidders meeting all eligibility conditions are declared as "Technically Qualified Bidders" (TQB);
- Initial Offer of all the TQBs are opened;
- Ranking and elimination based on the Initial Offers to determine the "Qualified Bidders" (Qbs);
- TQBs shall be ranked in a descending order on the basis of the respective Initial Offer;
- The TQBs who have submitted the similar Initial Offer, shall be assigned the same rank;

Determination of Qualified Bidders

- If 2 to 3 TQBs, all shall be considered as Qualified Bidders (Qbs);
- If 4 to 6 TQBs, lowest ranked TQB shall be eliminated and remaining are considered as Qbs;
- If there are 7 or more TQBs, 1/3rd of TQBs subject to maximum of 3 shall be eliminated;
- If there are more than 3TQBs at lowest rank, all TQBs shall be eliminated and remaining are considered as Qualified Bidders;
- No TQBs shall be eliminated, if number of QBs after elimination is less than 3;
- The Applicable Floor Price for e-auction shall be the highest IPO of Qualified Bidders;
- The QB submitting the highest final offer shall be declared as the "Preferred Bidder" (PB);
- Upon the direction of Central Government, PB Bidder will become the "Successful Bidder" (SB);
- Coal Mine Development and Production Agreement (CMDPA) shall be executed with the SB;
- Upon the execution of the Vesting Order, the SB shall be entitled to a prospecting licence or a mining lease, as applicable, by the concerned State Government;
- Vesting Order shall be issued to the SB in accordance with applicable law post payment of upfront amount and submission of performance security

Payments and guarantees

Fixed amount

- Successful Bidder shall pay the Fixed Amount prior to issuance of Vesting Order and It shall include:
- Value of land and mine infrastructure;
- Cost of clearances, consents etc.;
- Cost of Geological Report;
- Cost incurred by CMPDIL and other Government agencies in deriving detailed geological boundary coordinates and in preparing geological report, mine dossier along with applicable taxes.

Performance Security

- For Fully Explored mines :
  - 65% of aggregate of (a) one year royalty and (b) one year revenue computed on the basis of peak rated capacity of the Coal Mine as per approved Mining Plan
  - For Unexplored/Partially Explored mines:
  - Before in-principle approval of mining plan, equal to 25% of estimated exploration expenses;
  - After in-principle approval of mining plan, same as fully explored mines;

Monthly payments:

- Shall be made on the basis of the Final Offer (% revenue share quoted) and monthly revenue;
- Revenue share for this purpose shall be product of:
  - i. Final Offer;
  - ii. Quantity of coal on which statutory royalty is payable during the month;
  - iii. Notional Price or Actual Price, whichever is higher, where
- Notional Price is the price arrived at after adjusting the Representative Price with sub-index of National Coal Index of the relevant basket of coal grade(s) on the date on which royalty becomes payable;
- Representative Price shall be a product of:
  - a) weights of the Base year; and
  - b) Latest available prices of these components at the time of issuance of the Tender Document;
- Actual Price shall mean the sale invoice value of coal, net of statutory dues;
- Other Statutory dues including taxes, royalty contribution to NMET and DMF etc. shall be payable as per Applicable law;

A model calculation is enclosed at Annexure considering the specified Bid Parameters and certain assumptions regarding cost of production/sale price of coal from the block.

The Ministry of Coal, GoI is of the view that:

- As the entire revenue from the auction/allotment of coal mines would accrue to the coal bearing States, this methodology shall incentivise them with increased revenues which can be utilised for the growth and development of backward areas and their inhabitants including tribals;
- The methodology is oriented to make maximum coal available in the market at the earliest;
- It also enables adequate competition which will allow discovery of market prices for the blocks and faster development of coal blocks;
- Higher investment will create direct and indirect employment in coal bearing areas especially in mining sector and will have an impact on economic development of these regions.

In conclusion – Opening of Coal sector for commercial mining by private companies has been permitted and this policy change is envisaged to help enhancing domestic coal production which would reduce imports of thermal coals and enhance energy security. The market forces are envisaged to improve technology, quality and safety of mining operations and induce competition in the sector thus meeting consumer's expectations. Having opened the sector, Government to urgently consider instituting an independent regulatory authority for coal. Finally, government to look at renewables as supplement to coal but not entirely replace it for at least next thirty years or so for the investors to consider participating in coal block auctions in a big manner.

Annexure

Model Calculation

(Considering Radhikapur East Coal Block, Talcher, Odisha)

a.	Geological Reserves - 172 million tonnes (mt)
b.	(Mineable reserves - 104 mt)
c.	Overburden removal (OBR) - 343 mcm.
d.	Average Stripping Ratio - 3.31 cum/t
e.	Peak Rated Capacity - 5 mtpa
f.	Monthly production - (5/12)=0.416 mt or 4.16 lakh tonnes
g.	sale price of coal - Rs. 1332/T
h.	Proposed Revenue Share - 4%
i.	Upfront fees @ 0.25% of GR = a X g X 0.0025= Rs.57.27 Cr to be paid in four instalments each of Rs.14.32 Cr
j.	Monthly Payment = h X f X g = Rs.2.22 Cr [or Rs.26.64 Cr/annum]
k.	Bid security - @ 20% of upfront amount = 0.20 X I = Rs. 11.45 Cr
l.	Performance security - @65% of aggregate of one year Royalty & one year revenue payable to state govt. = 0.65 [(0.14 X g X e) + (26.64 Cr)] = Rs. 87.24 Cr
Total outgo in the first year = i (57.27 Cr) + j (Rs.26.64 Cr) + k (Rs.11.45 Cr) + l (Rs. 87.24 Cr) = Rs.182.60 Cr	
Where Rs. 26.64 Cr is annual Revenue share and others i.e., Upfront payment, Bid security and Performance security are one time payments.	
In addition to the above, one has to pay the other expenditure (GR cost, LA cost etc.) incurred by the prior allotee for development of block and buy tender documents spending Rs.5 lakh.	
Note : This is only to show the likely magnitude of outgo for a successful bidder which may vary.	

References:

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2. Commercial Coal Mining, Auction Process - presentation of MoC
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4. CMSP Act & Rules
5. Mineral Laws Amendment Bill 2020
6. MMDR Act 2015
7. A paper - India: Coal Mining Sector: Road To De-Nationalisation, by Saket Shukla and Mariam Naaz Quadri

Coal & Renewables; not Coal vs Renewables

— Devendra N. Arolkar*

Abstract : ***In my enthusiasm to present a well-rounded case, I have ended up lengthening the article inordinately, at the risk of driving away potential readers. So providing an abstract is in order.***

The general impression that renewables will displace coal in the near future does not appear to have a sound basis. I have cited the experience of Germany in renewables and that of China in coal to drive home the point. Several forecasts indicate that in 2030 and 2040, our installed capacities of coal based generation will be significantly higher than the current one. Further, despite intense push by the Government, we will fall short on the renewable energy targets due to sticky issues like land acquisition, signing of PPAs/PSAs by DISCOMs, lending by the Banks who are already stressed and power sector being a significant contributor, accumulated losses as well as debt of DISCOMs etc. Also, due to economic and political reasons, exiting coal is next to impossible.

There is a need to protect the current installed capacity as well as be responsive to any new capacity requirement due to sudden increase in demand. Creating capacity takes long time and we have no idea of unmet demand or how demand will grow/gallop, else we may end up importing electricity like we import thermal coal.

Please read on…..

Background

It is believed that use of coal dates back to 3490 BC; however, it was only during the Industrial Revolution of 18th Century that coal began to dominate the economic environment and continues to dominate till date, it is presently the largest source of energy. Notwithstanding the same, since the last few years, obituaries are being written about the imminent/impending demise of coal. Such a negative bias is strengthened when one imagines green energy with wind mills and solar panels in pristine pastures as against dusty environment in the coal mining areas in India. Just a reminder to the RE enthusiasts, while drop in generation prices of solar is a recent phenomenon, wind mills have been in existence for centuries, yet coal prospered.

The current narrative of Coal vs Renewables gives an impression that the renewables are loaded with only positives and coal is nothing but a black villain and we should kill this villain, soonest the best. Also a fond belief that scaling up of renewables will be easy needs to be revisited.

Despite 75% of electricity being generated by thermal sources, it hardly gets its due recognition. This conundrum is sought to be evaluated objectively in the following paragraphs, specifically with respect to solar power which is expected to have higher growth trajectory, considering that we are blessed with abundant sunshine as well as coal.

1.0 Renewable Energy targets:

Year	RE Target	Solar Target	Solar Fructification Capacity Estimates
2022	175 GW	100 GW	CRISIL estimate of Aug 18: 80 GW, Mar 19: 70 GW FITCH estimate of June 19: 54.7 GW
2030	450 GW	280 GW	No visibility, target appears to be aspirational

1.1 ***Status of Solar projects in India :***

As per the report released by CEA in August 2020, SECI has tendered 18.9 GW of solar capacity out of which 13.8 GW is under construction. Out of 61 projects under this, Financial Closure has been achieved in 8 cases, Land Acquisition has been completed in 2 cases and orders for Plant and Machinery have been placed in 2 cases. PPAs/PSAs have not been signed in most cases.

At this rate, the capacity addition could be lower than 54.7 GW estimated by Fitch in June 2019 against the much publicized target of 100 GW by 2022. We can

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expect the current pandemic of Covid 19 to cause further delay.

1.2 ***Hurdles for Renewables (Solar in particular) taking off in India:***

1. ***Intermittency of generation :*** This will continue to be a major problem till long awaited storage battery technologies reach a point of strategic inflection and drive down the costs as well as prolong the useful life. Scrapping batteries after their useful life of 5 to 10 years is in itself will cause pollution on a large scale. Going by the experience of Narmada Bachao Aandolan, pumped storage of meaningful scale is a pipe dream in our country, notwithstanding CEA estimate of 96 GW of pumped storage potential.

2. ***Humongous land requirement :*** 5 acres per MW of solar is a mammoth requirement, and when you add the impact of low CUF of 20% (against upwards of 85% for TPPs), this land requirement gets magnified dramatically. This is the single biggest hurdle in scaling up of solar capacity in the country.

3. ***Funding by Banks :*** With massive exposure of Rs. 5.9 Lakh Cr to power sector, with rampant haircuts up to 80% and the looming threat of more loans becoming NPAs, expecting Banks to fund renewable projects of Private Sector on a large scale is unrealistic.

4. ***PPAs/PSAs by DISCOM :*** With commitments through PPAs already in excess of their requirement and the resulting outgo of fixed costs/capacity charges (without even drawing commensurate power), payment of salaries and pension obligations to staff even when their plants are shut down/backed down, ever burgeoning subsidies wherein large part goes unfunded; it is but natural that the DISCOMs are unwilling/ reluctant to sign further PPAs/PSAs. Hope they learn something from the past excesses in signing PPAs as well as withstand the pressure from vested interests. Regulators too need to pitch in to ensure that viability of the DISCOMs is not further compromised and the sector has some chance of survival/revival.

5. ***Sunk cost of coal based plants :*** In the event of materialization of large capacity addition in renewables and viability of storage becomes a reality, TPPs may shift to marginal costing, with variable cost in the range of Rs 1.3 (for pit head plant) to Rs 2.5 for a load center plant and still outcompete renewables. This possibility cannot be ruled out.

Considering the above, achieving renewables target of 450 GW by 2029-30 looks difficult.

2.0 Electricity Demand:

2.1 CEA, in its January 2020 "Report on Optimal Generation Capacity for 2029-30" has estimated coal based generation of 1358 BU in 2029-30, requiring 892 million tons of coal at specific consumption of 0.65 kg/kWh, with PLF at 66%. Coal based capacity is forecasted at 267 GW in 2029-30 against current capacity of 199.6 GW. With several coal based plants becoming due for retirement in the intervening years , significant addition to coal based capacity is inevitable. Total generation is pegged at 2325 BU in 2029-30. It would be appropriate to mention that while CEA has given due attention to seasonality and variability of renewables and modeled accordingly, intermittency appears to have been overlooked.

2.2 ***Forecast of Electricity demand on the basis of per capita consumption:***

Based on the current trend of growth in population (1.2% pa) and growth in per capita consumption of electricity (4.3% pa), capacity of 584 GW is required in 2029-2030. If we aspire to reach the level that China was in 2010, capacity of 913 GW is required in 2029-30. Base year is taken as 2014-15, since generation capacity was quite constrained then. Ratio of BU/GW has been extrapolated.

Scenario	Year	Population Cr *	Population Growth CAGR capita *	Elec cons- Units per	CAGR Elec cons- capita *	BU required	Total Capacity Units per GW	BU/GW factor
	2014-15	130	Base	957 (A)	Base	1244 (A)	268 (A)	4.64
	2019-20	136	1.20%	1181 (A)	4.30%	1606 (A)	356 (A)	-
A	2029-30	144	1.20%	1877 (E)	4.30%	2709 (E)	584 (E)	-
B				2943 (E)	Match China per capita consumption of 2010	4238 (E)	913 (E)	-

**the three parameters are showing some discrepancy with respect to correlation.*

It is high time that we move away from competing with the likes of Nigeria, Congo, Ivory Coast, Ghana on the basis of per capita GDP and set the bar higher. Considering that a good 25% of the population doesn't have access to electricity, we should move away from the mindset of incremental growth in per capita consumption of electricity. Believing that in 2030 we can match China of 2010 need not be preposterous, rather we need to do so.

3.0 Experience of the poster boy for renewables- Germany:

	Non-renewables			Renewables				
Source	Coal+ Lignite	Natural Gas	Nuclear	Bio mass	Solar	Wind	Hydro	Waste
Share in Generation in 2018	35.4%	12.9%	11.8%	7.0%	7.2%	17.3%	2.6%	1%

As can be seen from the above table, solar and wind are supplying only 24.5% of electricity, despite enjoying subsidies for the past 18 years. Bio-mass that is contributing 7% is also a polluting fuel, though renewable. It is also reported that cost of power has gone up by 50% in Germany ever since renewables were given push. California has similar experience in terms of pushing up of costs. On the contrary, in the case of France where 80% of power is from nuclear, power is cheaper and the cost is going down continuously.

4.0 Experience of China, an equally populous, but much more developed country:

From per capita consumption of 993 Units in 2000, the usage galloped to 2943 Units in 2010 and 3927 Units in 2014, mirroring their economic development. China has capped their coal based capacity at 1300 GW against projected coal based capacity 267 GW 2029-30 in our case. Presently, China burns over 3 billion tons of coal, whopping 50% of global share. It may be pertinent to note that @ 1990, India and China were at comparable level on the economic development parameters. We cannot aspire to emulate Chinese economic miracle without emulating their energy transformation. High time we called this carbon imperialism bluff of the developed world. We should also remember that Chinese banks are funding 101 GW capacity in 24 nations.

Indonesia too continues to ramp up its coal production and exports; has set 609 million tons target for production in 2021 against 550 million tons target of 2020.

5.0 Challenges posed by DISCOMs:

Ultimately, success of the renewable capacity that is being added will be determined by the DISCOMs through which this power will have to be sold. And the fate is going to be no different than the humungous coal based capacity that was added between 2011 and 2017, primarily in Private sector, at a CAGR of over 12%. Rather, the fate may be worse than thermal plants since most DISCOMs have already contracted long term capacity far in excess of their requirements and are bleeding through payment of capacity charges even where they don't draw power. As an example, Maharashtra has contracted capacity of 35,000 MW, currently drawing 14,500 MW and would rarely have drawn beyond 20,000 MW. On top, the gap between Average Cost of Supply (ACS) and Average Revenue Realized (ARR) on all India basis was Rs 0.52 per unit in 2018-19, this is not going away despite UDAY schemes and several initiatives of Ministry of Power. In 2018-19, DISCOMs have accumulated losses of Rs 4.88 Lakh Crore and AT&C losses of 22.01%, this doesn't inspire confidence that the house will be put in order anytime soon. This has also resulted in some States like AP wanting to renegotiate the PPAs as also some successful solar Bidders line ACME, Azure, Renew cancelling some of the PPAs.

6.0 Future of coal in India:

In view of the aforesaid, future of coal , at least for the next few decades in the context of our country, is definitely not bleak as it is made out to be. It will be meaningful to take note of the following in respect of coal.

6.1 ***Thermal (coal) power, a favorite whipping boy:***

1. ***Bad Name :*** Despite generating 75% of electricity, thanks to concerted campaign by the Greens, thermal power is getting ostracized. There is hardly any objective evaluation of its contribution.

2. ***High taxes:*** Along with heavily taxed "sin" products like cigarettes, coal is getting increasingly taxed day by day. For common grade of thermal coal (G11), direct taxes and levies are almost equal to selling price. It may be borne in mind that this selling price in itself has lot of hidden taxes; on diesel, on salaries, on profits of coal companies, on profits of contractors and host of indirect taxes paid in the course of consuming various products and services by the individuals and entities involved. On the contrary, renewables are heavily subsidized, including waiver on ISTS charges (almost a rupee per unit) and AT&C losses. Also, subsidizing railway passengers increases the cost of coal.

3. ***Image as a highly polluting fuel :*** It is ironical that bio mass which is also a polluting fuel is being included in the "green energy" bucket, thereby helping the propaganda. If one analyses the decrease in pollution during the recent lockdowns, it is clear that bulk of the pollution is caused by vehicles, dust produced at construction sites and factories/kilns with inefficient combustion processes. Following table provides an indication.

Decrease in Pollution level in Mumbai during the lockdown:

	PM 10	Reduction	PM 2.5	Reduction	Thermal PLF	Reduction
May 2020	27-68 µg	68%	12-40 µg	69%	47.9%	25%
May 2019	94-205 µg	-	48-127 µg	-	63.6%	-

PLF reduction was moderate, at 25; pollution reduced significantly.

6.2 ***Why it is difficult to move away from coal?***

1. ***Economic value added :*** The economy of the coal bearing States is heavily dependent on coal, be it collection of taxes and royalties by the State, employment provided by Coal Companies and its subcontractors/transporters, driving supporting business activities, Railways etc. People seem to be oblivious to this contribution. Can't imagine how this can be compensated if coal mining is reduced (closing for the next several decades is out of question). Remember, exiting any activity in India is next to impossible. By one reckoning, more than 70 lakh persons are employed/engaged in coal sector, Coal companies and Railways are amongst the largest employers.

2. ***Abundance :*** Country is blessed with abundant reserves, which can be mined cheaply (if done more efficiently). Minus taxes and inefficiencies, energy cost of Rs 0.6 per unit is feasible at pithead, which is indeed very low.

3. ***Subsidizing of passenger traffic of Indian Railways:*** Coal freight is overpriced by one third to subsidize passenger traffic.

4. ***Limitations on Installed and effective capacity of Renewables:*** Despite massive push by the Government and the infatuated Media, Institutes, Academia gloating about the impending demise of coal and breakneck rise of renewables, capacity creation is not moving at the intended pace. Once economy revives, coal will have to supply even more power.

5. ***Stage of development:*** With a quarter of our population not having access to electricity and 40% still using firewood/kerosene/dung for

cooking and lighting; we need energy from all the sources that we can muster. With negligible oil and gas reserves, it is the coal that has to shoulder the burden of the development of the economy.

6. ***Grid balancing:*** The Grid starts experiencing issues when renewables exceed 20% to 30% of the power generation mix. Without storage of peaking plants, integration would be challenging.

Way forward:

1. Accept that both coal and renewables have to co-exist, with the former taking lion's share for few more decades. Do not put coal on euthanasia through excessive taxes and uncharitable narratives. Continue to keep the installed capacity of TPPs in "Ready to Operate" condition, else we may have ignominy of importing electricity too.

2. Be ready to revive stalled coal projects in case desired capacity of the renewables doesn't materialize. We need power, source may not matter in case of shortage. Don't throw out the baby with the bath tub. Forecast of coal based capacity rising to the level of 330-441 GW in 2040 may be closer to reality than RE enthusiasts believe.

3. Promote even faster adoption of EVs to control pollution in the cities. We are way off from the target of 7 million hybrid/electric vehicles on roads by 2020.

4. Stand up to the carbon imperialism of the developed world. Our economic development has to go hand in hand with emission controls. FGD adoption could be an area that may be reviewed critically; whether spending so much money and replacing one type of pollution with another type is meaningful.

5. To meet emission targets, targeting coal need not be the only option; go for low hanging fruits like control on emissions from kilns, ovens, chemical factories, minimizing burning of wood, stopping burning of crop residue, minimize household use of kerosene, avoiding coal transportation by road etc.

6. Be realistic about actual installations of RE and contribution in terms of generation from RE. Allow the ever reliable and dependable workhorse-coal to do its work.

7. Realize that the Tax payers money is stuck in stranded assets in thermal power, no need to throw more money in renewables if they are likely to get stranded likewise. No amount of diktats can override economic logic.

8. Be realistic about reforming the DISCOMs, it will take time, rather lot of time. Faster adoption of solar pumps can reduce the subsidy burden. Smart prepaid meters can reduce leakage and improve collection. Overhauling the Regulatory framework can improve the working.

9. The model that may be appropriate for developed Western Nations with a small population base may not be suitable for us. China could be a better example to emulate for our economic development considering our current level of development.

10. Promote clean coal technologies and coal gasification so that adverse impact on the environment can be reduced.

11. Continue investing in coal mining, processing/ beneficition and evacuation infrastructure and upgrading the technologies.

In conclusion, the irrational exuberance about Renewables displacing coal in large measures will have to be taken with a pinch of salt. Banks need to watch out for lending, retail investors need to be cautious on subscribing to the IPOs that would be in the pipeline, else we will have a repeat of the last binge in power sector IPOs wherein most people were loser. We also should not show undue hurry in administering euthanasia to coal based power plants, we need them for the development of the Country. Lastly, investors in the stock market, coal blocks and coal mining/transportation/processing/ beneficiation infrastructure would do well to reflect on the wise words of the Oracle of Omaha, Mr. Warren Buffet- "Be fearful when others are Greedy and be Greedy when others are Fearful".

2020 Australian Coal Preparation Trends

— Andrew Swanson*, Nerrida Scott**

1. Introduction

This article has been prepared for inclusion in a 20th Anniversary edition of the CPSI Journal. Congratulations are in order to the CPSI for providing twenty years of service to Indian coal preparation.

A detailed account of the Australian coal industry, and its coal preparation practice, was published in the special XIX ICPC edition of the CPSI Journal in late 2019 (Swanson, 2019). Consequently, this article will simply provide an update on what is happening in Australia and, looking to the future, contains a summary of coal preparation R&D activities.

2. Australian Production Data

The long-term production trends for the Australian coal industry are shown in Figure 1. There had been around 30 years of steady growth in production up until around 2013, and since that time production has plateaued, with perhaps a small increase in the last two years. Production increases were driven by significant increases in exports, with both coking and steam coal exports rising substantially.

Since 2013, the general world economic circumstances have been somewhat subdued and raw export volumes have remained flat. Table 1 summarises the production data from the last five years and shows raw coal production of around 570 Mt/y and exports of 385 Mt/y. The value of coal exports in Table 1 demonstrates the importance of coal to Australia's export income, getting to as high as A$70 B two years ago; it was as low as A$34.5 B in 2014/15, however coal prices increased markedly, and the coal export value has jumped to over A$55 B for the next four years.

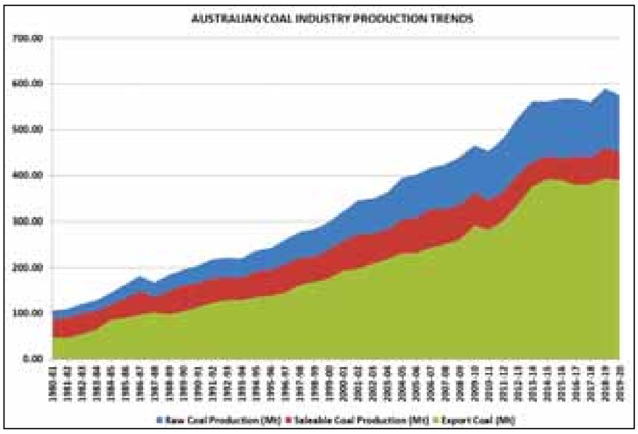

Figure 1 : Long Term Production Trends for Australian Coal Industry

Table 1 : Production Data for Australian Coal Industry

Year	2015-16	2016-17	2017-18	2018-19	2019-20
Production Data (Mt/y)					
Raw Coal	567.7	567.4	560.7	589.6	575.6
Saleable Coal	437.0	443.0	439.1	460.5	451.5
Export Coal	389.3	378.9	381.9	393.3	389.6
Coking Coal - Prime	119.5	114.5	117.7	121.0	120.6
Coking Coal - non Prime	68.5	62.7	61.6	62.5	56.3
Thermal	201.3	201.7	202.7	209.8	212.6
Value of Export (A$B)	34.5	54.2	60.4	69.6	55.0

Australia has abundant deposits of black coal (around 80 Bt), covering a wide spectrum of rank, and so exports cover the whole range from high rank coking coals to lower rank thermal coals, including premium hard metallurgical coal, weakly coking coal, soft and semi-soft coking coal, PCI coals, and high and low energy thermal coals. Some typical specifications are given below and for Australian coals sulphur is invariably low at 0.5-0.7% ad.

Coal Type	Total Moist (% ar)	Ash (% ad)	Volatile Matt (% ad)	CSN	CV (kcal/kg gad)	HGI
Hard Coking	9.5	9.0	22	8.5		90
Semi-Hard Coking	10.0	8.5	24	7		80
Semi-Soft Coking	9.0	9.0	33	5	7350	50
Export Thermal	10.0	13.5	31		6850	50

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**ACARP, Australia

Figure 2 shows how the export prices of coal vary considerably and these directly impact on production and profitability. Prices dropped sharply from late 2011, especially coking coal, and then rebounded in mid-2016. However, over the last 18 months prices have again declined reflecting the state of the world economy.

Figure 2 : Trends in Export Prices for Australian Coals

3. Australian Coal Preparation

Approximately 90% of raw coal is washed in Australia, due to the need to meet tight export specifications. Domestically, raw coal is supplied to nearby thermal power stations with some washed coal used to steel works and other industries.

3.1 Typical circuits

In Australia, plant feed is mostly reduced to 50 mm and a typical modern coal washery will comprise:

- Wet screening at 2 mm
- Coarse coal processed in dense medium cyclones
- Mid-sized coal (-2+0.25 mm) treated in a water-based gravity process (spirals or hindered bed separators)
- The ultra-fine fraction is cleaned by froth flotation, although in many steam coal plants the -0.1 mm material is simply discarded to tailings.

As coking coal products are being pursued from poorer quality coals, more complex circuits involving size and gravity separations have been developed.

3.2 Latest trends

Since 2012, there has been a focus on reducing costs, removing bottlenecks and increasing efficiencies. Thus, there have been many small upgrades to improve operations and to increase availability. The focus on costs has resulted in appreciable reductions in employment in the coal sector, and these have been very significant in the support sector (suppliers, consultants, engineering companies).

The recovery of water from tailings has received appreciable attention, some enforced by new regulations. Thus, many plants have been looking at using not only belt press filters but also solid bowl centrifuges and plate and frame filters. Normal practice for steam coal washeries was to direct the slimes (-0.1 mm) material to tailings, and this can represent an appreciable loss of coal. Thus, there is a large potential improvement in revenue if coal can be recovered from tailings and so there have been several flotation plants installed to process these streams.

3.3 New Plants and Significant Upgrades

The generally subdued state of the industry has meant that there have been few new plants and coal projects. Two new plants have been commissioned in recent years including:

- Mt Pleasant - 1500 t/h plant using dense medium cyclones and spirals
- Byweren - 550 t/h washery using dense medium cyclones, spirals and flotation.

The Carmichael Coal Project has commenced development in the last year and it produces a lower rank thermal product. In the first stage (10 Mt/y), this coal will be unwashed. There are two coking coal projects believed to be close to commitment - Olive Downs and Eagle Downs.

4. Recent Australian Coal Preparation Related Research and Development

Industry funded R&D, through ACARP, and has delivered incremental and step improvements to Australian coal preparation plants. The key ACARP coal preparation R&D strategies are maintenance, improved recovery and plant capacity. Work is focused on maximising yield, reducing production costs, minimising emissions, reducing water consumption and the use of lower quality water without adversely impacting on process efficiency. While reports from these projects are only directly available to the Australian coal industry, papers based on such reports are widely published, and abstracts can be viewed on the ACARP website (www.acarp.com.au).

Attachment A contains a list of recent research publications from ACARP. Below some projects of note are summarised, but there are many other great projects that can be seen on the ACARP website.

4.1 Flotation

McMahon's work (C27028) reviewed historical resource data examples of Australian coal flotation results, and assessed the representation of resource potential for product ash and yield against the laboratory method used. It was found that the Australian Standard method application can be less effectual where a lesser number of increments, than required by Australian Standards, are utilized. From the data evaluated, a best methodology, and reagent dosages, was determined in relation to coal quality. The outcomes of the project were the definition of the best modified froth flotation method, based generally on Australian Standards methods, definition of effective reagent dosages, and an outcomes guide for different raw size/ash froth outcomes, though on less increments than recommended by the Australian Standard.

The work of Park and Wang of the University of Queensland on improving flotation recovery has demonstrated great potential gains from controlling froth behaviour (C26012). This project provided an effective real time froth monitoring tool and a simple and fast tool for monitoring frother concentration in flotation cells, and in the water circuits. The ability to measure frother concentration will help coal flotation plants identify the amount and location of frother addition to optimise the process and improve its smoothness.

Also, by the same authors, a project looking at the use of oscillatory air in flotation (C27004) was recently published. Pilot-scale coal flotation tests were conducted using a column with two different spargers: one made from a perforated plate and the other made from a porous plate. The oscillatory airflow was generated, and improvement of flotation yield was found to be achievable with oscillatory air supply for both spargers tested, but the sparger made from the perforated plate gave much greater improvement. A technical barrier, for future site trials, has been identified, namely the scaling up of the device for generating oscillatory airflow at large air flowrates.

4.2 Dewatering

Chen, Huai and Peng (ACARP Project C24040) tackled a well-known problem with flotation froth contamination in dewatering equipment. They trialed a variety of different techniques, both mechanical and chemical, to improve froth with success on a laboratory scale and then followed up with field trials. The trial attempted physical deaeration and chemical deaeration, as well as a combination of the two. The project identified chemicals that were effective in deaeration, as well as effective mechanical methods. Case studies were conducted in two plants to test the deaeration techniques developed in the laboratory. Both plants had very stable froths produced in flotation which negatively affected the dewatering process. Dewatering tests were conducted after deaeration and the results showed a significant improvement in filtration in Plant 1 and in thickening in Plant 2.

Project C25012 also looked at dewatering, and Ejtemaei and Nguyen conducted pilot scale studies using a solid bowl centrifuge, both at mine sites and in lab pilot scale. The degree of difficulty associated with fine coal tailings dewatering differs from mine to mine as the process water and surface properties of tailings can change significantly. These dewatering and handling problems are caused by the complex surface properties and gelation due to the swelling characteristics of smectite-type clays, which can result in high yield stress, high dosages of dewatering chemical aids, low settling rates, and poor supernatant clarity. Pilot scale trials on tailings thickener underflow were completed at different pool depths and with different differential rates to maximise capture of ultra-fine clay mineral particles without using chemicals. Different anionic and cationic surfactants and flocculants were trialed and assessed against dewatering performance. These results were also compared by feed type and clay type, providing insight into the relative benefits of different chemical reagents on dewatering of different types of tailings. The different feed type studies results showed that in the presence of clay tailings containing more negative surface charge and swelling types, pool depth in the clarification zone of the centrifuge should be increased to recover an acceptable clear centrate, with some sacrifice in cake moisture content. It was also discovered that process water chemistry played a critical role in affecting the dewatering performance through neutralisation of the particle surface charge.

4.3 Coarse Coal Circuits

Project C24050 by O'Brien on 'Options for the Addition and Control of Non-Magnetic Material in the Correct Medium' investigated methods to maintain non-magnetics concentration in the correct medium at a level which promoted medium stability. The method used was tested in a plant environment and it was found that the system performed as expected. The importance of non-magnetic concentration in a dense medium circuit, operating at densities below a relative density (RD) of 1.4, is measured using the DMC differential (RD underflow minus RD overflow) related to circuit stability. Using a nucleonic density gauge and a magnetite monitor, a non-magnetics concentration of the medium was inferred and compared with the differential which was measured online using electrical impedance spectrometers in the drain sections of the product and reject screens. The DMC circuit effects were able to be observed with changes in non-magnetics concentration. It is worth noting that most plant instruments cannot see this variation and that this research has enabled greater visibility of the effect of non-magnetics concentration on the control of DMC circuits.

4.4 Coal Analysis

The Coal Grain Analysis (CGA) technique has been a topic of interest over the years, and the involvement of numerous researchers on the topic (C27032, C25019, C27033, C26015, C26009) has culminated in the development of a Coal Grain Analysis Handbook (C27032). While research continues to be published on CGA, the technique is now available to industry via commercial laboratories. Coal preparation related CGA projects include the derivation of large scale was habilities from small samples and the understanding of flotation performance.

4.5 Fine Coal Classification

It is well recognised that the efficient classification of fine coal in the range of 0.04 - 0.3 mm is a key technology area to improve the efficiency of coal preparation. The C27012 project (Swanson, O'Brien and Swanson) looked at previous research, and discussions were held with producers and equipment suppliers about plant needs, best practice and potential equipment developments. It is clear that hydrocyclones will continue to be the workhorses of the industry; there are applications for sieve bends and there may be a role for Derrick Screens.

Simulations using a range of feed types indicated one of the challenges with cyclones is the density effect, and this is not overcome even if the cyclone efficiency could be increased appreciably. Screens do not have this problem but are usually limited in capacity. Combinations of cyclones and screening technologies have the potential to alleviate these issues, and this project demonstrated the efficacy of the established practice of using cyclones and sieve bends to achieve size classifications around 0.25 mm. The simulations also indicated the potential value of using a combination of cyclones and Derrick Screens to improve classifications around 0.125 mm.

5. References

ACARP, Project Summaries, http://www.acarp. com.au/

Swanson, A. "Coal Preparation in Australia - 2019", XIX ICPC Edition of CPSI Journal, November, 2019.

ATTACHMENT A

Listing of Recent ACARP Projects

Project	Report Title	Authors	Author Organisation	Date Published
C27004	Improving Coal Flotation with Oscillatory Air Supply	Liguang Wang, Hangil Park	The University of Queensland	20 Sept, 2020
C25018	Improving Solids Recovery and Moisture Reduction in Ultrafine Coal Dewatering	Changzhi Bai, Hangil Park, Liguang Wang	The University of Queensland	20 Aug, 2020
C27028	Lab Froth Flotation Testing Guide with Coal Quality	Chris McMahon	McMahon Coal Quality Resources	7 Aug, 2020
C24050	Options For the Addition and Control of Non-Magnetic Material in the Correct Medium	Michael O'Brien	CSIRO	30 Jun, 2020
C27012	Towards Better Fine Coal Classification	Matthew Swanson, Michael O'Brien, Andrew Swanson	QCC Resources	23 Jun, 2020
C26012	Improved Flotation Recovery Via Controlling Froth Behaviour	Hangil Park, Liguang Wang	University of Queensland	20 May, 2020
C27032	Coal Grain Analysis Applications Handbook	Bruce Atkinson, Priyanthi Hapugoda, Silvie Koval, Graham O'Brien, Karryn Warren, Sandra Atkinson	Basacon Services	29 Apr, 2020
C24040	Improving the Dewatering Efficiency of Fine Flotation Concentrates by De-aerating Froth Products - Plant Tests	Xumeng Chen, Yangyang Huai and Yongjun Peng	University of Queensland	1 Jan, 2020
C25019	Adaptation of Coal Grain Analysis to Improve Flotation Yield Estimation	Bruce Atkinson	QCC Resources	17 Oct, 2019
C27033	Comprehensive Flotation Model Using CGA Particle Surface Composition	Cathy Evans, Bruce Atkinson	University of Queensland, Basacon Services	12 Oct, 2019
C25012	Dewatering of Ultrafine Coals and Tailings by Centrifugation: Pilot Scale Studies	Majid Ejtemaei, Anh Nguyen	The University of Queensland	1 Aug, 2019

C26009	Improved Precision of Determining Coal in Urban Dust	Graham O'Brien, Silvie Koval, Michael Plater, Karryn Warren, Michael Campbell, Jason Campbell, Nick Stanning	CSIRO, Steel River Testing, Coal bridge	1 Jul, 2019
C26034	Coking Properties Deterioration in Small Samples	Chris McMahon	McMahon Coal Quality Resources	24 Jun, 2019
C24049	Performance-Enhanced Diesel Collector for Coal Flotation	Shenggen Hu and Philip Ofori	CSIRO	1 Jun, 2019
C24051	Effect of Particle Crowding at the Vortex Finder and Spigot on Dense Medium Cyclone Operation	Michael O'Brien, Clint McNally and Bruce Firth	CSIRO	1 Apr, 2019
C26015	Novel Characterisation of Coal Petrography for Improving the Dewatering of Fine Coals Using Chemicals	Majid Ejtemaei, Jianlong Wang, Anh Nguyen, Priyanthi Hapugoda and Graham O'Brien	The University of Queensland and CSIRO	1 Mar, 2019
C25009	Rapid Extraction of Frothers from Process Water	James Dickinson, Frances Neville, Peter Ireland, Callan Lowes and Kevin Galvin	University of Newcastle	28 Feb, 2019
C26014	Low Cost Online Measurement of Particle Size and Density for Diagnostics Across the Fine Coal Circuit	Rohan Stanger, Quang Anh Tran, Peter Stepien, Clint Bruin, Terry Wall	The University of Newcastle and ResTech	11 Feb, 2019

Dense Medium Cyclone Instrumentations: Overview and use in Circuit Optimisation

— Amit Kumar Sinha*

Abstract

Dense Medium Cyclone (DMC) geometry and DMC performance have been widely explored in the past. Some investigations have been made into the dynamic changes that take place over a DMC circuit while the plant is running, however this has been limited by the lack of on-line plant data. Understanding of the dynamics of the whole DMC circuit requires extensive evaluation of several new monitoring/measurement devices which have the potential to significantly change the management and control of Dense Medium Cyclone circuit in the future. The key process performance parameters (or factors) for a DMC circuit are the throughput, yield and quality which can be monitored and pathways for smart sensors/instruments in-line to provide an understanding of the estimated values of the factors describing the level of performance, the separation density and Ep of the DMC were demonstrated dynamically.

The objective of this article is to list out major set of instruments which may be used for control and automation and at the same time to collate outcomes and benefits arising because of the minute-by-minute monitoring of the most important coal preparation process leading to definite improvements in DMC performance due to use of DMC instrumentation and software development resulting in The Intelligent Plant.

Keywords: *Yield, monitoring, Ep, Intelligent Plant.*

1. Introduction

Dense medium cyclones (DMCs) are known to be efficient, high-tonnage devices suitable for upgrading particles in the 50 to 0.5 mm size range. Advances in dense medium processing have been more pronounced in the circuit design area rather than in the DMC itself. Furthermore, technology has limited operators' ability to see the subtle changes that occur in the dense medium, for example, when the circuit is unstable. The field data required to develop these tools was collected by conducting detailed sampling, instrument output signals and evaluation programs at several industrial plant sites. This has led to development of Expert systems which offer a convenient means of providing end users with expertise from a variety of knowledge sources including statistical expressions, process models and operator experience. In the case of DMC circuits, the expert system consisted of separate modules and sets of instruments for diagnosis (trouble-shooting) and simulation and optimization techniques. Several options existed to transfer the data off-site through Instrument control and data acquisition resulting into The Intelligent Plant. Instruments are required in-line within the plant for obtaining measurements for understanding of process under consideration, transmission of the data and information and development of suitable model or algorithm to derive status of various process parameters.

2. Instruments in Dense Medium Circuit

- ***Screen Motion Analysers :*** Screen motion analysers are located on the de-sliming and the product and reject drain and rinse screens. These give a clear understanding of the motion and condition of the screens and provide an estimate of

Accelerometers attached using magnets to the screen side plates.

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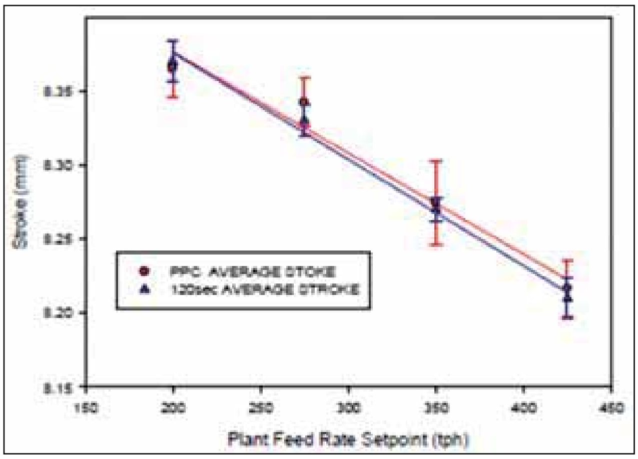
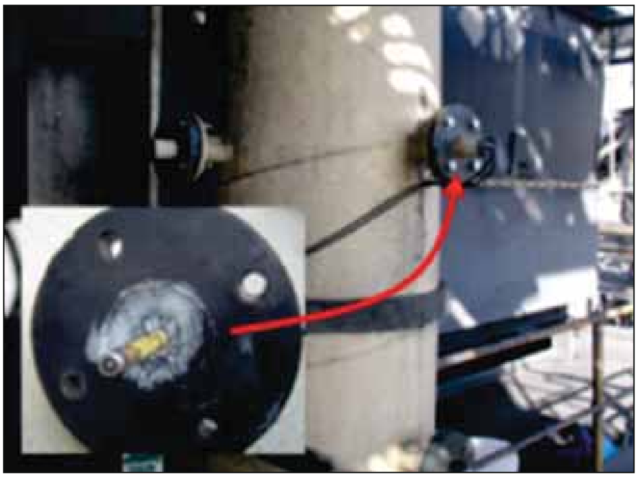
the tonnes of solids passing over the screens. The yield from the DMC circuit and an indication of the size distribution of the feed to the plant can then be quantified. These have Operational Life of around 12 months.



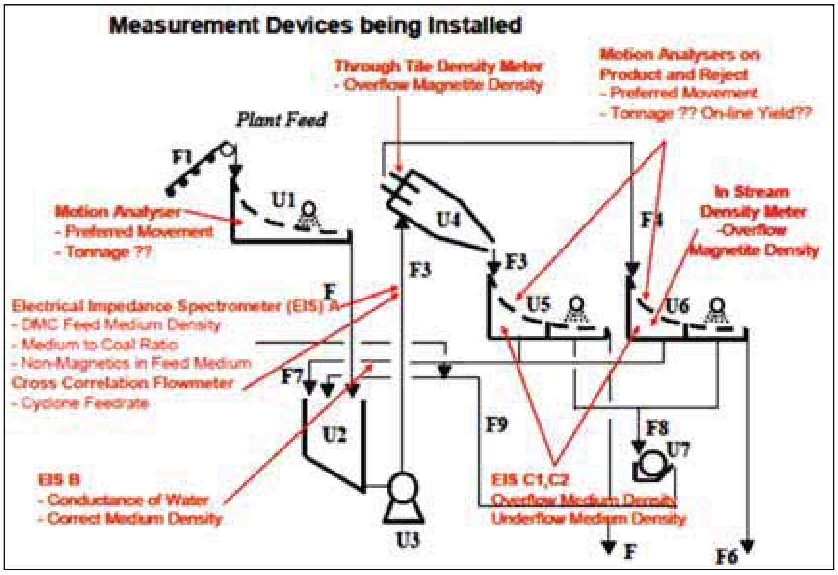
- ***Electrical Impedance Spectrometers (EIS) :*** It provides measurements of the medium density and its composition. These were placed on the return correct medium, the overflow and underflow mediums and the feed medium. Operational Life of Electrode around 2 years and front send sampler with tube is around 6 to 8 months.

EIS electrode assembly installed in under-pans of drain section of the drain & rinse screens for measuring the density of overflow/underflow medium. On the top of the electrode cell, there is a collection tray to concentrate the slurry flow entering the cell. The flow entering the EIS cell in the under pan of product screen was sufficient to fully fill the EIS electrode cell. With a wider collection tray, the slurry flow entering the EIS electrode cell in the under pan of the reject screen also was able to fully fill the cell.

- ***Density Meters :*** The Through Tile Density Meter and In Stream Density Meter were placed in the overflow pipe from the DMC vortex finder and underneath the product drain and rinse screen. These provided measurements of the amount of



magnetite in the medium at these points in the circuit (Operational life Up to Years)



- ***Online Ash Analyzers :*** The Online Ash Analyzer uses a dual Gamma - ray penetration method to eliminate the influence of coal porosity, particle size and other factors and to rapidly measure the coal ash and calorific value. This method is the most commonly used technique for fast online Coal Quality Analyzer.

3. Preliminary use of Instruments Measurement and Model Development

The key process performance parameters (or factors) for a DMC circuit are the throughput, yield and quality. Unfortunately, the drive to maximize throughput tends to compromise the latter two factors. There are causal relationships between the design, control and operational limiting factors and the performance factors linked via the factors summarizing the fluid mechanic environment which exists in the cyclone. The hierarchy of the factors for the DMC circuit can be taken as follows and the linkage of these factors is shown in Chart 1 below.

a. *Design factors :* These are essentially dependent on the geometry of cyclone.

- Diameter of Cyclone (Dc).
- Diameter of inlet (Di).
- Diameter of Vortex Finder (Dvf).
- Diameter of Spigot (Ds).

b. *Control Factors :* These factors are varied simply for a short period of time.

- Pressure (P) of the feed slurry as it enters the feed cyclone.
- Density of feed slurry(ρf).
- Slurry Solids concentration.
- Washability of Feed Coal.

c. *Operating Limiting Factors:* These factors are considered to contain information which is very important to the efficient operation of the DMC circuit.

- Q- Volumetric Flow rate of feed slurry in (m^3/h).
- M: C- Medium to Coal Ratio.
- Qu- Volumetric Flow of Slurry to Underflow of Cyclone.
- Qo- Volumetric Flow of Slurry to Overflow of Cyclone.

The above three factor groups define the fluid mechanic environment within the cyclone and determine the values of the factors which describe important characteristics of that environment:

- %Om- Percentage of medium reporting to Overflow.
- ρo- Density of medium reporting to Overflow of cyclone.

- ρu- Density of medium reporting to Underflow of cyclone.
- ρdiff- Difference in medium density of U/F and O/F.

d. *Performance Factors :* The above parameters result in separation of particles and the efficiency of the process which is described by the parameters RD50, Ep and Offset (RD50- ρf).

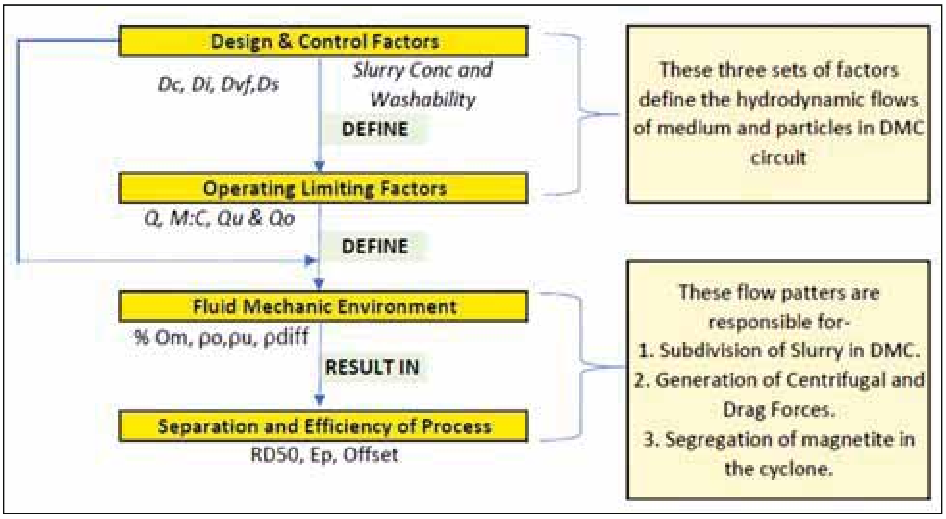


Chart 1 : Linkage of the various types of factors associated with a DMC circuit.

Sensors for obtaining measurements which provide some understanding of an activity occurring in the process under consideration; ex- massflow at specific points, fluid density and composition and suitable algorithms employed to derive new information on the status of the process; yield, feed size distribution, separation density, density differential.

Consequently, various models were developed to process instrument data and with the aid of that Suitable algorithms employed to derive new information on the status of the process; yield, feed size distribution, separation density, density differential from the model and calculations developed. Once the RD50 and Ep are known for any particle size d, a partition curve may easily be generated. The important DMC circuit performance controlling factors, feed, product and reject medium densities can be monitored and pathways for smart sensors to provide an understanding of the estimated values of the factors describing the level of performance, the separation density and Ep of the DMC were demonstrated dynamically.

Volumetric Flow		
Cyclone Dia	1000	mm
Head	9	9D
Spigot Dia	340	mm
Vortex Dia	700	mm
Volumetric Flow	***554.0***	***cum/h***

Pressure Drop Calculation		
Cyclone Dia	1000	mm
Head	9.00	9D
RD of Feed	1.4	-
Pressure Drop	***123.5***	***kPa***

Media to Coal Ratio		
Volume of Water	400	cum/h
Tonnage of Mag	300	t/h
Tonnage of Coal	150	t/h
SG of Mag	4.8	-
SG of Coal	1.35	-
Volume of Medium (Water + Mag)	462.5	cum/h
Volume of Coal	111.11	cum/h
Media to Coal Ratio	***4.1625***	-

Dense Medium Cyclones Parameters		
Cyclone Dia	1000	mm
Head	9	9D
Spigot Dia	340	mm
Vortex Dia	700	mm
Fractional Flow Split to Spigot	***0.020***	***(Qu/Qf)***
Feed Medium Density	1.29	Assumed
Media Grind Size	31	microns
Media to Coal Ratio	4.9	-
A	-0.15132	-
Underflow Medium Density	***2.15***	-
Overflow Medium Density	***1.26***	-
Corrected D50 (D50c)	***1.475***	-
Particle Size	13	mm
Ep for any particle size	***0.0038***	-
Separation Density	***1.473***	-
Breakaway Size	***4.99***	***mm***

(colour key)	INPUT DATA
(colour key)	CALCULATED DATA

Excel Spreadsheet for calculation of Ep, RD50, Offset and other major parameters in DMC

Due to harsh environmental conditions within the coal preparation plant to which the instruments are exposed and due to unavailability of skilled operators, some technical problems are being noticed such as calibration error, PLC & DCS issues etc. But these minor breakouts may be resolved in a short span of time thereby improving the capability of the instruments.

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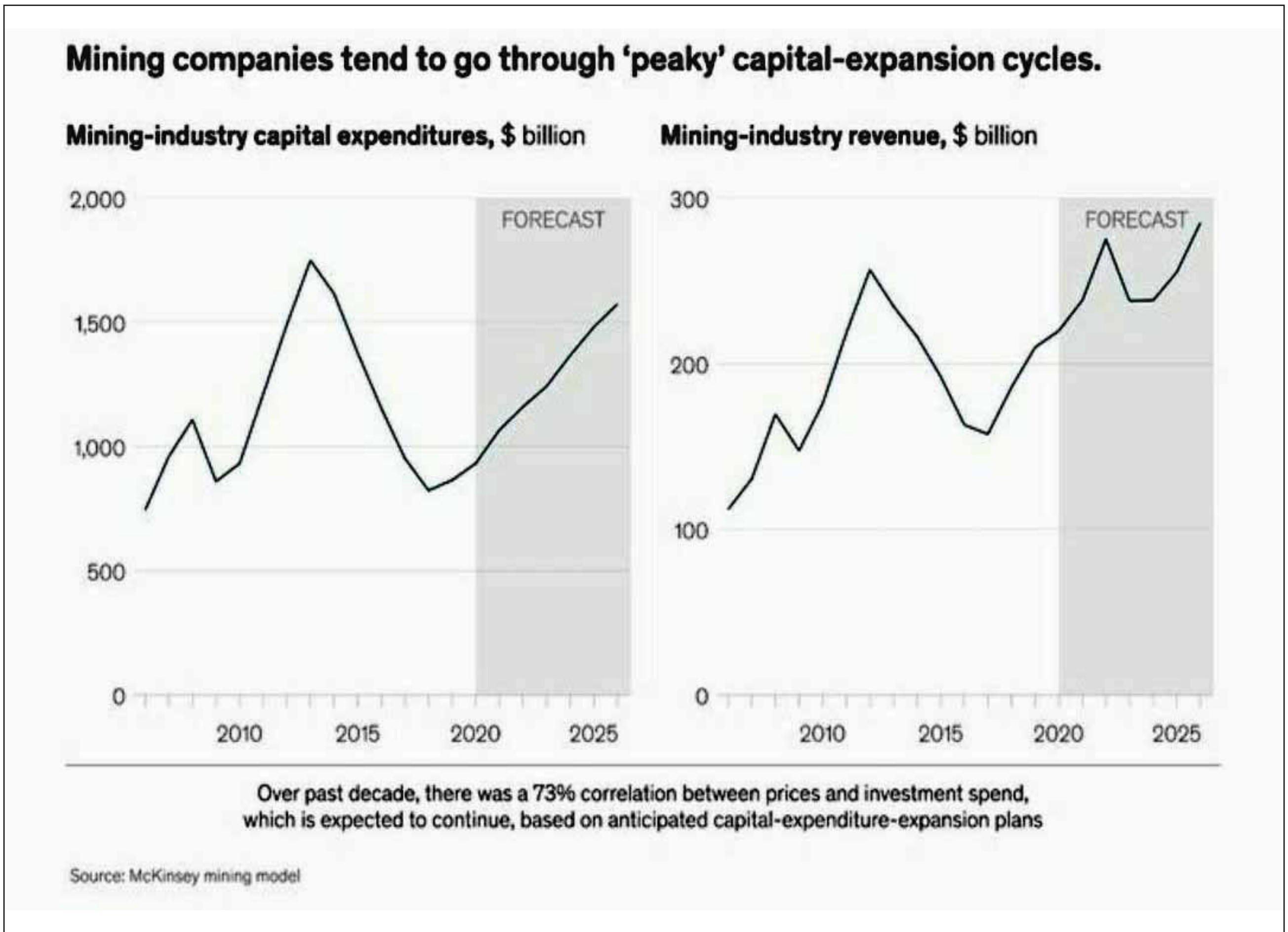


Reimagining Efficiency: An Energy Productivity Storyline

— Padu S. Padmanaban*

If efficiency is all about how energy is used, should we not first question what it is used for? That so, is it time for energy planners and analysts to embrace a new concept that is based on the principle of maximizing the economic value in terms of GDP or corporate revenue that society obtains from energy. In the institutions of economic planning in many countries around the world energy productivity is being increasingly seen as a key driver of sustainable development as a bulwark against climate change. The term energy productivity has come of age as a way of framing energy planning and policy making, most notably in Australia, USA and surprisingly, the Middle East.

There is a fundamental difference in the nature of decoupling between GDP and energy consumption among the major economies of the world. The dynamics as it relates to this pairing is a fascinating interplay between economic growth as defined by a country's GDP and its energy consumption. The indices of sectoral energy consumption and GDP for a selection of developed and developing nations showed some unmistakable patterns. While USA and Germany among the industrialized countries witnessed an absolute decoupling effect (i.e. GDP growing while energy consumption falls), in China and India the decoupling effect has been relative (i.e. GDP rising faster than the increase in energy consumption). This linkage is relative and not absolute as is the case in G 7 countries (i.e. Germany, USA) since in India, gross domestic product (GDP) is rising faster than the increase in energy consumption. This relative decoupling is happening due to two reasons. The first is the efficiency effect. After a period of deterioration between 2003 and 2005, the efficiency effect suggests a constant improvement of energy efficiency in the economy (i.e. from a base of 1.00 in 1990 it declined to almost 0.7 in 2014). The second is the structural effect. From a base of 1.00 in 1990 it has increased to almost 1.20 in 2014, indicating that the economy is slowly beginning to pivot towards the services sector but not as aggressively as one would assume. The case of Gulf countries as exemplified by Saudi Arabia is quite different from both India and G7 countries since decoupling had yet to take place (i.e. energy consumption rising faster than the increase in GDP). In the case of Saudi Arabia and by extension in the Gulf countries, energy productivity was either stable or declining. Ultimately, if this trend was to continue it could result in declining national per capita incomes and possible fiscal deficits as more and more energy resources were diverted to relatively low value domestic consumption rather than be exported. To move beyond the business-as-usual path of declining or plateaued energy productivity, Saudi Arabia and other Gulf countries needed to make targeted investments in infrastructure, technology and innovation that support a structural shift in the economy and energy efficiency.

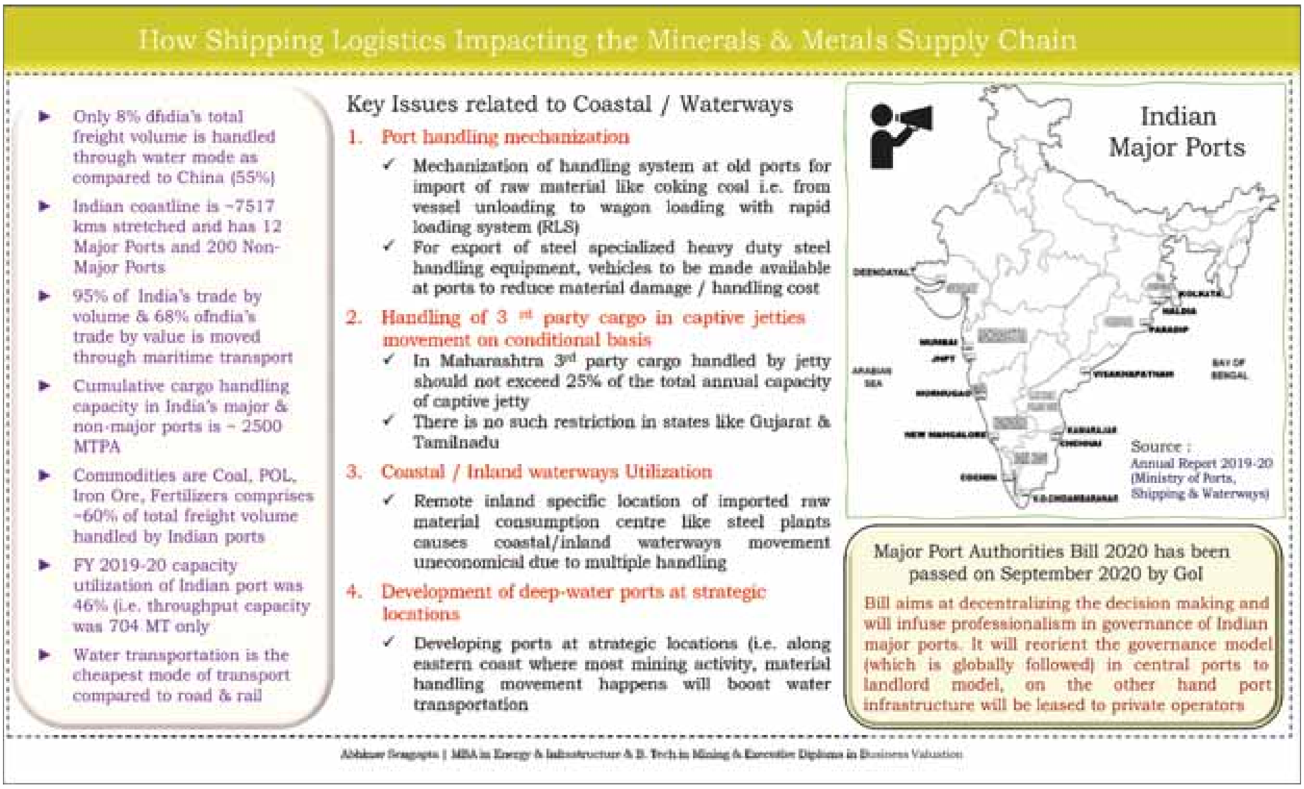
The case of India requires some amplification. In India, energy consumption from value added activities had risen in index terms from a base of 1.00 in 1990 to almost 4.50 in 2014. During this period the size of the economy has also grown from a base of 1.00 to 4.50. This suggest a close linkage between economic growth and energy consumption which is to be expected and is referred to by economists as the "activity effect". This linkage is relative and not absolute as is the case in G 7 countries (i.e. Germany, USA) since in India, gross domestic product (GDP) is rising faster than the increase in energy consumption. This relative decoupling is happening due to two reasons. The first is the efficiency effect. After a period of deterioration between 2003 and 2005, the efficiency effect suggests a constant improvement of energy efficiency in the economy (i.e. from a base of 1.00 in 1990 it declined to

*Former Program Director of the South Asia Regional Initiative for Energy (SARI/E).

almost 0.7 in 2014). The second is the structural effect. From a base of 1.00 in 1990 it has increased to almost 1.20 in 2014, indicating that the economy is slowly beginning to pivot towards the services sector but not as aggressively as one would assume.

Between 1990 and 2015 energy productivity rose in almost all major economies around the world, including India where it grew by 72%. This increase was in part due to India's economic and industrial reforms of 1991 and rising per capita energy consumption from a relatively low base. However, it was also due to the expansion and modernization of energy-intensive heavy industry reflecting higher levels of energy efficiency. Looking at the global shifts in greater detail it can be seen that China had greater success in improving energy productivity (203% versus 72% for India) coming as it were from almost similar per capita energy consumption in the 1980s.

The journey has been long, over 40 years, in India and across countries and continents in pursuit of understanding the demand side of the energy equation. The first stage in the 70s was the stress on 'fuel efficiency' to reduce dependence on petroleum oil imports through technical interventions. This led to a expansion of efforts in the 80s where the term was broadened to ' energy conservation' to also include life style changes and socio-economic approaches. This gave way to the current term, 'energy efficiency' with focus on precise accounting of energy balances of inputs and outputs in appliances, equipments and processes. And finally now at the threshold of a new concept,' energy productivity', that is based on the principle of maximizing the economic value in terms of GDP or corporate revenue that society obtains from energy through modernization and structural diversification. Still in its early phases of adoption, time will tell whether this forward thinking will widely take hold and finally move energy efficiency from the boiler room to the board room as energy efficiency practitioners have long strived for.



A Review of Global Coal Preparation Technology and its relevance for preparing Indian Power Station Fuel (PSF) and Coking Coal

— **David Woodruff***

1.0 Introduction

If we look at the preferred Coal Preparation Technology, used in the major Coal producing regions globally, we can see that whilst there is some similarity in the choices for the different Coal types, there are different flowsheet choices in different regions of the world. If we look at these different choices globally, we can consider, if any, of the process choices are relevant for Indian Coals.

In all instances the choice of process is made by evaluating the raw feed Washability analysis with reference to the quality of products required. Over 85% of the Coal which is processed globally is undertaken using Gravity Separation Techniques, and 100% of the plus 0.5mm size fraction. The Washability data describes the distribution by Specific Gravity of the Raw Coal and quantifies the ash content at each density fraction. By analysing the data at the point at which a theoretical S.G. cut point is required to produce a particular product, the degree of difficulty of separation can be established.

The degree of difficulty is often expressed by reference to the "near gravity material" (NGM). NGM is defined as the % of the raw feed which is +/- 0.1 S.G. of the theoretically required S.G. cut point, to produce a designated product quality in terms of Ash content.

NGM is different for every raw Coal for every desired product. It can range from almost zero % for some Northern Hemisphere Coals, producing PSF, to over 90% in the Southern Hemisphere to produce low ash, Coking Coal quality. India is by far the region with the highest NGM, when producing both PSF and Coking Coals.

2.0 Plant Design Choices in the Major Coal Producing Regions in Order of Industry Size, Excluding India

2.1 *China*

China is the world's largest producer, user and importer of Coal. Almost 50% of global output is mined in China and Coal remains the dominant fuel for Power Generation. Chinese Coals vary in type and washability data. Since China began to open up to the world in the 1980's, Coal technology has been imported from around the world. This includes both conventional Dense Medium processes and Jig technology. However, in recent times, the most commonly used technology for indigenous Chinese Coal processing has been an unconventional Dense Medium Process treating the Coal from up to 100mm top size to 0.150 mm bottom size, often accompanied by Froth Flotation on the finest Fraction.

This technology, which was developed Beijing Guohua Technology Group and the Tangshan Branch of the Coal Science and Technology Research institute of China, utilizes s a Three-Product Cyclonic Dense Medium Vessel, with subsequent re-processing of the 1.0 mm × 0.15 mm fraction in fine coal Dense Medium Cyclones, located within the Medium recovery circuit. Fig. 1 outlines the flowsheet for this process, and Fig. 2 shows the Three-Product Dense Medium vessel.

The Primary Dense Medium stage is a large diameter cylindrical, centrifugal vessel, similar to a LARCODEMS or Dynawhirlpool separator. Raw Coal,

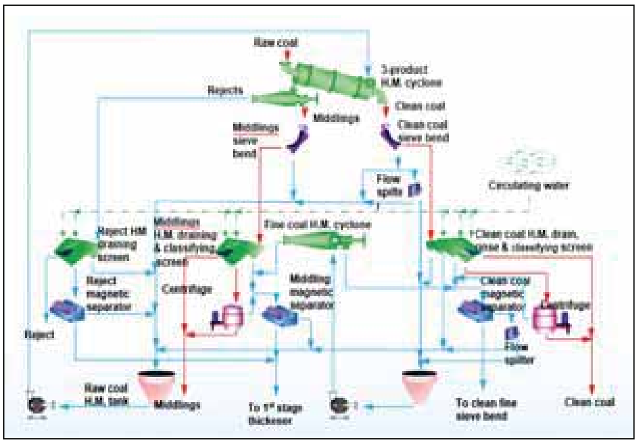


Fig 1 : Process Flowsheet

*Process Consultant FLSmidth (UK) Ltd.

Fig 2: Three-Product Dense Medium Vessel

which is not de-slimed, prior to the unit, is fed at atmospheric pressure into the eye of the vortex, created via a tangential entry of circulating medium from the feed pump. Clean Coal Floats are discharged, via a vortex finder, at the bottom centre of the vessel. Primary Sinks are discharged from a tangential exit at the top of the vessel.

The Primary Sinks are fed directly to a secondary, more classic, Dense Medium Cyclone shaped unit. The secondary separation produces a middlings, higher ash product, and a final discard.

The Clean Coal and middlings products are passed over sieve bends to remove the minus 0.5mm material and pumped to small diameter DMC's for a "re-wash". The +0.5mm Clean Coal, middlings and all the large Discard is drained and rinsed in a conventional manner on vibrating screens. Clean Coal and middlings are also screened and rinsed and then centrifuged. The Clean Coal from the fine coal DMC is collected from the Clean Coal Magnetic Separator Effluent and dewatered.

As this flowsheet has been presented in the Western World, there have been many discussions about the technology at international conferences. The main questions raised by global experts concern the following points:-

i) The Control of the Specific Gravity of the secondary separation;

ii) The top particle size limit, given the secondary DMC unit feed entry diameter;

iii) The Magnetite consumption of the system without any de-sliming prior to the Three-Product Cyclone.

In response to the first question, the Separation density in the secondary Cyclone is controlled, according to the inventors, by adjusting the percentage of non-magnetic slimes in the circulating dense medium. The higher the % of non - magnetics, the lower the secondary separation S.G. and vice - versa.

The top particle size limit of the vessel is the largest particle size which can be accommodated in the DMC section. For a conventional DMC, the limit of feed particle size is 1/3 × the feed entry diameter. For a 1m diameter DMC this is 75mm. If 100mm particles are fed to the primary unit, the possibility of blockage will be significantly increased.

The Magnetite consumption issue has caused the most discussion. In some versions of the system the feed is de-slimed at 1.0mm or 0.5mm. In these cases the Magnetite consumption will be exactly the same as any other Dense Medium System, treating the same size distribution.

For the version where de-sliming does not take place, consumption figures of 0.55kg per TPH of Raw Feed to 2.0kg per TPH have been quoted in 32 working Plants. In the plants which include desliming the figures are quoted as 0.7 = 2.0Kg accross 36 plants. The consumption figures are in all cases effected by the quality of the plant design and operational efficiency (Ref 1).

From conventional wisdom the conclusion can only be that Magnetite consumption (loss) is a function of the particle size of the feed, and the efficiency of the Magnetic Separators, recovering the Magnetite. The finer the feed, the greater the surface area, the greater the loss will be. In addition, the fines products, which are passed through the Magnetic Separators, could significantly increase the contamination in Magnetic Separator Concentrates, causing contamination in the circulating Dense Medium, which in turn can affect separation performance and system recovery.

Whatever the objections of the purists, the system has been installed on over 300 plants in China, and a few installations in the wider world.

The Finest Fraction, which cannot be upgraded by the Fine Coal DMC, is recovered by one or two stages of Froth Flotation Cells and the primary Flotation concentrate and fine Clean Coal, minus 1mm is dewatered using Screen Bowl Centrifuges.

The secondary Flotation Concentrate and Flotation Tailings are thickened and dewatered by recessed plate Filter Presses. The water circuit is then closed requiring no tailings lagoon.

2.2 *USA*

In the USA there have been many different Process Flowsheets used for Coal Preparation in over a century and a half. These Flowsheets have varied from Baum Jigs to Dense Medium Systems, including the world's first practical Dense Medium System, the Chance Cone, introduced exactly one hundred years ago this year.

Most recent modern plants in USA have used Dense Medium Technology for the fraction plus 0.5 or 1.0mm.

In general in the USA, the degree of difficulty is highest for the low S.G. separations required for low ash products, such as Coking Coal. For PSF product, either as the main product, or a middlings product from a Coking Coal plant the product quality is lower, and the desired S.G. cut point is higher, meaning that often the % NGM is lower, but in most cases the Dense Medium Process is still used.

In many US plants the feed is screened at 13mm and the plus 13mm product is processed separately in a Dense Medium Bath. Fig 3 outlines a typical US PSF flowsheet.

In the most commonly used Flowsheet in modern CPP's in the USA, the raw feed is initially screened at between 13mm to 25mm, and the Large Coal up to 200mm top size is processed in a Dense Medium Bath (DMB). The Clean Coal from the DMB can be crushed to the top size limit of the product without any increase in overall product moisture.

The reason that DMB's have been largely retained in USA is that the US Coals tend to be more liberated than Southern Hemisphere Coals, across the full particle size range. The Split Feed flowsheet allows the optimum S.G. cut point for maximum yield to be different in the coarse and small Coal size ranges (Ref 2).

The Raw Coal minus 13mm - 25mm is usually de-

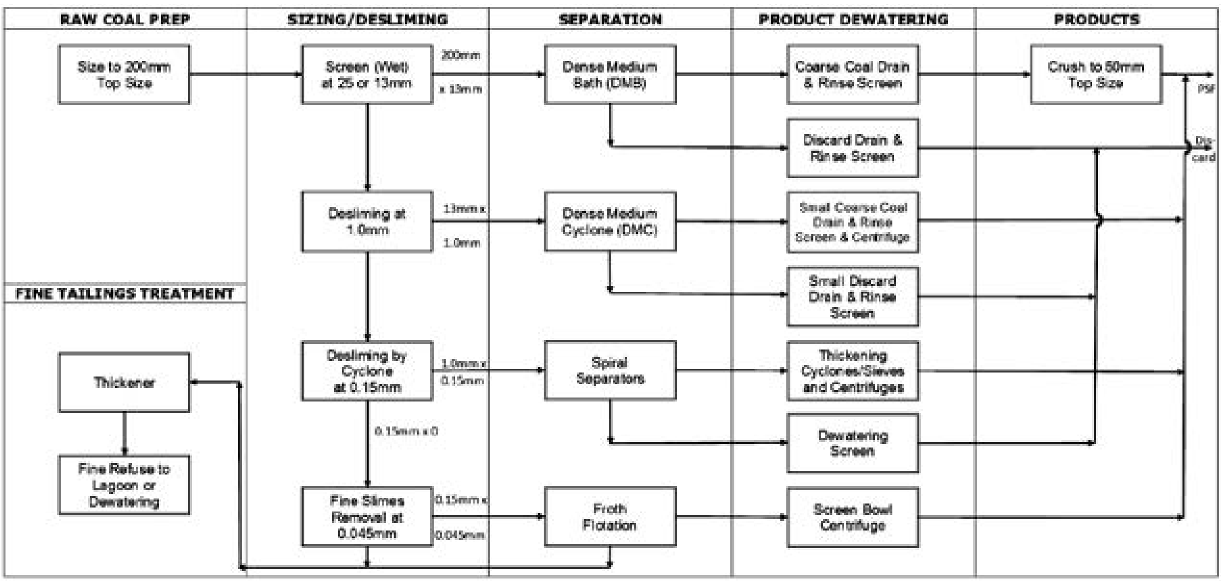


Fig 3 : USA PSF Flowsheet

slimed at 1.0 mm. This fraction is then pumped to Dense Medium Cyclones (DMC's). In recent times modern cyclones with flexible geometry, larger diameters and vastly improved lining systems have replaced the original DSM Cyclones installed since the 1950's. By retaining the Dense Medium Baths in the Flowsheet, the DMC's are working on a narrower size distribution than in a total DMC plant and therefore have the highest separation efficiency.

The intermediate sized raw Coal 1.0mm × 0.15mm is generally processed in Spiral Separators for PSF production. Spiral Separators usually operate at an S.G. of 1.7 to 1.8, which is acceptable for PSF production. For Coking Coals, the Reflux Classifier is being introduced due to its ability to cut at a lower S.G. of separation of ~1.5. This allows the Clean Coal in this size range to be more readily accepted into the low ash Coking Coal Product, thereby maximising overall Coking Coal yield.

For the very finest Fraction minus 0.15mm Column Flotation is commonly used. Research has shown that if the minus 45microns is removed prior to Flotation and discarded, the Flotation product can be of very high quality and low ash. Removal of the superfine, high ash, fraction also significantly improves the product moisture, achieved using Screen Bowl Centrifuges.

Fine Refuse is Thickened and now more commonly dewatered in Recessed Plate Filter Presses, rather than being pumped to Lagoons.

2.3 *Australia*

In Australia in recent years there have been many large plants constructed to facilitate the PSF and Coking Coal Export Markets. Whilst there are still some examples of the split DMB/DMC Plants almost exclusively, in recent years plant flowsheets have followed a similar trend (Fig 4).

The Raw Coal is reduced in several Crushing stages to ~50mm top size. Mineral Sizers and intermediate Screens are used to minimise fines production. The reason for the size reduction is better liberation of Coal and simplicity of plant design.

The Flowsheet has been greatly simplified by the development of large diameter DMC's. Units up to 1.5M diameter are now available with Capacities in excess of 750TPH each (Fig 5). The increase in size of the DMC's has also removed one of the major issues previously experienced with the original smaller diameter/capacity DSM Cyclones. In a multiple Cyclone Circuit the inefficiency of the Multiple DMC distributors was affecting the efficiency of the plant. This meant that a system with several smaller DMC's could be separating at several different S.G. cut points, and different feed loadings, causing significant inefficiency.

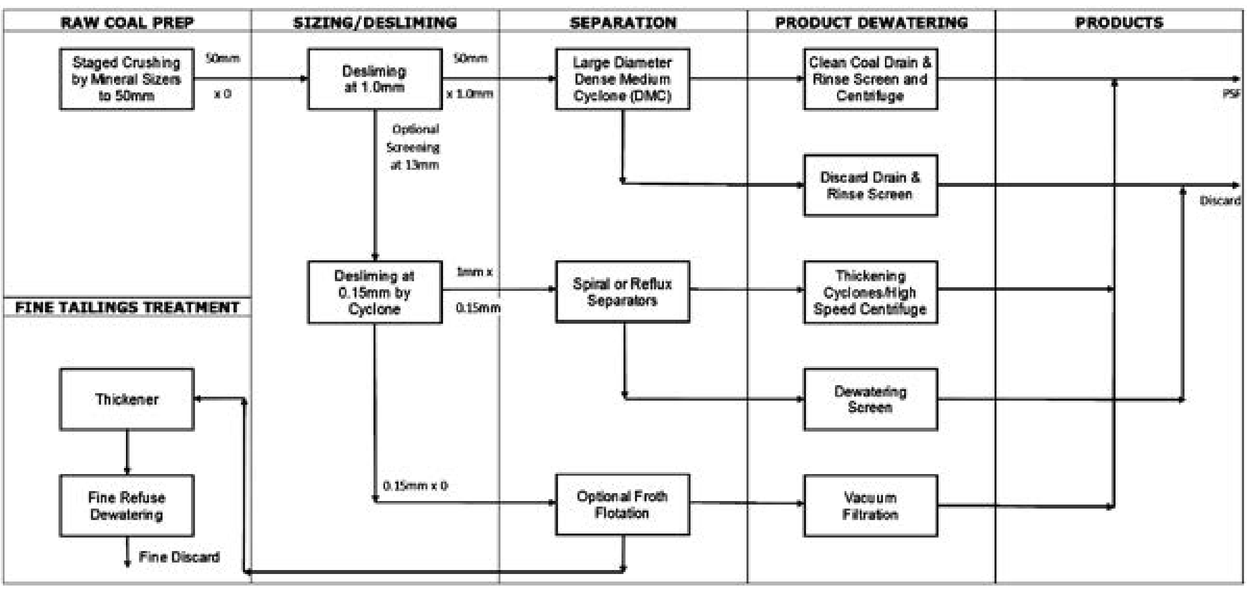


Fig 4 : Australian PSF Flowsheet

Fig 5 : Large Diameter Modern DMC

The introduction of single parallel streams of one DMC feed pump to one Large Diameter DMC alleviated this problem. The increase in unit size of all other items in the Dense Medium Circuit, such as Pumps, Vibrating Screens, Vibrating Basket Centrifuges and Magnetic Separators, has meant that single unit plant streams of 500TPH or more, can be installed and extremely high plant capacities achieved from a minimum number of streams.

The Coals in Australia, particularly in New South Wales, are often difficult to treat with Froth Flotation, consequently the flowsheets usually include separate Gravity separation circuits for the 1.0mm × 0.15mm Fraction. These circuits use Spiral Separators and Reflux Classifiers to treat this fraction of the feed. It was the Development of the Spiral Separators in Australia in the 1970's which first allowed some fines treatment where Froth Flotation was impossible. The spin off from the introduction of Spirals was to increase the bottom size of the DMC to 1.0mm from 0.5mm. In doing this the De-sliming operation was simplified and Magnetite consumption was reduced, compared with treating the 0.5mm bottom size. In recent times the Reflux Classifier was also developed in Australia, and this device has replaced Spirals in some Coking Coal plants due to the ability to separate at a lower Specific Gravity, thereby maximising Coking Coal yield. Clean Coal in this size range is thickened in Cyclones and dewatered using combinations of High-Speed Vibrating Screens and Screen/Scroll Centrifuges.

For Plants where Flotation is possible on the 0.15mm × 0 fraction there are many different types of Cell designs used, from Conventional Mechanical Cells to Column types and the Jameson Cell technology, which was also developed in Australia. The Clean Coal from this fraction is dewatered on Vacuum Filters of all types including Horizontal Belt Vacuum Filters and High-Speed large diameter Disc Filters.

With the restriction on the use of Tailings ponds, most plants now include Tailings dewatering systems using fully automatic Recessed Plate Filter Presses, Belt Filter Presses or Solid Bowl Centrifuges.

2.4 *South Africa*

In South Africa the choice of flowsheet for Coal plus 1.0mm is exclusively Dense Medium technology, due to high percentages of NGM. In the 1970's these plants used combinations of Dense Medium Baths or WEMCO Drum Separators, coupled with smaller diameter DMC's. Most systems produced a high-grade low ash Clean Coal product for export and a middlings domestic PSF product, thus requiring a two-stage separation process at lower and higher S.G.'s. Fine Coal treatment was originally almost non-existent because of the lack of susceptibility to Flotation of most South African Coals.

In recent times the Flowsheets have followed a similar route to that used in Australia, with large Diameter DMC's working on pre-crushed feed at 50mm top size and 1.0mm bottom size. In some cases the 50mm × 1.0mm material has been split at 13mm and treated in two separate DMC streams, to optimise cut point, efficiency and thereby optimise Export Quality yield. The combined primary sinks being re-treated for PSF production in a second DMC stage (Fig 6).

Other points of interest in South Africa are the plants in the Waterburg region, where a unique Dense Medium

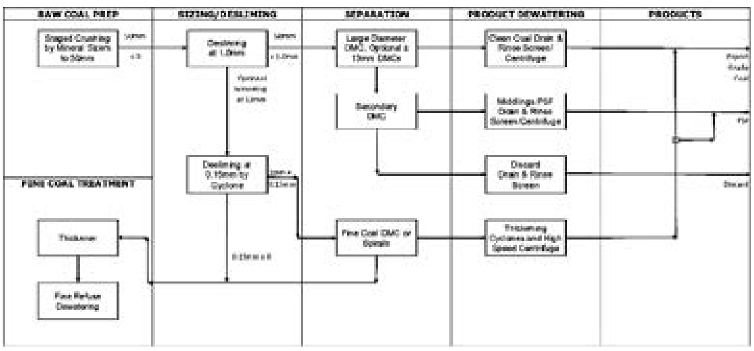


Fig 6 : Typical South African Flowsheet with Options circuit is employed which uses a LARCODEMS as a de-stoning pre stage at 1.8-1.9 S.G. to remove barren rock. The LARCODEMS is a large diameter cylindrical centrifugal vessel, which was developed by the UK National Coal Board in the 1980's. To maintain the High Circulating medium S.G. a densifying circuit is added into the medium circuit. The LARCODEMS Floats product is then crushed to 50mm and treated in two stages of conventional DMC's to produce a high-grade Export Coal, and a middlings for PSF.

There is also one installation using the Chinese Three-Product Cyclone system, but this system includes de-sliming at 1.0mm ahead of the circuit.

For Fines Treatment, flotation has always been difficult on South African Coals, there are some installations of Column Flotation, but in general Spirals are often used on the 1mm × 0.15mm fraction to produce PSF grades.

There are also now Fine Coal Dense Medium systems being built to produce export grade quality Coal. The minus 1mm feed is de-slimed at 0.15mm and the Fine Coal DMC's operate at a lower S.G. than spirals to produce a high grade product. Although Fine Coal Dense Medium Systems have been occasionally used since the 1950's, it is only in South Africa where these systems have been successfully employed and economically viable.

In common with most modern Coal Preparation Plants the Tailings minus 0.15mm are Thickened and Dewatered on Automatic Recessed Plate Filter Presses, or Belt Filter Presses, to close the water circuit. This is particularly the case in the Waterburg region, which is very arid.

2.5 ***Russia***

In the Russian Federation the vast majority of Coal Production is in the remote Siberian region. In recent times the import of Western Technology has become possible and plants generally follow a format similar to USA. The difference is the special measures required for operating at temperatures as low as -50 degrees Centigrade..

To allow plants to continue to operate in the harsh winter temperatures, the plants are built inside heated buildings with even the Tailings Thickeners inside the heated building envelope Fig 7, showing the Plant Thickener within the building envelope. Water

Fig 7 : Russian Plant

Circuits are always closed with Flotation Tailings dewatered by Belt Filter Presses, and Fine Coal products from Flotation are dewatered using Hyperbaric Filters, or Recessed Plate Filter presses to meet very stringent moisture limits. If the Clean Coal products are too high in moisture the unloading of rail trucks in the sub-zero temperatures can be very problematical.

In such a vast region there are many variations in raw Coal Washability. Large and Small Coal are usually processed using a combination of DMB's and DMC's. Three-product separation is often required to produce high grade and PSF grade products for both domestic and export markets. The DMB is often a local Russian type the most common being the vertical wheel SKV, but the DMC's are usually imported modern versions.

There are Spirals used on the intermediate size of 1mm × 0.15mm, but there are also many plants which successfully process down to 0.5mm in DMC's and use Mechanical flotation on the 0.5mm × 0 fraction.

2.6 ***Indonesia***

In Indonesia there is very little Coal processing required due to the very thick Coal seams and inherent very low Ash content. Some small modular DMC plants have been built to process the top and bottom of the Coal seams, but in comparison to the total tonnages being mined the capacity of these plants is very small.

2.7 ***Eastern Europe***

In Eastern Europe the countries that were once part of the Soviet Union usually follow the technology used in Russia. The exception is Poland, which has almost exclusively stayed with Jig Technology, although there is now interest in comparing the Jig process with DMC's.

3.0 Options for India

India already has many Coal Preparation Plants for both PSF and Coking Coal processing. However, only 25% of the indigenously produced PSF Coal is currently being processed. In order to generate power and produce steel, the primary building blocks of a developing economy, a significant increase in Coal output and CPP capacity is required.

Indian Raw Coal quality is probably the poorest in the world and presents the most difficult separation problems when producing both Coking Coal and PSF. It is clear this is a unique problem and no flowsheet, currently used elsewhere in the world, exactly matches India's requirements.

It would seem that for Coking Coal the best process in India will be to continue to crush the Raw Coal to liberate coking properties(as fine as 13mm), and use Two-Stage DMC's coupled with intermediate water based gravity processes treating the 0.5mm × 0.25mm fraction and Froth Flotation of fines.

For PSF an adapted system, somewhat similar to that employed in the Waterburg region of RSA, maybe of interest. This would have a Primary de-stoning stage, using a Dense Medium Drum, which can take up to 200mm top size × 13mm bottom size, treating Coal at a high S.G. to remove stone, followed by controlled crushing of the primary floats to minus 50mm, to minimise fines and then a single stage of DMC's could offer one solution. Using this flowsheet Fine untreated Coal could possibly be blended into the product after dewatering.

The application of Dry processing in arid regions, where ROM Coal moisture is very low, to effect a primary destoning stage could also be worthy of further investigation.

References:

1) Comparison of Heavy Medium consumptions between raw coal desliming and non - desliming processes. ICPC 2019 New Delhi Author : Shuyan Zhao Beijing Guohua Technology Group.

2) The Coal Handbook Woodhead Publishing 2012 Chapter 14 Author : Dr Peter Bethel.

Renewables : A Shift to RE Hybrid Tenders

Why the shift towards hybrid tenders is being conceived?

1. *Power supply from Solar & Wind are intermittent in nature because both the sources are not available at all the time – As sunlight is available only on daytime with varying intensity while wind velocity keeps changing*
2. *Renewable energy developers were right away supplying electricity to the grid and have not invested in any energy storage system thus the electricity supply remains intermittent*
3. *Discoms reluctant to buy power from standalone wind and solar projects due to intermittent supply. Continuous electricity supply requires energy storage (batteries) which will ultimately increase the RE tariffs*
4. *Power requirement round the clock for all the projects will be constraint on account of dynamic load pattern (i.e. variation between supply and consumption) along with various RE generators who have various constraints and a grid operator balancing all the supply*
5. *For standalone wind projects developers there is a waning interest due to limited availability high velocity wind sites, challenges in land acquisition and poor power evacuation infrastructure (i.e. transmission connectivity)*
6. *For standalone solar projects availability of large barren land along with good solar iridescence is a challenge. Also the land allotted will be blocked for project life (i.e. 25 years) with no other provision for alternate usage*
7. *It is far easier to set up a solar project in an area conducive for wind projects too*

In the hybrid option, the system is designed using solar panels and small wind turbines generators for generating electricity , however, these two energy sources complement each other, which could help overcome the problems of variability of generation and grid security, and thereby discoms' reluctance

Co-located hybrid Solar-Wind projects are expected to be more competitive as they are supported by higher plant load factor expectation and reduction in project cost as against standalone systems due to sharing of common infrastructure such as land and evacuation network

Challenges to be overcome for success of RE Hybrid Tenders

- ✓ Co-existing land availability of both good wind and solar resource sites that will qualifying for wind-solar hybrid plants in true sense
- ✓ The co-location clause (necessitating the wind and solar components to be located at the same place) needs to be removed in order to bring in more competitive tariffs
- ✓ Availability of adequate transmission infrastructure
- ✓ Addressing technical issues like grid balancing is required

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Commercial Coal Auctions Results Analysis

— Abhinav Sengupta*

On 18th of June 2020 Govt. of India had announced first ever commercial coal mining auctioning process. In total 38 coal blocks were put under the hammer covering 5 different states Madhya Pradesh, Jharkhand, Maharashtra, Odisha and Chhattisgarh. After 145 daysfrom its announcement date, on 09th November 2020, Ministry of Coal (MoC) has successfully completed India's 1st ever commercial coal block auctions. Following are the major highlights of the entire commercial coal auction process

Before e-Auction (During Bid Submission Stage):

i. In total 38 No. of coal blocks were put up on commercial coal auctions spanning around 5 states Madhya Pradesh, Chhattisgarh, Odisha, Maharashtra & Jharkhand.

ii. Overall, 278 tenders were purchased amongst all the coal blocks offered.

iii. Finally, 42 companies participated in the commercial coal block auctions and 76 no. of bids submitted in total.

iv. Only 22 blocks out of 38 has witnessed participation i.e. (~60% success factor) with average no. of bids in participated coal blocks is ~3.30 (approximately).

v. Chhattisgarh has seen the tepid response with only 2 blocks out of 7 got bids while Maharashtra's 2 blocks got 100% response

vi. Only 50% of partially explored coal blocks has got responses.

vii. Approx. 71% of bidders has shown interest towards OC blocks while 21% has shown towards UG blocks and remaining 8% towards OC & UG Blocks.

After e-Auction:

a) In total 42 bidders had participated in the 2nd round of e-auctions for the 13 OC coal blocks & 6 UG coal blocks.

b) Out of 19 coal blocks 16 coal blocks are non-coking (i.e. grade ranging from G7, G8, G10, G11, G12 & G13)

c) There are 3 number of coking coal blocks (i.e. Steel grade – I (one coal block) & Washery grade – III (two coal blocks each)

d) In total 17 coal blocks are fully explored while 2 coal blocks are partially explored

e) 17 companies have won coal blocks out of 42 participated in India's 1st Commercial coal block auctions

f) 11 coal blocks out of 19 (~58%) were having mine capacity less than 1.50 MTPA (with 0.15 MTPA lowest & 10 MTPA is the highest)

g) Aggressive bidding has been witnessed for 8 coal blocks i.e. Marki Mangli II, Radhikapur West, Brahmadia, Sahapur West, Sahapur East, Gare Pelma IV/7 and Goitoria (East & West)

h) The lowest FPO (%) discovered for a block was 9.50% (i.e. Urtan North) and highest FPO (%) was 66.75% (i.e. Gare Pelma IV/7)

i) The bidding pattern showed the high FPO (%) for the coal blocks with lower mine capacity & higher coal quality

j) Amongst 14 winning bidders out of 42 participated are Mining players, MDOs, Coal traders, State PSUs and Power Players

k) Govt is going to get more than ~2000 crore of annual revenue sharing through the auctions apart from Royalty, DMF & NMET

Winning Bid = *f*(Mine Capacity, Coal Grade, End User Utilisation, Market for Sale, Stripping Ratio, Strategic Advantage)

(Strategic Advantage includes lower transportation cost to nearest EUP, prior allottee, owning adjacent mine, life of mine etc.)

*PwC India.

Commercial Coal Block Auctions Results at a Glance

S. No.	Coal Blocks	State	Exploration Status	Capacity (mtpa)	S.R (cum/t)	Grade	Mine Type	Bidders	TQB	IPO	FPO	No. of Quotes	Winner
1	Chakla	Jharkhand	Fully	5.30	4.46	G11	OC	3	3	14.00%	14.25%	1	Hindalco
2	Radhikapur (West)	Odisha	Fully	6.00	4.19	G13	OC	4	4	15.75%	21.00%	21	Vedanta
3	Takli-Jena	Maharashtra	Fully	1.50	NA	G8	UG	2	2	30.25%	30.75%	2	Aurobindo Infra
4	Urtan	Madhya Pradesh	Fully	0.65	NA	W-III	UG	2	2	10.25%	10.50%	1	JMS Mining
5	Marki Mangli II	Maharashtra	Fully	0.30	7.40	G8	OC	3	3	13.50%	30.75%	69	Yazdani Int.
6	Bandha	Madhya Pradesh	Partially	5.00	NA	G7	UG	3	3	20.75%	21.00%	1	Essel Mining
7	Brahmadiha	Jharkhand	Fully	0.15	10.43	S-I	OC	6	6	34.75%	41.75%	28	APMDC
8	Dhirauli	Madhya Pradesh	Fully	3.00	NA	G8	OC	2	2	12.00%	12.50%	2	Stratatech Mineral
9	Sahapur (West)	Madhya Pradesh	Fully	0.60	NA	G7	UG	4	4	12.50%	26.00%	54	Sarda Energy
10	Gare Palma IV/1	Chattisgarh	Fully	6.00	3.40	G12	OC	3	3	24.00%	25.00%	4	Jindal Power
11& 12	Gotitoria (E&W)	Madhya Pradesh	Fully	0.30	8.00	G8	OC	8	8	21.75%	54.00%	129	Boulder Stone Mart
13	Urtan North	Madhya Pradesh	Fully	0.60	NA	W-III	UG	3	3	9.00%	9.50%	1	JMS Mining
14	Rajhara North	Jharkhand	Fully	0.75	2.56	G8	OC	4	4	22.00%	23.00%	4	Fairmine Carbon Pvt
15	Sahapur (East)	Madhya Pradesh	Fully	0.70	NA	G8	UG	4	4	26.00%	41.00%	60	Chowgule & Co.
16	Radhikapur (East)	Odisha	Fully	5.00	3.61	G13	OC	4	4	16.50%	16.75%	1	Essel Mining
17	Urma Paharitola	Jharkhand	Partially	10.00	NA	G10	OC	6	6	26.25%	26.50%	1	Aurobindo Infra
18	Gondulpara	Jharkhand	Fully	4.00	1.77	G10	OC	4	4	20.25%	20.75%	2	Adani Enterprise
19	Gare Palma IV/7	Chattisgarh	Fully	1.20	3.36	G11	OC	8	8	44.00%	66.75%	91	Sarda Energy

Source : *MSTC E-Commerce*

Detailed analysis given in following pages...

Annex - I

Commercial Coal Block Auction – Result Analysis

- ✓ Ministry of Coal has successfully completed e-auction process of 19 commercial coal blocks held between 2nd to 9th November 2020
- ✓ In total 5 states with 19 coal blocks i.e. Madhya Pradesh (8), Jharkhand (5), Chhattisgarh (2), Odisha (2) & Maharashtra (2) were put up for forward e-auctioning offering ~ 51 MTPA of coal
- ✓ In total 42 bidders had participated in the 2nd round of e-auctions for the 13 OC coal blocks & 6 UG coal blocks
- ✓ Out of 19 coal blocks 16 coal blocks are non-coking (i.e. grade ranging from G7, G8, G10, G11, G12 & G13)
- ✓ There are 3 number of coking coal blocks (i.e. Steel grade – I (one coal block) & Washery grade – III (two coal blocks each)
- ✓ In total 17 coal blocks are fully explored while 2 coal blocks are partially explored
- ✓ 17 companies have won coal blocks out of 42 participated in India's 1st Commercial coal block auctions
- ✓ 11 coal blocks out of 19 (~58%) were having mine capacity less than 1.50 MTPA (with 0.15 MTPA lowest & 10 MTPA is the highest)
- ✓ Aggressive bidding has been witnessed for 8 coal blocks (i.e Marki Mangli II, Radhikapur West, Brahmadia, Sahapur West, Sahapur East, Gare Pelma IV/7 and Goitoria (East & West)
- ✓ The lowest FPO (%) discovered for a block was 9.50% (i.e. Urtan North) and highest FPO (%) was 66.75% (i.e. Gare Pelma IV/7)
- ✓ The bidding pattern showed the high FPO (%) for the coal blocks with lower mine capacity & higher coal quality
- ✓ Amongst 14 winning bidders out of 42 participated are Mining players, MDOs, Coal traders, State PSUs and Power Players
- ✓ Govt is going to get more than ~2000 crore of annual revenue sharing through the auctions apart from Royalty, DMF & NMET

Winning Bid = *f(Mine Capacity, Coal Grade, End User Utilisation, Market for Sale, Stripping Ratio, Strategic Advantage)*
Strategic Advantage includes lower transportation cost to nearest EUP, prior allottee, owning adjacent mine, life of mine etc.)

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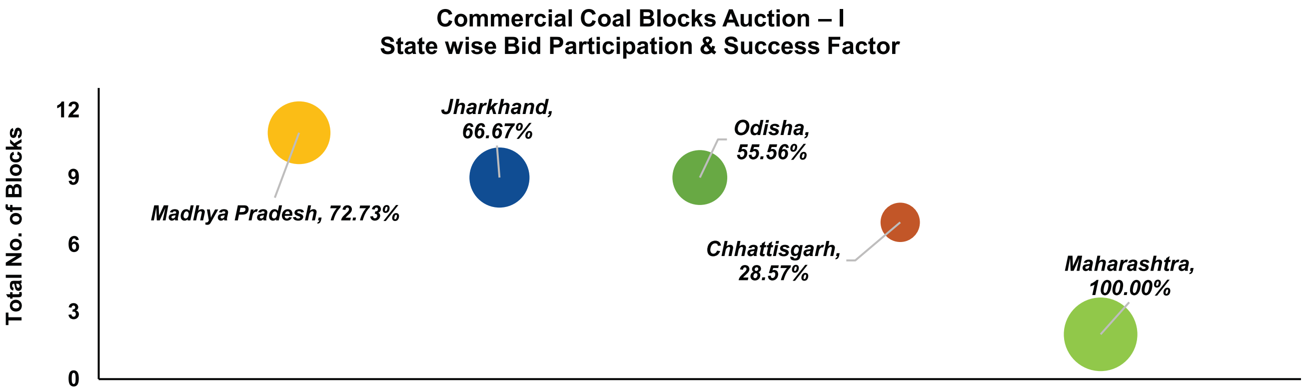
Annex - II

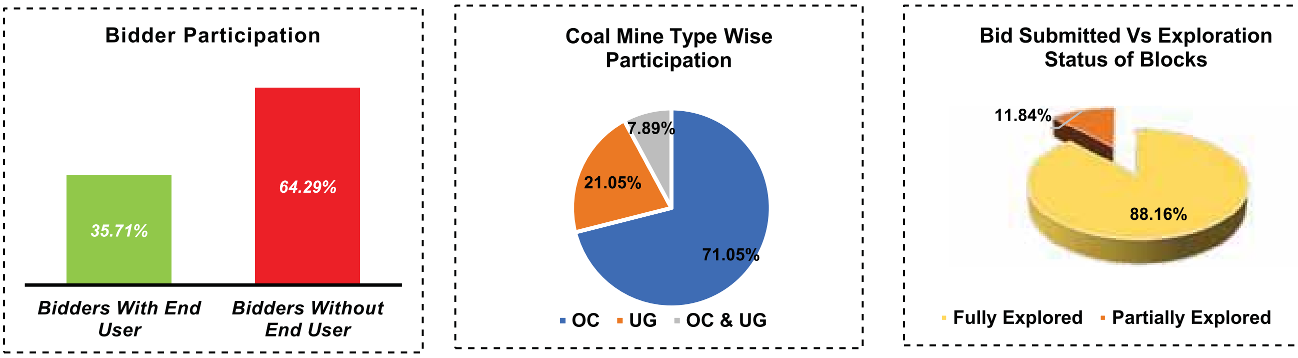
Impact of Commercial Coal Auctions

S. No.	Bidder Type	Impact
1	Mine Owner / MDO Player	• Higher FPO (%) will lower the operating margins for the coal mines. Thereby coal blocks with higher stripping ratio & poor grade will not be sustainable for future mining.
		• For Underground coal blocks high revenue sharing % and lower mine capacity will bring down the overall viability of the coal project and might become difficult to operationalize.
		• On the other hand, commercially, mined coal needs to be competitive to coal mined by CIL/ SCCL.
2	Coal Trader	• Coal traders participating in the coal blocks are bringing in the strong market for sales of coal and its utilization. High FPO (%) will lower the EBIDTA for coal traders.
3	End User	• Usage of coal is mostly as a feedstock for source of fuel or as a reducing agent. End users have secured the coal blocks for raw material security with specified end user requirement.
		• For power producers with high FPO (%) will increase the energy charge and hence the overall power tariff. The higher power tariff will be pass on to the consumer.
		• For steel producers higher FPO (%) will increase the input cost for steel making and thus the cost of semi-finished and finished steel.
		• For Aluminium players power cost consists of 30% to 40% for Aluminium refining. Higher FPO (%) will increase the raw material cost for Aluminium refining and thereby the cost of finished Aluminium.

Annex - III

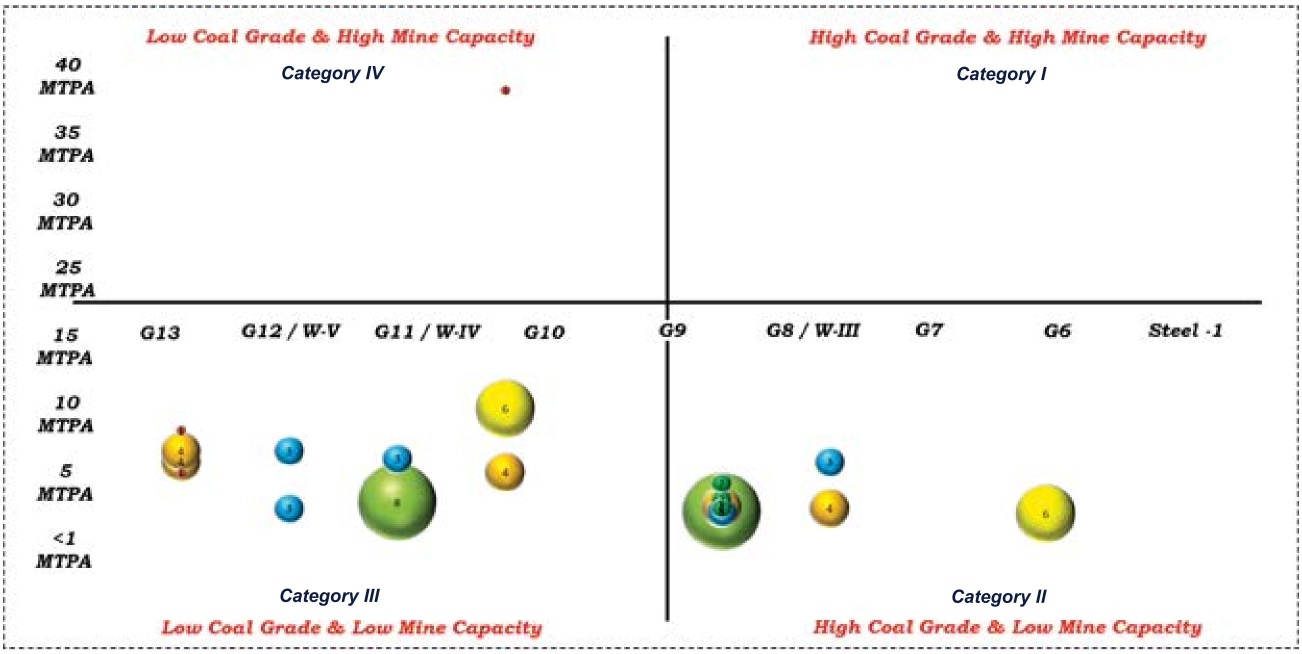


Commercial Coal Block Auction Success – State Wise Comparison Chart

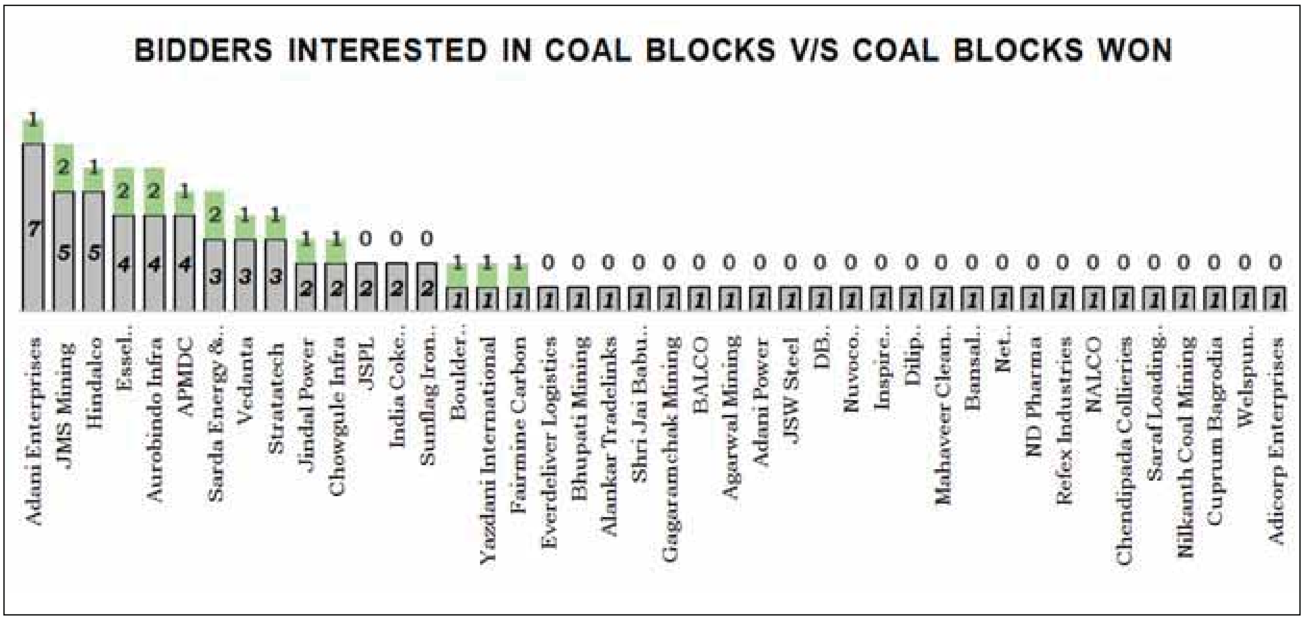


Bidders Participation w.r.t End User / Mine Type / Exploration Status of Coal Blocks

Commercial Coal Block Bidding Matrix & Its Analysis



Annex - IV



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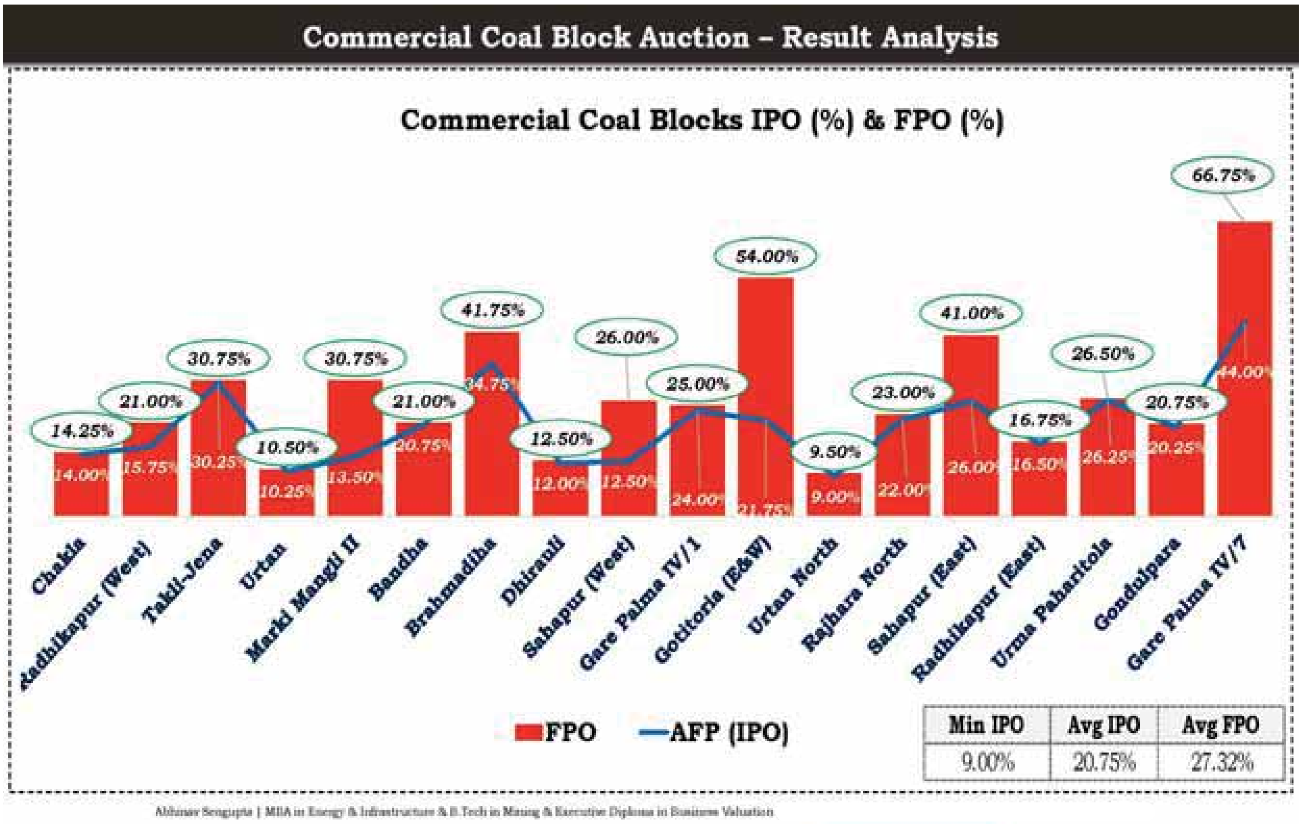

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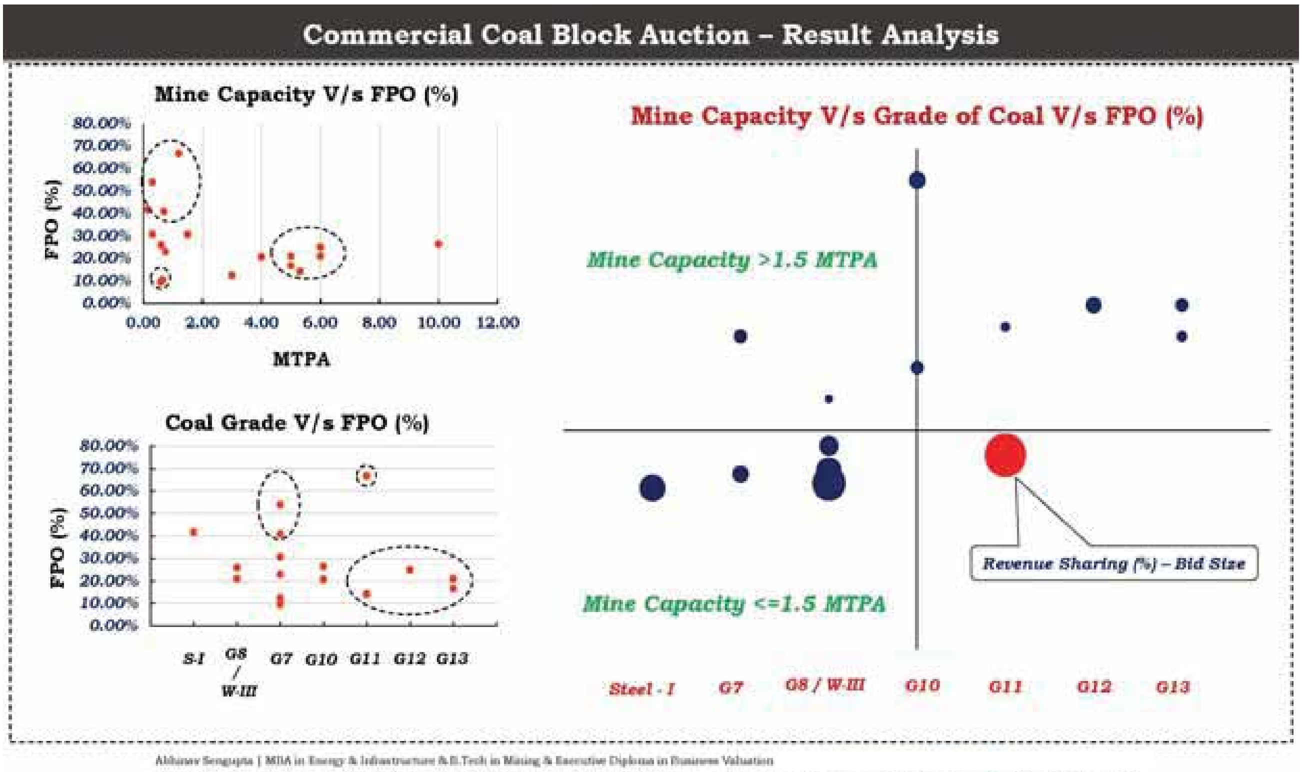
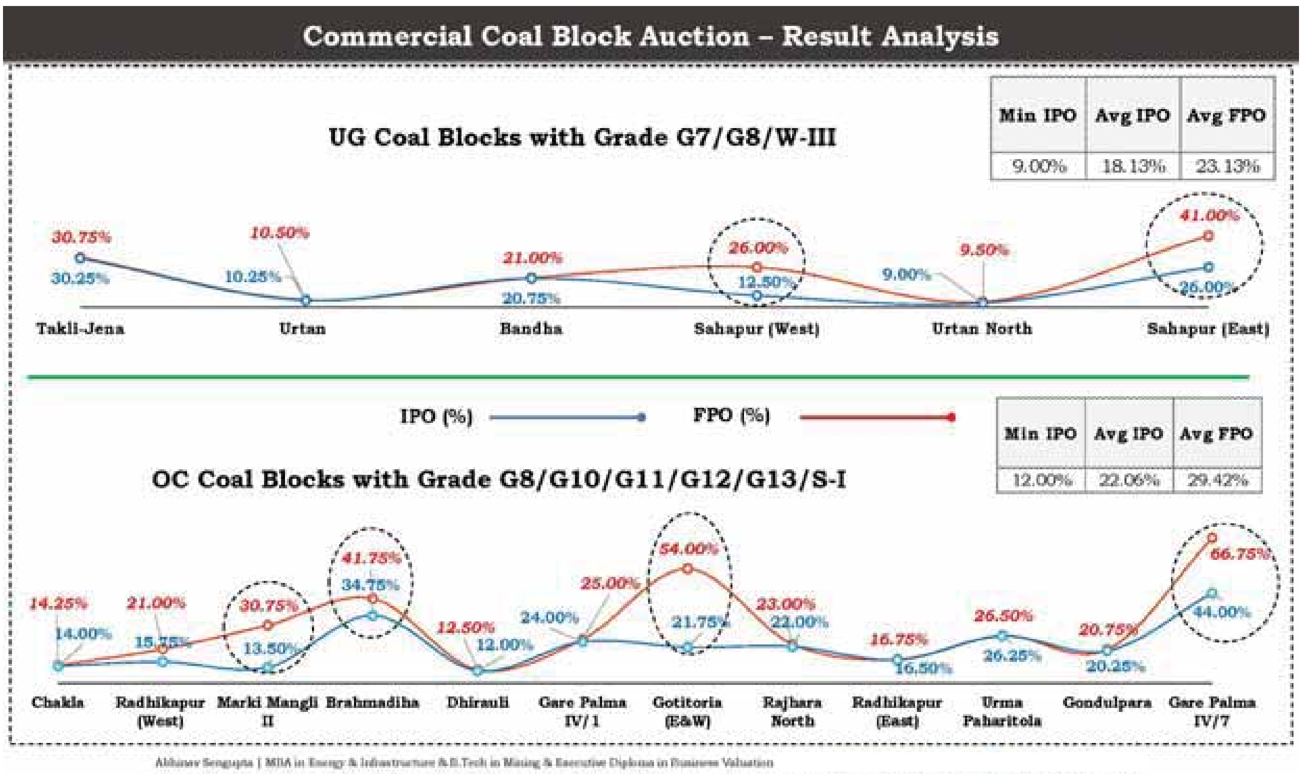


Annex - VII



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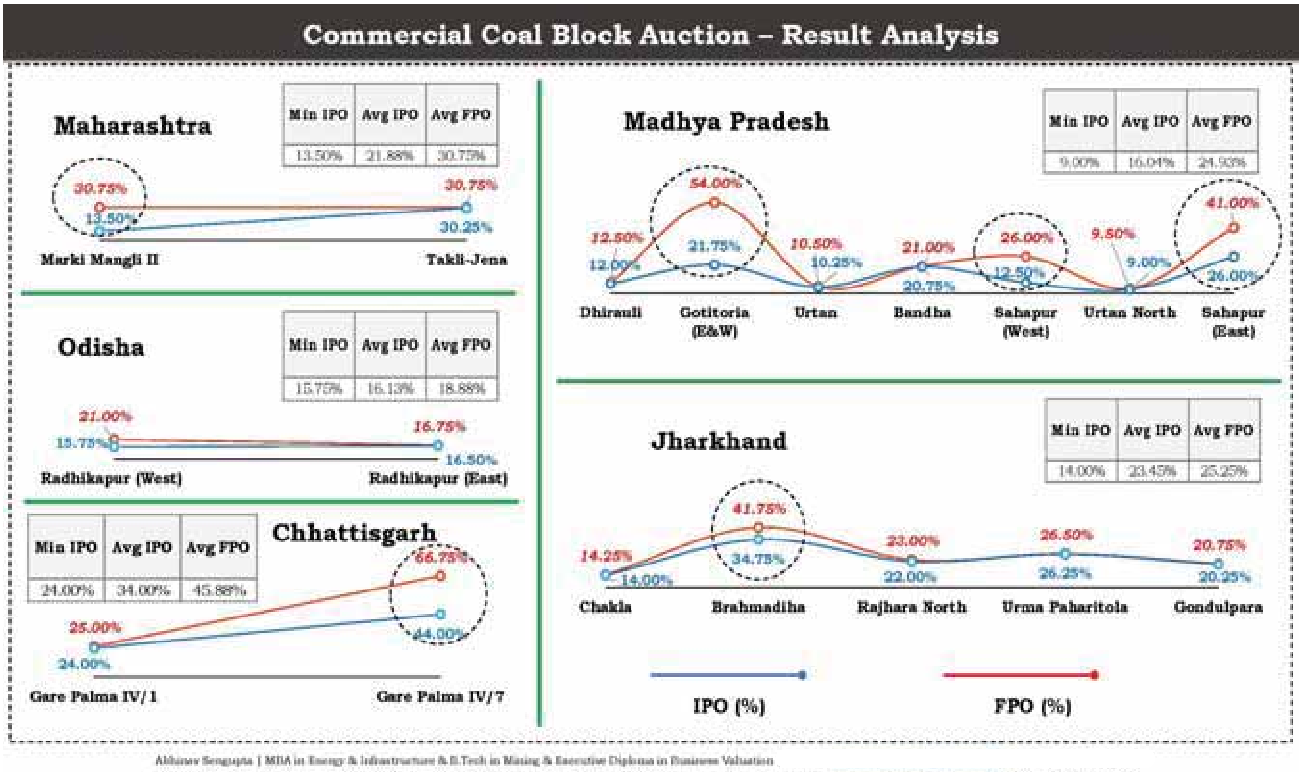
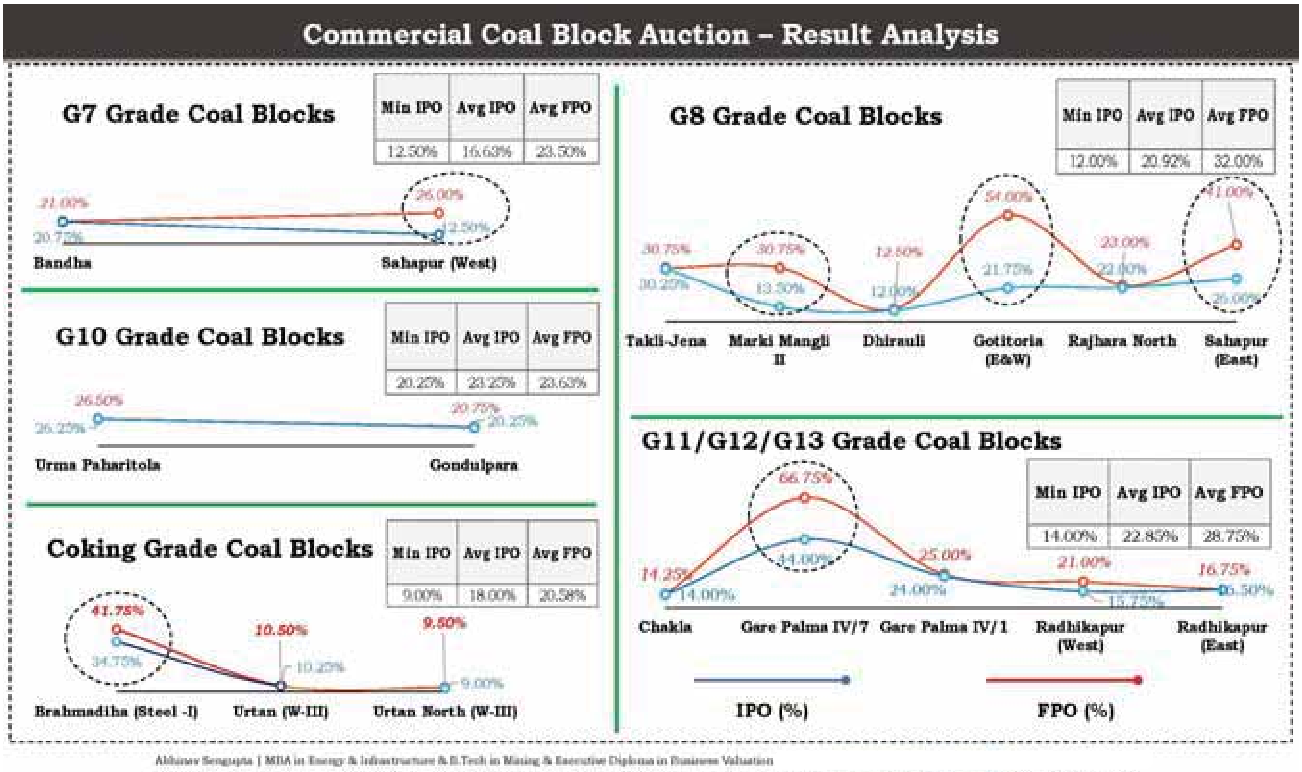


Annex - IX



Conclusions

The Commercial Coal Block Bidding Matrix is categorical representation of coal blocks offered for under three axis i.e. mine production capacity (Y axis) & notified grade of the coal blocks (X axis) and number of bidders participated (Z axis i.e. width of the bubble). The matrix gives the clear-cut picture of the market trend where the maximum interest is lying and thus the competition. The following observations are there:

1. **Category I :** High Coal Grade & High Production Capacity:
   a. No coal blocks were offered under this category
2. **Category II :** High Coal Grade & Low Production Capacity:
   a. 15 Coal blocks were offered under this category
   b. 11 Coal blocks out of 15 have received participation
   c. 50% of coal blocks are below (<1 MTPA Capacity) & total 6 UG blocks were offered
   d. Banda in Madhya Pradesh is the only partially explored coal block and received 3 bids
   e. Total 38 bids out if 76 (i.e. 50% of bidding) happened under this category
3. **Category III :** Low Coal Grade & High Production Capacity:
   a. 18 Coal blocks were offered under this category
   b. Only 44% of blocks witnessed successfully bidding i.e. 8 out of 18 (exclusive of 2 blocks which received 1 bid each)
   c. Only 37 bids out of 76 fallen under category (48%)
   d. Urma Paharitola is the only partially explored block received 6 bids (out of 3 partially explored blocks offered under this category)
4. **Category IV :** Low Coal Grade & High Production Capacity:
   a. Only 5 Coal blocks falls under this category.
   b. Only 2 Coal blocks i.e. jointly as 1 coal block (Chendipada & Chendipada II) has received only 1 bid and gets cancelled ultimately
   c. All the Coal blocks were fully explored and auction success % remains 0% (zero) under this category
5. **Summarization**
   a. 98% of the bidding happened in coal blocks with lower capacity i.e. < = 10 MTPA
   b. 50% of the bidders had preferred low mine capacity block with relatively higher grade
   c. 48% of the bidders had preferred low mine capacity block with lower grade
   d. 45% of bidders has preferred mine with less than or equal to 1 MTPA capacity.

No. of Bidders with Coal Blocks Participations.

Disclaimer : The views expressed by the author are personal and data taken are from the open sources.
Source : MSTC e-acuctions.

Statistical Analysis of Coal Quality

— Saunak Dey*

Background

Thermal Power Plants are heavily dependent on coal for production of electricity. Though there are various parameters which should be looked into holistically for determination of the quality of the coal, one of the most important parameter that industry wide is looked into is the Gross Calorific Value (commonly known as the GCV of coal).

GCV is the single most factor which determines the total quantity of coal that will be required to produce the desired quantum of electricity. Needless to say that GCV and quantity of coal required are inversely proportional. Therefore, higher the GCV of coal, lower is the quantity requirement.

GCV is measured and reported in the industry under three different conditions such as:

a. Air Dried Basis GCV (GCV-ADB);

b. As Received Basis GCV (GCV-ARB); and

c. Equilibrated Basis GCV (GCV-Eq.B).

a. Air Dried Basis GCV (GCV-ADB):

The given coal sample is air dried and the GCV is measured thereafter as per the procedure given in the relevant IS (Indian Standard). GCV-ADB is the only GCV of coal which is actually measured in Bomb Calorimeter for a given sample. In other assessments of GCV i.e GCV-ARB, GCV-Equilibrated, the GCV-ADB analysis result is corrected to the field conditions by using the respective Moisture content recorded for different situations.

b. As Received Basis GCV (GCV-ARB):

This is assessed taking into consideration the total moisture, i.e., moisture inherently present in coal and surface moisture present in the Coal. GCV-ARB (often termed as Total Moisture Basis - GCV) is derived by applying a correction to the assessed GCV-ADB to the extent of the Total Moisture (TM) content in the coal. In essence, GCV-ADB analysis is corrected to reflect the actual conditions in the field to obtain the As Received Basis GCV (GCV-ARB). This gives the exact GCV of the coal at the point of sampling; be it at the Mines end (Coal dispatched), Plant Receipt end (Coal Received) or Firing end (fed to the boiler).

As coal is never processed and brought to laboratory conditions before feeding to the boiler, GCV-ARB gives the true representation of the actual Heat Value of coal which is available for firing. GCV-ARB can be estimated as per the formula given below: -

GCV-ARB = GCV-ADB * (100-Total Moisture) / (100-Inherent Moisture)

c. Equilibrated Basis GCV (GCV-Eq.B):

In this the sample is brought to standardized moisture and humidity levels and GCV of the resultant sample is reported. Equilibrated Basis GCV is obtained by measuring the Equilibrated Moisture of coal under laboratory conditions of 60% Relative Humidity (RH) and 40°C ambient temperature and applying the similar correction to the assessed GCV-ADB. GCV-Eq.B is estimated as per the formula given below:-

Equilibrated Basis GCV = GCV-ADB * (100-Equilibrated Moisture) / (100-Inherent Moisture)

The values of GCV in Air Dried Basis, As Received Basis, Equilibrated Basis differs substantially and mainly depends on the measurement of moisture content of coal and hence cannot be generalized. To elaborate more on this, a practical example of a sample tested in all the above methods is given below:

Parameter	Value
Total Moisture%	15.90
Inherent Moisture%	5.46
Equilibrated Moisture%	10.43
GCV-Air Dried Basis (as measured in Bomb calorimeter Kcal/kg)	3742
GCV-Eq. Basis (Kcal/kg)	3545
GCV-As Received Basis (Kcal/kg)	3328

*Senior General Manager, Jindal India Thermal Power Limited.

Clearly the difference between the GCV-Eq.B and GCV-ARB is ~200 Kcal/kg, which is not any Grade slippage or quality deterioration of coal being dispatched from mine but it is only the difference between two different methods of assessing the heat value corresponding to two different situations.

Most of the power plants in India (Both GENCOs and the IPPs) generally have either full or part of their entire coal requirement for a year tied up under Long Term Fuel Supply Agreement (FSA) with a particular subsidiary of Coal India Limited (CIL) such as Mahanadi Coalfields Limited (MCL), Eastern Coalfields Limited (ECL), South Eastern Coalfields Limited (SECL), etc. Moreover, most of the time, the coal is supplied from two or three specific mines of that subsidiary to the power plants.

Here comes the question of predictability of the coal quality which has a high variation which generally occurs due to seasonality factor, and many other factors associated with the mine, transportation, etc.

Going forward, we would try to statistically derive the probabilities/expectations of getting coal of various GCVs from a particular mine.

Data Collection

Let us consider that a power plant has received the following GCVs of coal in As Received Basis (ARB) in the last five years from a particular coal mine (as shown in Table 1). Since the coal received in power plant is being put in use without subjecting it to the laboratory conditions, GCV-ARB is the most appropriate values to consider for GCV of coal.

Table 1 : Historical GCV (ARB) Values

	FY 2015-16	**FY 2016-17**	**FY 2017-18**	**FY 2018-19**	**FY 2019-20**
April	3,630	3,403	2,716	2,915	3,082
May	3,687	3,312	2,497	2,915	2,772
June	3,557	3,230	2,703	2,908	2,903
July	3,195	3,533	2,688	2,620	2,960
August	3,359	3,440	2,658	2,713	2,993
September	3,262	3,451	2,802	2,903	2,935
October	3,220	3,437	2,958	2,858	2,729
November	3,518	3,344	2,855	3,219	3,097
December	3,244	3,509	3,164	3,155	2,964
January	3,375	3,000	3,086	3,014	2,741
February	3,432	2,954	3,193	3,170	2,962
March	3,419	3,162	2,921	3,111	2,971

As per the below graph (Figure 1), it is pretty evident that there is huge variation in the GCV of coal on month to month basis.

Figure 1

Statistical Analysis

From the above Table 1, the following information are computed:

Standard Deviation	282
Median	3,084
Mean	3,092
Maximum	3,687
Minimum	2,497
Skewness	0.124

Now, if we plot a Histogram of the GCV values from Table 1, we will get the below graph which is similar to a Right Skewed Normal Distribution Curve (Figure 2). The X-Axis of the graph are the ranges of the GCV values with bandwidth of 195. Whereas, the Y-Axis is the frequency of occurrence in that GCV interval.

Figure 2

If one tail is longer than another, the distribution is skewed. These distributions are sometimes called asymmetric or asymmetrical distributions as they don't show any kind of symmetry. Symmetry means that one half of the distribution is a mirror image of the other half. For example, the normal distribution is a symmetric distribution with no skew. The tails are exactly the same. The below graph (Figure 3) is an example of normal distribution:

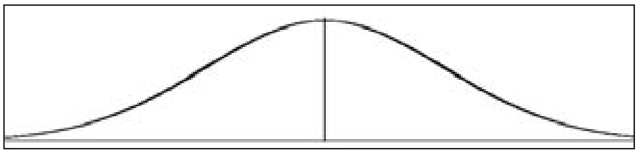


Figure 3

A right-skewed distribution has a long right tail (Figure 4B). Right-skewed distributions are also called positive-skew distributions. That's because there is a long tail in the positive direction on the number line. The mean is also to the right of the peak. The figure below illustrates the same.

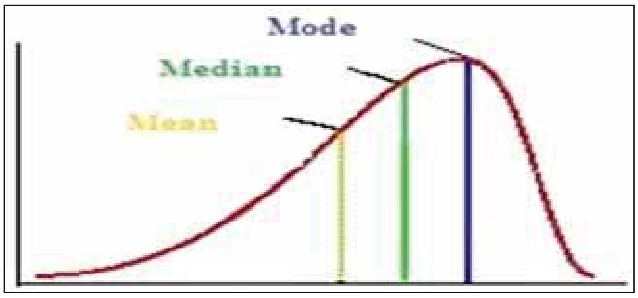


Figure 4A : Left-Skewed (Negative Skewness)

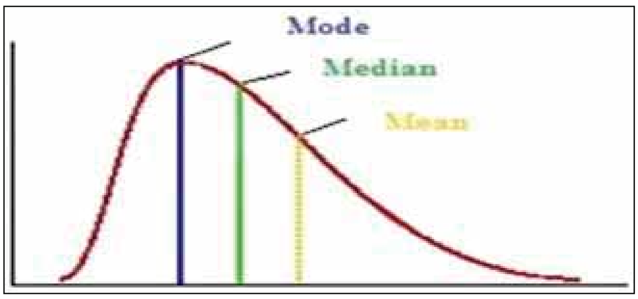


Figure 4B : Right-Skewed (Positive Skewness)

In our case, the distribution of the GCV values is similar to the Right Skewed (Figure 5).

Skewness refers to distortion or asymmetry in a symmetrical bell curve, or normal distribution, in a set of data. If the curve is shifted to the left or to the right, it

Figure 5

is said to be skewed. Skewness can be quantified as a representation of the extent to which a given distribution varies from a normal distribution. A normal distribution has a skew of zero. The Skewness for a distribution can be calculated with the formula:

$$G_1 = \frac{n}{(n-1)(n-2)} \sum_{i=1}^{n} \left(\frac{x_i - \bar{x}}{s} \right)^3$$

Where, G_1 = Skewness; n = no. of data points;
X_i = i^{th} data point; s = Standard Deviation; $\bar{x}$ = Mean;

The results of the calculation tell us:

- The direction of the skew (positive or negative);
- How the sample compares with a normal (symmetric) distribution. The further the skew result is from zero, the greater the skew;

Now, the Skewness for the data-set from Table-1 comes out to be

Skewness = 0.1242

Now, to remove the Skewness of the above data and to bring it closer to the normal distribution, we would perform LOG to the Base 10 transformation on the data set. The below Table 2 shows the Log transformed GCV values:

Table 2 : Historical GCV Values converted-LOG Base 10

	FY 2015-16	**FY 2016-17**	**FY 2017-18**	**FY 2018-19**	**FY 2019-20**
April	3.56	3.53	3.43	3.46	3.49
May	3.57	3.52	3.40	3.46	3.44
June	3.55	3.51	3.43	3.46	3.46
July	3.50	3.55	3.43	3.42	3.47
August	3.53	3.54	3.42	3.43	3.48
September	3.51	3.54	3.45	3.46	3.47

October	3.51	3.54	3.47	3.46	3.44
November	3.55	3.52	3.46	3.51	3.49
December	3.51	3.55	3.50	3.50	3.47
January	3.53	3.48	3.49	3.48	3.44
February	3.54	3.47	3.50	3.50	3.47
March	3.53	3.50	3.47	3.49	3.47

From the above table, we can compute the following:

SD	0.0397
Median	3.4891
Mean	3.4884
Maximum	3.5667
Minimum	3.3974
Skewness	-0.0412

It is evident from the above that the Skewness of the distribution has drastically reduced from 0.1242 to -0.0412 which is almost one third of the prior and very close to ZERO which happens to be for a Normal Distribution. Now, if we plot a Histogram of the GCV values from Table 2, we will get the below graph which is similar to a Normal Distribution Curve (Figure 6A & 6B). The X-Axis of the graph are the range of the LOG Base 10 GCV values with bandwidth of 0.036. Whereas, the Y-Axis is the frequency of occurrence in that GCV interval.

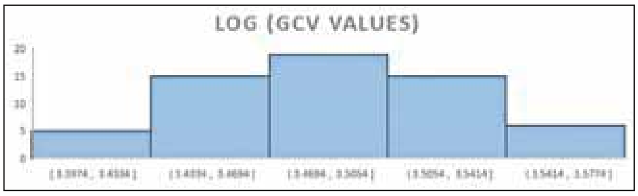


Figure 6A

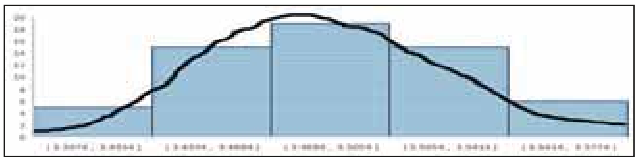


Figure 6B

As, we have converted the data set of the GCV values to a normal distribution, we will now move towards the Z-Score/Value for a normal distribution.

The Z-score is the number of standard deviations a given data point lies from the mean.

Formula of Z Score:

$$Z = \frac{x - \mu}{\sigma}$$

where, μ = Mean; σ = Standard Deviation.

Now, we have taken certain GCV Values to compute the Z-Score which is shown in the below Table 3 :

Table 3 : Z Score Computation for various range of GCVs

	Minimum	Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8	Maximum
GCV	2,497	2,800	2,900	3,000	3,100	3,200	3,300	3,400	3500	3,687
LOG (GCV)	3.3974	3.4472	3.4624	3.4771	3.4914	3.5051	3.5185	3.5315	3.5441	3.5667
Z score	-2.2939	-1.0401	-0.6561	-0.2851	0.0738	0,4213	0.7580	1.0848	1.4020	1.9717

From the Z-Score value we can compute the probabilities of getting the GCV values from the Z-Score table as shown below Table 4:

Table 4 : Probabilities of getting Coal for ranges of GCV

	Probability	Cum. Pro.
P (Z<Minimum)	1.09%	1.09%
P (Minimum<Z<Range 1)	13.83%	14.91%
P (Range 1<Z<Range 2)	10.67%	25.59%
P (Range 2<Z<Range 3)	13.19%	38.78%
P (Range 3<Z<Range 4)	14.16%	52.94%
P (Range 4<Z<Range 5)	13.38%	66.32%
P (Range 5<Z<Range 6)	11.25%	77.58%
P (Range 6<Z<Range 7)	8.52%	86.10%
P (Range 7<Z<Range 8)	5.85%	91.95%
P (Range 8<Z<Maximum)	5.61%	97.57%
P (Z>Maximum)	2.43%	100.00%
Total	100.00%	

The below graph shows the probability distribution of the expected GCV Values (Figure 7):

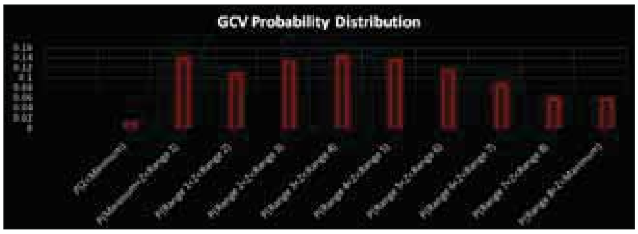


Figure 7 Thus, statistically we have derived the probabilities of getting coal of various quality ranges which will ultimately help us to plan the coal procurement strategy for the entire power plant.

Challenges & Way Forward

- Fixation of Annual Contracted Quantity (ACQ) based on GCV-ARB and not GCV-Eq.B.

The first and foremost challenge the coal consumers/ power producers face is the fixation of Annual Contracted Quantity (ACQ) under Fuel Supply Agreement based on GCV-Eq.B contrary to GCV-ARB which has a direct impact of 200 Kcal/ Kg as discussed in the Background section of this article.

To give a perspective, as per CEA norms of coal consumption for thermal power plants issued on March 2019, typically a 1000 MW thermal power plant has an annual coal requirement of 5.335 million MT (@ 85% Normative Requirement) at G-13 grade of coal whose GCV-Eq.B would typically range from 3400 - 3700 Kcal/ Kg. Now, if we consider that the average coal received is 3550 Kcal/ Kg GCV-Eq.B, then under GCV-ARB is value would be 3350 Kcal/ Kg. Therefore, there is a shortfall of 6% coal quantity i.e. 0.32 million MT to generate the same quantum of power which translates into additional Rs. 64 Cr. cost to the power generators. This additional requirement of coal is met through various auctions such as Special Forward e-Auction and Spot e-Auction which are available a premium ranging from 15% to 56% over the Notified Price of coal under Regulated Sector. Thus, the power producers who are already in stress have to bear this extra financial burden.

The probable solution may be the fixing of the ACQ based on GCV-ARB and not on GCV-Eq.B. The easy it sounds, the herculean task it is to implement as CIL will have a direct impact in its top line and bottom line because the incremental increase in the ACQ has to be supplied at the Notified Price which otherwise is being sold under various auctions.

- Year on Year degradation of coal quality

Under this linkage policy, linkages were awarded after due consideration by the Standing Linkage Committee Long Term (SLC-LT), and after recommendation by SLC LT, LOA's were issued by CIL subsidiaries and Fuel Supply Agreements were entered into after fulfilling the stipulated conditions and milestones within a specified period.

LOAs were signed by the respective CIL subsidiaries and accordingly the amount of coal to be received by the Independent Power Plants (IPPs) was calculated based on available grade of coal. For example, in case of Mahanadi Coalfields Limited (MCL), "F" grade coal was allocated.

The then grading of coal (Seven Grades- based on Useful Heat Value (UHV) - A, B, C, D, E, F, G) was effective till 31/12/2011. But subsequently migration from UHV based grading to Gross Calorific Value (GCV) based grading was incorporated (Grade G1, G2, G3...G17) post 01/01/2012.

Consequent to this change, the coal companies had to indicate equivalence of old grades in the new system. This matter had inherent problem due to difference in the grade intervals in the two systems. Moreover, establishing direct equivalence of UHV and GCV was not feasible. The coal companies therefore resorted to approximate methods of establishing equivalence. They indicated a range of grades in the new system as equal to a single grade in the old system. In case of MCL "F" grade coal was put in equivalence to G10 to G13 grade of coal.

From Table 1, it is evident that the year on year average GCV-ARB has deteriorated drastically for the mine whose declared grade is G14 (Figure 8).

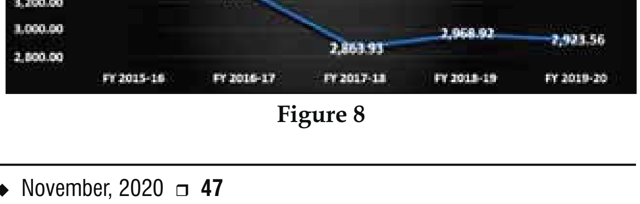


Figure 8

Now, one may question that, the above data is for a particular mine and not for the whole set of mines under the subsidiary - MCL.

To give a perspective, the table below (Table 5) is an excerpt from the "Provisional Coal Statistics 2018-19" published by Coal Controller's Organization -Ministry of Coal.

MCL has all most all the coal mined (99.22%) of grades G12 (29.26%), G13 (45.48%), and G14 (24.48%). Therefore, the IPPs sourcing coal from MCL are deprived of grade G10 and G11 committed under FSAs. This results in receipt of lower average GCV of 3547.5 Kcal/Kg (11.33% lower) compared to Fuel Supply Agreement (FSA) of average GCV 4000.5 Kcal/Kg, resulting in procurement of the additional required coal under various auction schemes at higher price.

The table below (Table 6) further enumerates the issue:

This is ultimately affecting the Independent Power Producers (IPPs) capacity utilization as they have to source the balance coal at higher prices from e-auction/ imports to run the plants at full capacity and serve the PPAs. All power plants getting coal from MCL under FSAs are facing this problem of receiving higher quantities of inferior coal making the operation of the plant suboptimal. Since imported/e-auction coal is costlier, the power companiesare more likely to run into losses and after some time become a Non-Performing Asset (NPA).

The probable solution to this problem is to have re-gradation of mines every quarter which is currently done on half yearly basis and also to make suitable adjustments in Annual Contracted Quantities (ACQs) so that the coal companies which are committed to

Sl. No.	Description	% Asset Utilization	Remarks
A	Annual Contracted Quantity (ACQ) as per FSA	85%	Based on 85% Normative Availability
B	Difference in GCV-ARB and GCV-Eq.B	6%	There is a difference of 200 Kcal/ Kg
C	Reduced GCV due to receiving of inferior grade of coal	11.33%	Receipt of G-12, G-13 and G-14 grade Coal in place of G-10, G-11, G-12, and G13
D = A X (1-B) X (1-C)	Actual Capacity Utilization	70%	With the quantity of coal in the FSA, only 70 % of capacity utilization is possible

<table>
<tr><th colspan="21">Non-Coking Grade Coal Production Statistics 2018-19 (Percentage of Production in different grades)</th></tr>
<tr><th>Grades</th><th rowspan="2">G1</th><th rowspan="2">G2</th><th rowspan="2">G3</th><th rowspan="2">G4</th><th rowspan="2">G5</th><th rowspan="2">G6</th><th rowspan="2">G7</th><th rowspan="2">G8</th><th rowspan="2">G9</th><th>G10</th><th>G11</th><th>G12</th><th>G13</th><th rowspan="2">G14</th><th rowspan="2">G15</th><th rowspan="2">G16</th><th rowspan="2">G17</th><th rowspan="2">UNG</th><th rowspan="2">Washery Feed</th><th rowspan="2">Total N/C Coal</th></tr>
<tr><th>Companies</th><th colspan="4">"F" Grade Coal as per FSA</th></tr>
<tr><td>ECL</td><td colspan="9">66.09%</td><td colspan="2">0.19%</td><td colspan="2">33.72%</td><td>0.00%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>BCCL</td><td colspan="9">98.46%</td><td colspan="2">1.54%</td><td colspan="2">0.00%</td><td>0.00%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>CCL</td><td colspan="9">32.85%</td><td colspan="2">51.00%</td><td colspan="2">15.25%</td><td>0.90%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>NCL</td><td colspan="9">48.87%</td><td colspan="2">44.81%</td><td colspan="2">6.32%</td><td>0.00%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>WCL</td><td colspan="9">19.73%</td><td colspan="2">57.79%</td><td colspan="2">22.48%</td><td>0.00%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>SECL</td><td colspan="9">14.96%</td><td colspan="2">78.16%</td><td colspan="2">3.98%</td><td>0.93%</td><td colspan="2">1.96%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>MCL</td><td colspan="9">0.29%</td><td colspan="2">0.49%</td><td colspan="2">74.74%</td><td>24.48%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>NEC</td><td colspan="9">100.00%</td><td colspan="2">0.00%</td><td colspan="2">0.00%</td><td>0.00%</td><td colspan="2">0.00%</td><td colspan="3">0.00%</td><td>100%</td></tr>
<tr><td>Total CIL</td><td colspan="9">25.02%</td><td colspan="2">39.50%</td><td colspan="2">27.67%</td><td>6.55%</td><td colspan="2">1.27%</td><td colspan="3">0.00%</td><td>100%</td></tr>
</table>

Table 5

supply "F" grade coal (G10, G11, G12, and G13) to power plants to adjust supplies by giving additional coal in case the supply contains a higher proportion of lower grade coal in the specified range for the full utilization of installed capacities.

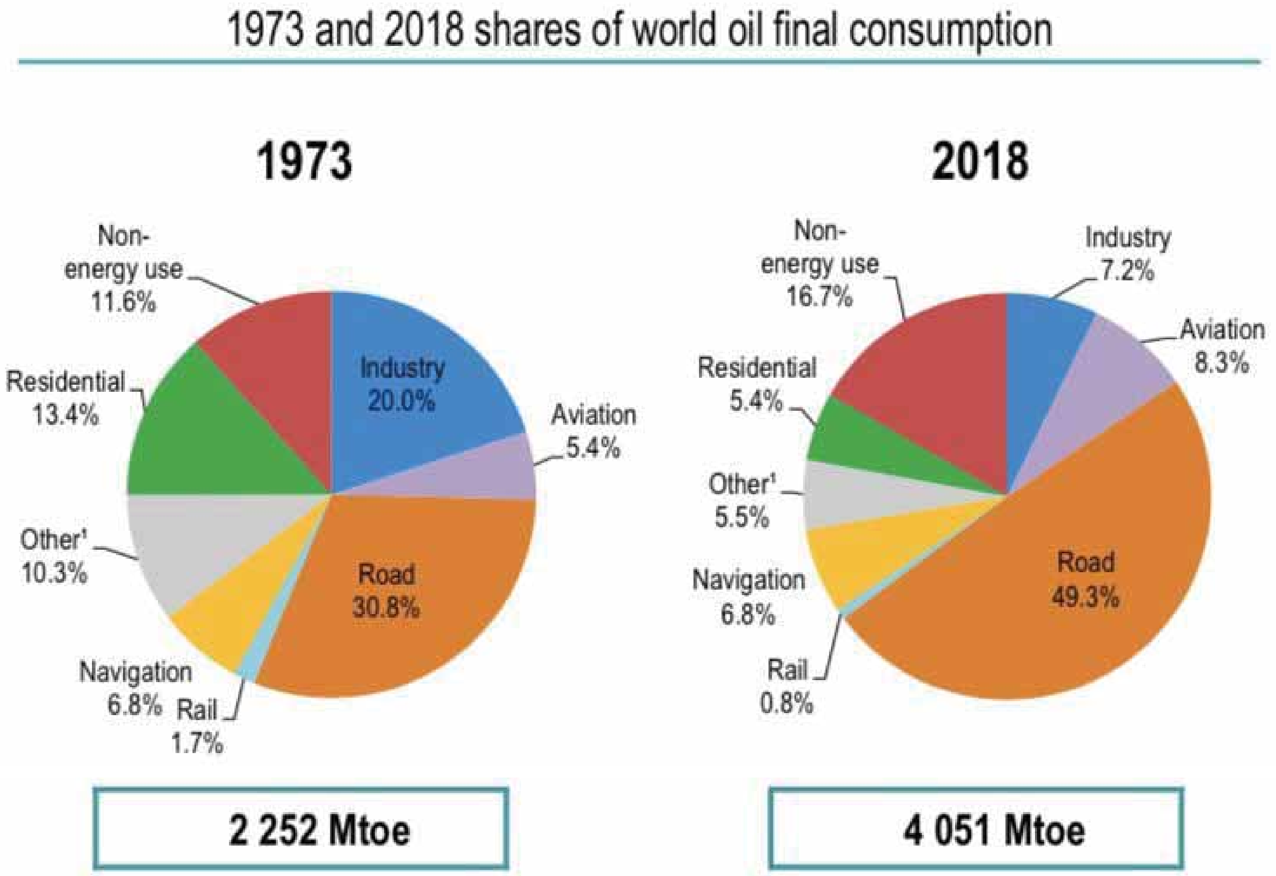
On the basis of heat value lost, a suitable formula can be worked out to assess the extent of adjustment required.

Conclusion

Till date, there have been monopoly of the CIL for supply of coal, resulting in diminished bargaining power of the consumers. But, as the commercial mining operations are to start, and with the bleak future of the thermal power plants, who are the major consumers of coal, considering the focus on clean and green energy puts question mark on the mere existence of the coal behemoth 15-20 years down the line, thus the monopolistic approach of CIL is surely going to be in a downward trend.

The fact that the dip in power demand due the pandemic COVID-19 resulting in lesser offtake of coal by the consumers thereby piling of coal stocks in the mines have forced the coal behemoth to bend and offer coal under various auctions at Notified Price i.e. at no premium for the period April'20 to Sep'20.

Thus, this is absolutely the right time for the consumers to take up the issues related to coal quality with CIL and rectify the lacunas and be somewhat in a balanced system.



Source : LinkedIn post by Alessandro Blasi on 6th September 2020.

Evolution of Coal Processing Practices at Tata Steel

— Bhargav Dhavala*, Kunal Mathanker*,
Debaprasad Chakraborty* & Dr. Suman Sit*

Abstract

In 1951/52, Tata Steel became a pioneer in Asia by setting up its first coal washery in West Bokaro& Jhariausing Chance Cone process. Fine coal (-6mm) was used directly without beneficiation. Chance Cone process was eventually replaced by Dense Media Cyclones and mechanical flotation cells in 1982. 1990s witnessed the replacement of DSM cyclones with scrolled evolute followed by introduction of pump fed cyclones and replacement of flat-bottom flotation cells with U-bottom ones.

Technological improvements between 2000-2018 touch-based most of the critical unit operations: Introduction of Sizers, Replacement of Elliptical screens with Banana screens, Introduction of new-generation mixing mechanism in flotation & substitution of Diesel with green reagent and Replacement of Screen bowl centrifuges with Vacuum Belt Filter. Focus was also put on automation of the technological processes: PGNAA based real-time ash monitoring system to ensure consistency in the product quality.

Increase in demand of coking coal and the deteriorating raw coal quality demand that we continuously scan the world & adopt best technologies to become a technology leader in the business. Down the line, Tata Steel aims to have:

(a) Intermediate size beneficiation circuit, (b) Superior technologies for fine coal beneficiation and (c) Advanced measurement and control systems in place.

Keywords: *Dense Media Cyclone, Flotation, Banana screen, Vaccum Belt Filter, Intermediate size beneficiation.*

1. Introduction

Tata Steel meets its coal requirement for coke making from two captive coal mines: Jharia (underground) and West Bokaro (open cast) located in the state of Jharkhand. Indian coals are high in ash content (~35%) owing to their drift origin and come under 'difficult-to-wash 'category due to high Near Gravity Material (~40-50%). Hence, coal produced from the captive mines cannot be used directly for coke making.

To make it suitable for coke making, it is beneficiated in a washery and the washed coal is then used for coke making. Tata Steel became a pioneer in Asia by setting up its first coal washery in West Bokaro & Jharia in 1951 & 1952, respectively. The journey of coal beneficiation practices at Tata Steel in a nutshell is shown in Figure 1 and the story behind each step is explained in detail subsequently.

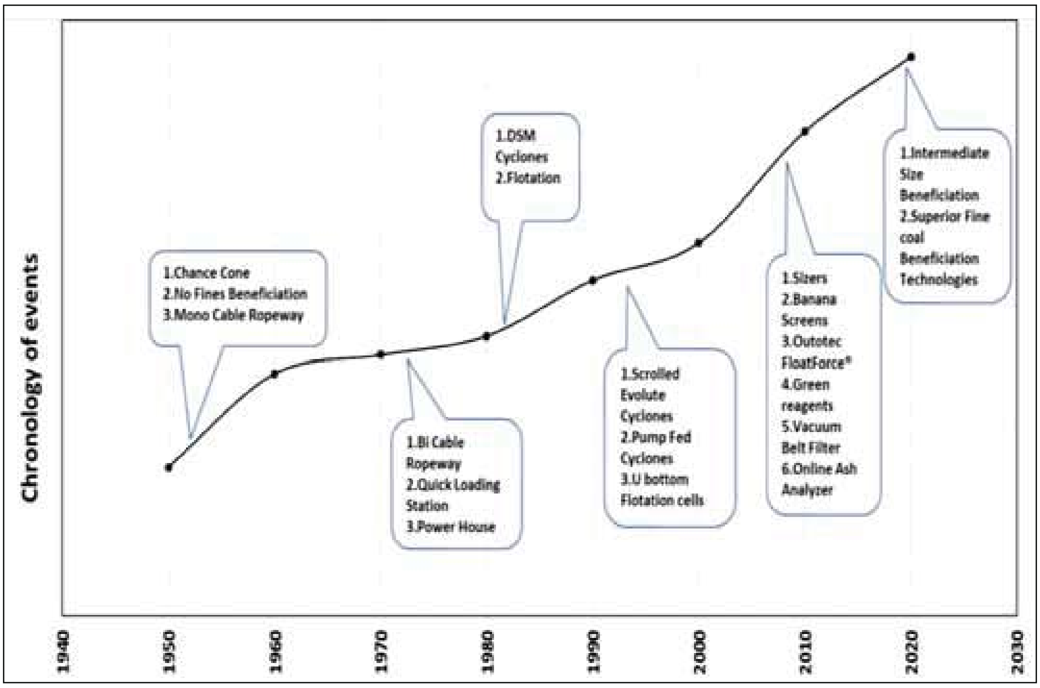


Fig. 1 : Technological Improvements - chronology of events

*Tata Steel Limited, Jamshedpur, Jharkhand.

2. Technological Improvements in Coal Beneficiation at Tata Steel

2.1 1950s - 1970s (Chance Cone Process)

Raw coal having an ash content of 20-23% was crushed and reduced to -75 mm size followed by screening at 6mm.75*6mm size fraction of coal was beneficiated in Chance Cone process (a dense media separator utilizing sand as media) whereas the finer fraction (-6 mm) was directly added without beneficiation to the washed coal and used (Figure 2). The composite clean coal having an ash of 19% was transported to the railway siding via. a mono-cable ropeway. Yield of clean coal varied from 65-90% and most of the equipments were manually controlled. Until early 1970s, only top seams were worked and fed to the washery. In the late 1970s, the middle and lower seams having comparatively higher ash were also mined, a bi-cable ropeway for transportation of washed coal from the washery to the railway siding, a quick loading system at the railway siding and a power house were also added.

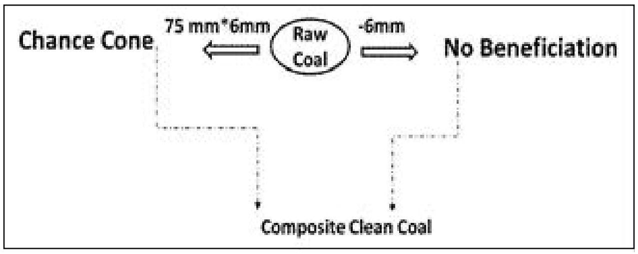


Fig. 2 : Flowsheet in 1950-1970s

2.2 1980s (Dense Media Cyclones and Froth Flotation)

Advent of new technologies, continuous deterioration in the mined raw coal quality supplemented by the poor performance of Chance Cone process was witnessed. Earlier, the coal washeries did not have any fines treatment circuits; they were simply blended with the washed coarser coals owing to the very good quality. However, with time, quality of fines deteriorated significantly and it was practically impossible to maintain the quality of washed coal by direct mixing. Detailed studies were carried out to arrive at the correct feed top size to the washery to optimize the clean coal yield at a desired ash. Eventually, Chance Cone process was replaced with

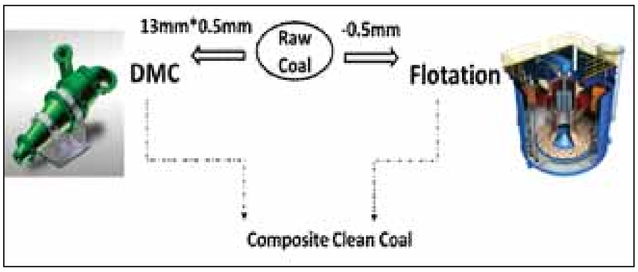


Fig. 3 : Flowsheet in 1980s

Dense Media Cyclones for processing coarser raw coal fraction:13 to 0.5mm and mechanical flotation cells for processing finer raw coal fraction: -0.5mm (Figure 3).

2.3 1990s

2.3.1 *Low Ep Scrolled Evolute Cyclones:* In the year 1998-99, Washeries switched over from Dutch State Mines (DSM) design cyclones to scrolled evolute design cyclones. Process performance improved as the Ep obtained was 0.02-0.025 as against 0.035-0.040 in the DSM cyclones. These cyclones are also of larger capacity thereby helping in increasing the plant throughput.

2.3.2 *Introduction of Pump Fed Cyclones & High -Low Concept in Cyclone Circuit:* At West Bokaro washery#3, parallel modular streams in cyclone circuit along with pump fed cyclones were introduced. Pump feeding system has its own share of pros and cons. Gravity feeding requires higher footprint but achieves a more consistent flow, less pump wear and feed degradation. There are two stages of cyclone washing in which the primary cyclones are operated at higher specific gravity to discard the rejects. The second stage cyclones are operated at lower specific gravity for separation of clean coal & middlings. These cyclones have V/f converters for maintaining the required inlet pressure thereby reducing the capital costs in comparison to a conventional gravity fed cyclone.

2.3.3 *Replacement of flat-bottom flotation cells with U-bottom ones:* U-bottom cells minimize the sanding/silting phenomenon. Sanding is high in flat-bottom cells due to lack of velocity in the un-agitated zones thereby allowing the larger particles to settle down.

2.4 2000-2018

2.4.1 *Introduction of Sizers to improve liberation:* Crushing and liberating coal to the correct size is of prime importance as it would improve the performance of the coal washery. Sizers were introduced in place of roll crushers to get optimum liberation at reduced noise and dust.

2.4.2 *Replacement of Elliptical screens with Banana screens to improve the desliming efficiency:* Earlier, elliptical screens were used for desliming raw coal at 0.5mm. Screening efficiency of these screens was found to be poor- it was observed that a substantial quantity of undersize i.e. (-) 0.5mm reported to the screen oversize. These finer coal particles create difficulties in maintaining the cut density inside the cyclone thereby impacting the efficiency. These screens were eventually replaced with robust Banana Screens.

2.4.3 *Introduction of 'Advanced new-generation mixing mechanism 'in Flotation cells:* At West Bokaro Washery-3, significantly high (20-25% by wt.) proportion of plus 0.5mm size coal particles report in the flotation cell feed. This was always a concern as most of these particles report to the flotation tailings. To improve the fines circuit performance, Tata Steel incorporated a new generation mixing mechanism- Outotec FloatForce® in one flotation bank to start with. This mechanism creates more turbulent energy and generates finer bubbles as it has separate chambers for air and slurry in the rotor assembly of the flotation cell (Figure 4). In the conventional mixing mechanism, the design of rotor-stator assembly is such that there is a single passage for both slurry and air and hence, air mixing with slurry is not fully effective. Outotec FloatForce® has also been found to be more effective in floating relatively coarser particles and pushing more coal slurry as compared to the conventionalmixing mechanism.

2.4.4 *Substitution of Diesel with green reagents in Flotation:* For ages, Diesel is being used as a collector in coal flotation. With the stringent environmental regulations and policies, replacement of diesel with a reagent that is environment friendly as well as technically & economically competent became inevitable. Diesel is also highly inflammable and prone to pilferage and hence, poses safety as well as environmental hazards. A Joint improvement initiative was taken with Nalco Chemicals for

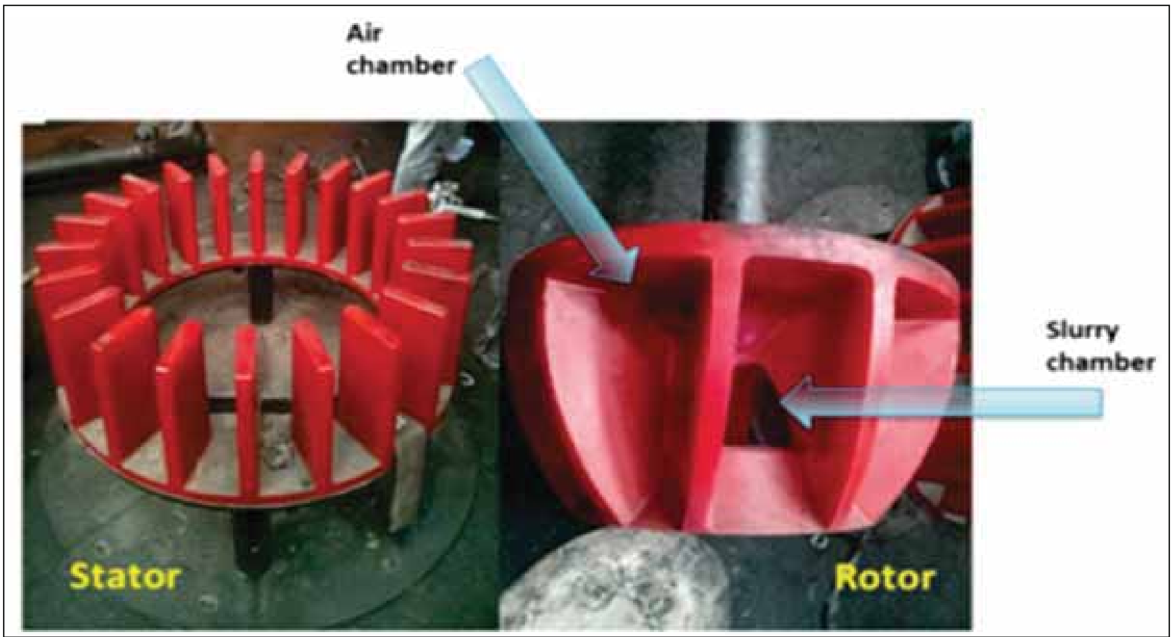


Fig. 4 : New generation mixing mechanism Outotec FloatForce®

the development of a synthetic collector which not only gives technically competent results but also is economical, safe and environment friendly.

2.4.5 *Introduction of Vacuum Belt Filter for dewatering fine clean coal:* Initially, Screen Bowl Centrifuges were used for dewatering fine clean coal: <0. 5mm.However, it was observed that ultra-fine coal particles were getting lost with the centrifuge effluents. To capture such low ash ultra-fine clean coal, Horizontal Vacuum Belt Filters (HVBF) were installed. The belt filter installed at West Bokaro washery#3 is also the world's largest HVBF with an effective filtration area of 145 m^2 for coal slurry.

2.4.6 *On Line Ash Analyzers for consistency in product quality:* Taking representative samples from conveyor belt and analyses for effective quality monitoring & control was time consuming. As a result, corrective actions could not be taken timely resulting in variations in the clean coal ash. To overcome the mentioned problems, online ash analyser based on Prompt Gamma Neutron Activation concept was introduced. Use of online analyzer to monitor ash has resulted in minimization of shift wise standard deviation in the clean coal ash.

2.5 *2018+ (Some already established, some need to be established)*

2.5.1 *Intermediate size beneficiation:* It has been observed through process audits that recovery of 0.5-0.25/0.15mm size fraction is the lowest of the lot in froth flotation process and 0.5mm is not the ideal top size for flotation. To improve the recovery of 0.5-0.25/0.15mm size fraction, intermediate size beneficiation in a Reflux Classifier (RC) has already been implemented at Jamadoba washery and would be replicated across the remaining coal washeries of Tata Steel in the near future (Figure 5).

2.5.2 *Superior technologies for fine coal beneficiation/difficult-to-float coals:* Flotation is a complex process controlled by factors which can be divided into three facets: coal characteristics, chemistry and machine characteristics. Factors within the coal and chemistry areas are dynamic and hence, need to be dealt with by personnel on an ongoing basis in normal plant operations. However, the most important characteristic of any flotation technology is air bubble generation and the size of air bubbles produced as this controls flotation kinetics and dictates the carrying capacity of the machine. Several technologies have come up for fine coal

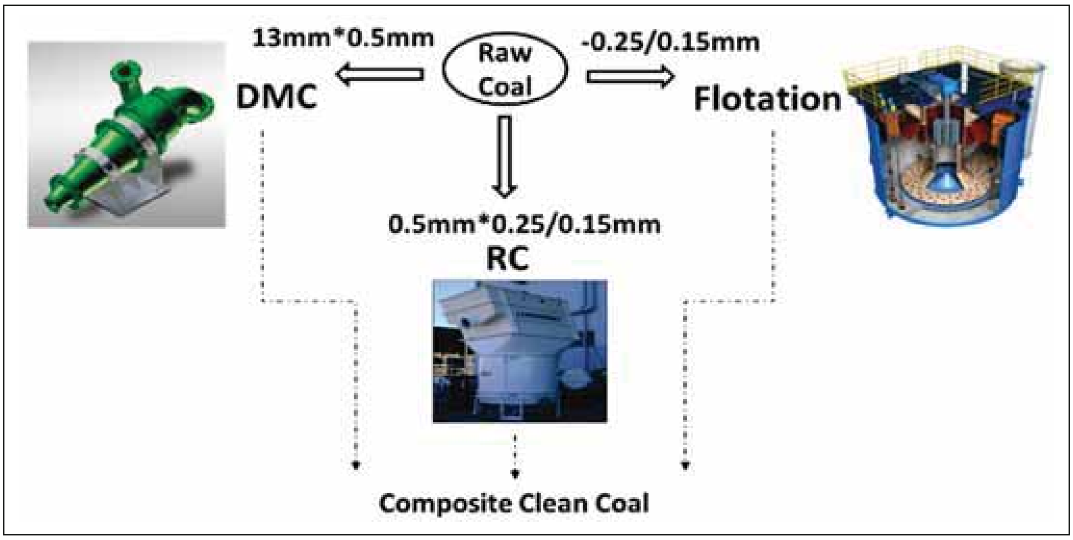


Fig. 5 : Futuristic Flowsheet

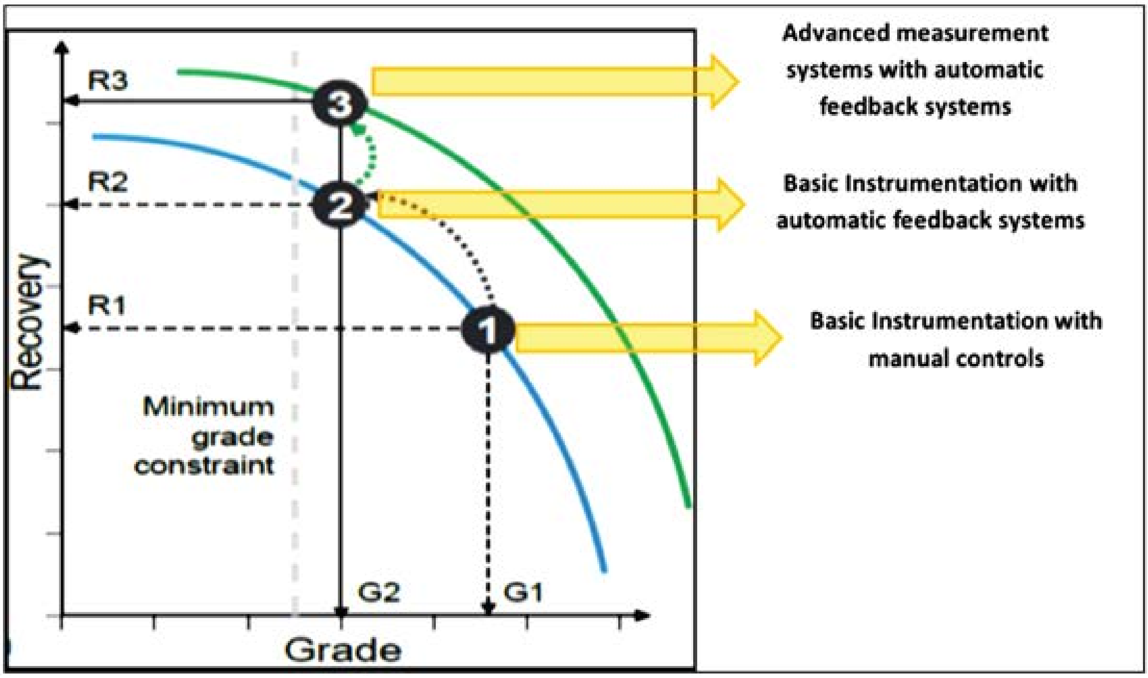


Fig. 6 : Automation in technological processes

beneficiation such as Column cells, Jameson cells and Jet flotation cells which have been found superior to the conventional mechanical flotation cells.

2.5.3 *Step-by-step approach to a fully automated plant:* In the age of Digitalization, IoT and Industry 4.0, it is equally important to have automation - basic & advanced measurement systems & control systems in the technological processes to achieve higher yields at the same grade and to become a technology leader in the business as shown in Figure 6.

3. Conclusions & Way Forward

Increase in demand of coking coal and the deteriorating raw coal quality demand that we continuously scan the world & adopt best technologies to become a technology leader in the business.

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Augmentation of Indigenous Low Volatile Coking Coals for Coke Making and Substitution of imported coking coal

— **T. Gouri Charan*, U.S. Chattopadhyay*, Pradeep K Singh***

Introduction

Jharia and Bokaro coalfields constitute the major resources of coking coal in India and the coalfields are presently being operated by Bharat Coking Coal Limited (BCCL) and Central Coalfields Limited (CCL). Presently, out of 32 billion tonnes of coking coal reserve in the country, approximately 8.5 billion tonnes fall into Low Volatile High Rank (LVHR) category that cannot be used directly in the steel industry. The present resource of LVHR coals is estimated to be about 7953 million tonnes in Jharia Coalfield and 496 million tonnes in East Bokaro Coalfield. These are mainly confined to seam VIII and below in Jharia Coalfield and Karo Group of seams in East Bokaro Coalfield. (Figure 1).

The Low Volatile Coking (LVC) coals by the term itself it indicates that the coal contain low volatile content, which directly cannot be used for metallurgical purpose. These coals are characterized as follows:

a) Thick seams, with number of bands, spreading over to some 30 km stretch along the strike direction.

b) Low volatile matter content (mean vitrinite reflectance varies between 1.25 and 1.45 percent) showing desirable maturity of coal.

c) High inertinite content (60-70%, sometimes even more) which are intimately mixed up with inorganic micro components as well as with vitrinite. As a result microlithotypes are mostly of vitrinertite and carbargillite, which gives a high percentage of near gravity material (50-60%) at the desired specific gravity of cut.

d) High raw coal ash (30-35%, sometimes even more).

e) Due to intimate mixing of micro components these coals have extremely poor liberation characteristics; when the raw coal is progressively crushed from 75, to say, 13 or 6 or even 3 mm (considered as the limit for existing coke oven technologies throughout the world), the yield of cleans at 17.5 0.5% ash varies between 30 and 35%

f) Difficult washability characteristics and high near gravity material (NGM) at the desired specific gravity of cut.

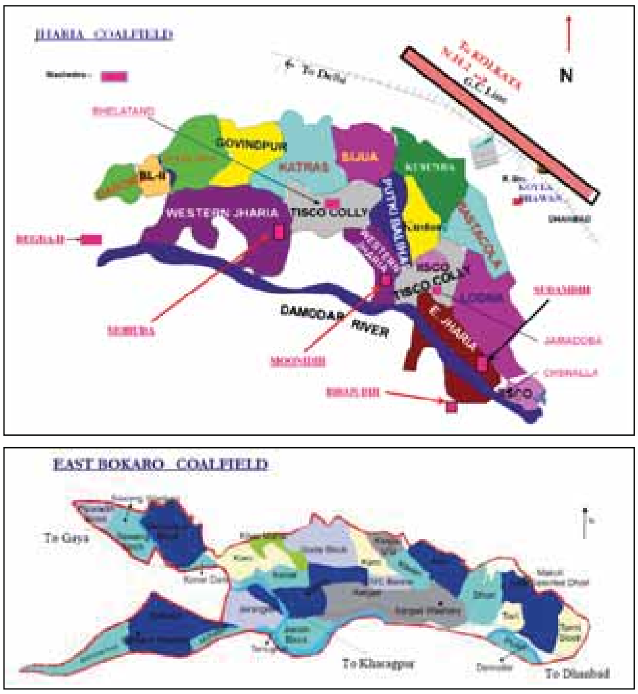

Figure 1 : Coking Coal (LVC) deposits in Jharia and Bokaro coalfields

The coking coal washeries in India were established for treating the upper seam coals of Jharia and Bokaro Coalfields, which are good quality coking coals. However, with passage of time the upper seam coals exhausted leaving behind lower seam coals, which are low volatile in nature. Unfortunately, the washability potential of the LVC coals are so poor that the existing washeries having conventional washing technologies are unable to supply coals of ash 17-18% as desired by indigenous metallurgical industries and cannot stand

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in competition with foreign coals because of poor yield of clean coal. As such, these coals are being supplied to the thermal power plants, against augmenting the demand of metallurgical coal for coke making thus, wasting the scarce coking coal resources.

Previous Studies

It has been found that a considerable quantity of high ash (>35%) Low Volatile Medium Coking (LVMC) coal, used as power coal, exhibits improvement in coking properties on washing and may therefore, be utilized in Steel making through Blast Furnace route. Washability studies have also proved that washed LVMC Coal have coking propensity and may be blended for steel making in metallurgical industry

As per the recommendation of an Expert Committee headed by Shri K.S.R. Chari, in the year 1992 a consolidated programme taken by Erstwhile Central Fuel Research Institute, Dhanbad, presently CSIR - Central Institute of Mining & Fuel Research (CIMFR) in association with Coal Indian Limited (CIL) & Steel Authority of India Limited (SAIL). It was decided to beneficiate the LVC coal of V/VI/VII/VIII seam coals of Golukdih Open Cast Project and prove the acceptability of washed LVC coal of V/VI/VII seam at 17-18% ash through testing at Bokaro Steel Plant's test coke oven.

The then existing central washery circuits (1992) are found to be inadequate for washing such LVC coal. Even the washeries designed to accommodate the difficult-to-wash coals could not satisfactorily beneficiate LVC coals, primarily due to their indifferent washability characteristics. So, it was decided by the committee that CFRI should develop an improved flow sheet and test about 1200 tonnes of coal in its 40 tph pilot plant for generation of 300 to 400 t of clean coal at 18% clean coal ash. During the year 1992, CFRI developed the flow sheet (Figure 2) and the details of washing are as follows:

a) Multi-stage beneficiation of raw coal produces four products saleable to Steel, Foundry, PF and FBC Power Plants. First stage of beneficiation in 3-product jig produces reject (ash 55-60%), middling (ash 33-35%) and 'Preclean' of ash around 22-25%. Deep beneficiation of the 'Preclean' in Heavy medium circuit and by flotation produces final cleans of 17-18% ash desired by the metallurgical industries while the sinks constitute the 'sweetened middling' (of ash 28 2%) suitable for the foundry coke industries.

b) Multi-stream beneficiation of coarse coals produces three products, specifically suitable for industries like Steel, PF and FBC Power Plants. Beneficiation of the coarser fraction in jig gives the major product for the PF power plants, while deep beneficiation of the finer fraction produces the 'Steel grade' cleans.

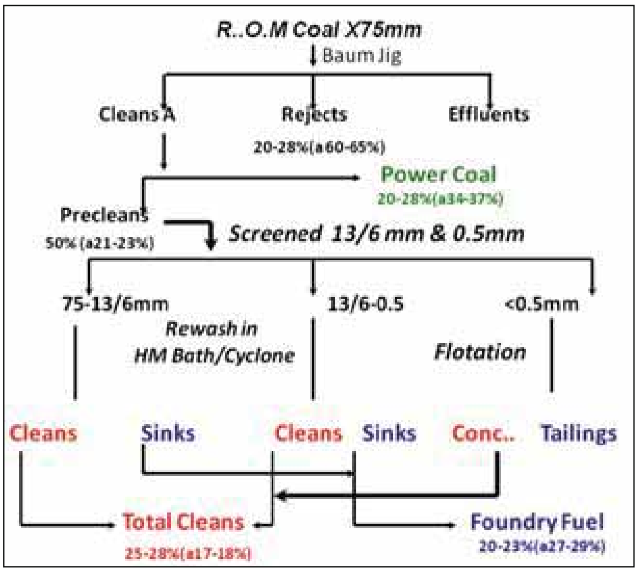

Figure 2 : A typical flow sheet for washing LVC coals of Eastern Sector, Jharia Coalfields

The product at 17.5 ± 0.5% ash (yield about 30%) was carbonized at CFRI, Research Development Centre Iron & Steel (RDCIS) & subsequently in the Bokaro Steel plant test coke oven. The results were highly encouraging and for the first time the possibility of blending such washed coal in coke oven charge as the prime coking coal component have been established.

Subsequently, the Technical Group headed by Shri R.K. Sachdev recommended the installation of 12 washeries (BCCL: 8 and CCL:4), each of 1 mt/year capacity to be set up during 8th and 9th plan periods to yield an additional 3.6 mt of coking coal by 2001-2002, based on the coal specific flowsheets designed by CFRI. The flowsheet was developed for 1 mt/year washery (figure-3).

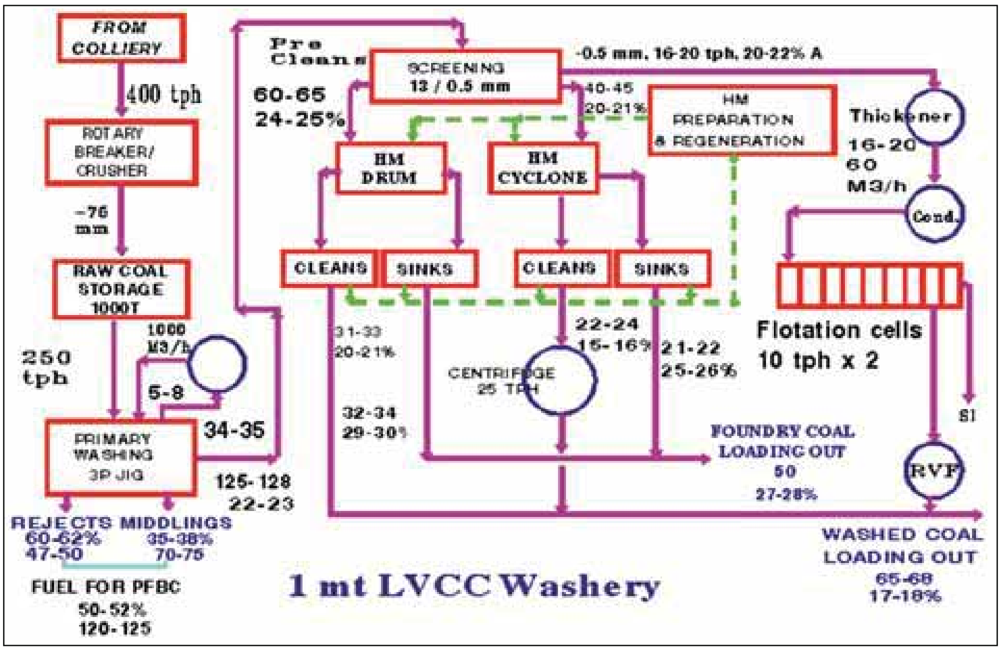

Figure 3 : Flowsheet for 1 mt/year washery

The findings of the preliminary studies carried out by CFRI for beneficiation of LVC coals where widely discussed in various forums and Ministries.

Work Carried Out During 10th Five Year Plan (2002 - 07)

CSIR - CIMFR carried out a project entitled "Quality Enhancement of Coal for Its Efficient Use - Technological Options for Efficient Utilization of Difficult- To- Wash Coking Coals For Use In Steel, Cement, Power Plants And Foundries.

In this project coal samples were collected from Muraidih, Satabdi, Block IV and Pulaitand (Western Jharia) and Kuju (W.Bokaro). The test results revealed that the characteristics of the lower seam coals of the Jharia Coalfields and West Bokaro Coalfields shows high ash percent, low Volatile matter and poor coking propensity. The washability studies on the raw coal crushed to 75 mm showed poor washability characteristics and the theoretical yield% for steel grade coal is considerably low.

The washing scheme developed by CFRI for the treatment of coals from the lower seams of Eastern part of Jharia coalfields may not be applicable for the Western sector. It is due to the poor yield at desired quality for use in metallurgical industries and the clean for foundry fuel and power may not be generated simultaneously.

Application of computer simulation on washability data for prediction of achievable power grade coal from coarser fraction and steel grade coal from finer fractions yielded results of 12.9% at 17.5% ash level (steel grade) 19.5% at 34.2% ash level (power) and 67.6% at 56.1% ash (FBC) for Muraidih OCP coals; while in the case of Kuju OCP Coals 13.7% at 17.5% ash level (steel grade) 60.1% at 34% ash level (power) and 26.2% at 49.9% ash (FBC) may be achievable.

In another study the raw coal was crushed to 75 mm and deshaled, at 1.80 sp.gr. The deshaled clean was crushed to 13 mm, the yield of cleans at 17.2% ash level is about 23.4%. While, when the deshaled clean was crushed to 6 mm, the yield of cleans at 17.2% ash level is about 23.6%. The coking propensity of the clean coal is good and can be used as a blend for steel making.

By following the route of Crushing the ROM coal to a suitable top size (75 mm) and deshaling the coal in a baum jig it was noticed that a pre-cleans at 33% ash level at an yield of 49.8% can be generated. By crushing the Jig Cleans at sizes 13, 6 & 3 mm, it was noticed that there is improvement in yield, considering two-product separation. The overall yield was about 23.1% at ash level of 17.4% for the jig cleans

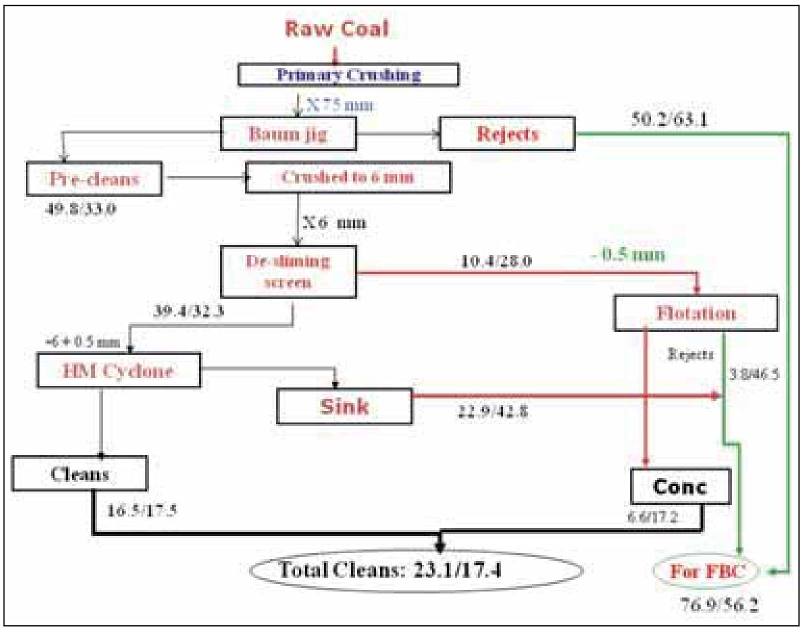

Figure 4 : Flow scheme for beneficiation of difficult-to-wash LVC coals of Western Jharia Sector, Jharia Coalfields

crushed to 6mm. Beneficiation scheme for the coals of Western Jharia is shown in Figure-4.

Cil R&D Funded Project, "Effective Utilization of Low Rank and Low Volatile High Rank Indian Coking Coal for BF Coke Making" (2012-13)

CSIR - CIMFR was involved in the pilot plant operations of the coal samples collected from Muraidih and North Urimari for generation of bulk quantity of clean coal at three different ash levels viz., 10%, 15% and 17%. The conclusions drawn from the project are as follows:

- Clean coal samples of Muraidih and North Urimari coals at 10%, 15% and 17% ash level have good coking properties and can be used in coke making.
- Laboratory scale washability study of North Urimari coals indicate that the yield at 10%, 14% and 17% ash level is 41%, 59% and 75% respectively. The pilot plant tests on North Urimari coals carried out at CIMFR, Dhanbad show that yield at 10%, 16% and 18% ash level is 21%, 40% and 48% respectively.
- Laboratory scale washability study of Muraidih coals indicate that the yield at 10%, 14% and 17% ash level is 15%, 34% and 43% respectively. The pilot plant tests on Muraidih coals carried out at CIMFR, Dhanbad show yield at 10%, 15% and 18% ash level is 11%, 18% and 22% respectively. The clean coal generated through pilot plant test of North Urimari and Muraidih coals were sent to RDCIS-SAIL, Ranchi for carbonization test.
- Upto 20% of high volatile low rank coal from Argada Seam, North Urimari Area, and South Karanpura Coalfield at ash content of about 10% and 15% can be used in Blast Furnace
- Use of 10% low ash Muraidih coal and 10% low ash North Urimari coal in blend produced very good quality coke under stamp charging process.
- Good quality coke can also be obtained by using a blend of 15% Muraidih coal in combination with 10% North Urimari coal at 10% ash through stamp charging method.
- It was also observed that even at 17% ash level, high volatile coals up to 10% and low volatile coal up to 10% can be used in blends without any deterioration in coke properties.
- Coke making through Stamp charging method produces coke having improvement in M10.

Present Status/Knowledge Gap

After the early studies carried out by CSIR-CIMFR in the year s 1992-94 on LVC coal using V/VI/VII/VIII seam coals of Golukdih Open Cast Project, Jharia Coalfields further laboratory studies on all major LVC coals of Jharia and Bokaro coalfields were conducted by CSIR-CIMFR, Research Development Centre Iron & Steel (RDCIS) and Central Mine Planning Design Institute (CMPDI).

Extensive, pilot plant studies were carried out by CSIR-CIMFR using both coarse and fine coal beneficiation circuits. The studies showed that after beneficiation and on carbonisation LVC coals exhibits improvement in coking properties on washing down to 17 to19% ash in clean coal and the same may be used as blend for metallurgical purpose.

The numerous laboratory tests and pilot scale studies have confirmed that these coals, if beneficiated to 17.5 0.5 percent ash level exhibit good caking properties and may be blended to produce blast furnace coke. Realizing the importance, Coal India Ltd. is already in the process to set up six NLW coking coal washeries on private-public cooperation concept (Table 1). Coal India is providing land, water, electricity and other infrastructure the private sectors are providing state of art technology and erecting, commissioning and operating these washeries. These washeries will be three product washeries producing Clean Coal of 18% ash, Middlings of less than 40% ash and Rejects.

Table 1 : Proposed new coking coal washeries

Sl. No.	Proposed washery	Company	Capacity
1.	Madhuban Washery	BCCL	5.0
2.	Patherdih Washery-I	BCCL	5.0
3.	Dugda Washery	BCCL	2.5
4.	Dahibadi Washery	BCCL	1.6
5.	Patherdih Washery-II	BCCL	2.5
6.	Dhori Washery	CCL	2.5

The flow sheet of the washery being constructed by Monnet at Patherdih washery is shown in Figure 5.

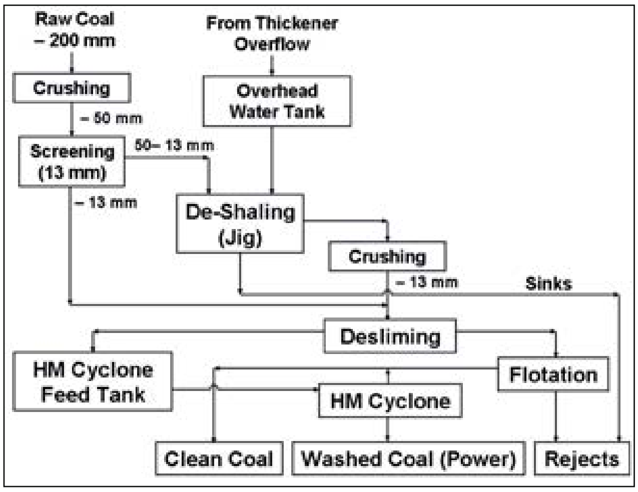

Figure 5 : Simplified Flowsheet of Patherdih Coal Washery

The LVC coal may be deshaled first in jigs and then crushed to 13 mm size for beneficiation in HM Cyclones. The fines generated by desliming crushed coal may be subjected to floatation for recovery of 18% ash content cleans which will enhance the total yield of cleans in the circuit. The sinks of HM Cyclones having ash around 40% may be used as Thermal Coal.

Based on these studies two washeries viz. Dahibari and Patherdih have already been inaugurated in January 2018 and March 2018 respectively and are under various stages of operation. Few more coking coal washeries are coming up in BCCL and CCL areas.

Assessing the Technical Feasibility of Washing Coking Coals to 13% Ash Content

A Committee was constituted by Ministry of Coal, Government of India on 09.03.17 under the Chairmanship of CMD, CMPDI to undertake a project on "To assess the technical feasibility of washing coking coals to the level of 13% ash content". The major conclusions drawn from this project were as follows:

- The various washability test of raw coal reveals that the ash% varies widely and is as high as 52%, with majority of the coal falling under W-IV and ungraded/ LVMC.
- There is considerable decrease in yield of clean coal at 13%, ash level when raw coal ash deteriorates from W-IV to ungraded. Simultaneously, yield also decreases adequately when clean coal ash is kept at 13% in comparison to 18%. It has been observed that in general the desired selling price of clean coal produced on washing W-IV coal is less than the desired selling price of clean coal produced on washing ungraded coal.
- In case of washing coal to obtain clean coal at 13% ash, there is huge generation of middlings when compared to that at 18% ash clean coal.
- In case of clean coal at 13% ash, it is obvious that significant quantity of coal having coking properties is reporting to the middlings which

could otherwise be used for metallurgical purpose.

- The study has revealed that the yield of clean coal at 13% ash varies from about 13% to 28%. The quality of raw coal feed varies widely depending on the seams being mined. Hence, the yield of clean coal will also vary widely from time to time.
- The tentative capital investment for setting up of a 2.5 Mty capacity washery has been broadly estimated as Rs. 390 Crores considering the tentative process flowsheet and infrastructure facilities.
- The washing cost per tonne of raw coal input has been estimated as Rs. 478.45 at 80% capacity utilization which may vary based on the technology and actual financial parameters at the time of implementation.

The extensive studies carried out on different LVC coals proved beyond doubt that if the feed ash content is more than 35% the theoretical recovery of clean coal varies from 20 to 30% at 18% clean coal ash content. The major knowledge gap lies at how to increase the recovery keeping the ash content at 18% and reduce the operating cost.

Scope of Future Studies:

The studies so far conducted concentrated on washing the coals at coarser size and not much data is available on the improvement of recovery by crushing/grinding to finer sizes as it is understood that by crushing/grinding to finer sizes the liberation of mineral matter with that of coal matrix will improve. Under this context, the future studies will be carried out as follows:

- Detailed characterization studies to understand the exact mineral assemblage of the coal matrix, liberation size, petrographic properties etc.
- Crushing/Grinding the raw/deshaled LVC coals to finer sizes viz., 6mm, 3mm and 0.5mm.
- Innovative beneficiation techniques for better yield along with dewatering of the clean coal.
- Utilization for metallurgical coke making through stamp charging process.

Major Recommendation from CIMFR

- Government of India should make a strategic plan for time bound stoppage of supply of Low Volatile coking coals to the power generating companies. This should be linked up with the construction and commissioning of new coking coal washeries and monitoring their implementation. Precious coking coals should not be burnt in Boilers for generating steam for power production.
- Considering washing technology by far established, the conventional washeries are to be supplemented by construction of new washeries with required technologies, which is the need of hour. CSIR - CIMFR had carried out extensive laboratory and pilot plant tests on all the major sources of LVC coals and developed new flow sheets, which may be utilized for construction of new washeries or for retrofitting/modernization of the existing washeries.
- For high ash LVC coals (>40% ash content), deshaling plants may be installed and the deshaled coal may be sent to the existing coal washeries for immediate recovery of clean coal from LVC coals.
- An efficient road map for blending of beneficiated LVC coals, heat affected coals, coking coal fines, low ash non coking coals, low sulfur coals of NE etc., with imported coals may also be considered, only after proper characterization for reducing the percentage of imported coal in the overall blend for coke making.
- Finally, Coal producers, research institutes, universities and the end users of coking coals should form a Joint Action Group for efficient use of LVC coals.

Given the High Ash Content of Indian Coal, How Important the Role of Independent Coal Testing Agencies?

— Ratnesh Rai*

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.

Testing of Coal and its Importance

- Identification of the chemical composition of coal has a strong influence on its combustibility.
- Identification of sulphur content in coal and reducing sulphur in the fuel combusted also will reduce sulphate formation and fine particulate emissions and help to improve visibility by reducing regional haze.
- 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 its ability 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.
- Coal testing help with a complete analysis of the quality of coal so that you can gauge the performance of the boiler design.

High Ash Content in Indian Coal and Its Impact

Ash content of coal produced in the country is generally 25 to 45 % whereas average ash content of imported coal varies from 10 to 20 %. Indian Coal has comparatively higher ash content than imported coal due to drift theory of formation of coal deposits in India. Coal seams formed due to drift theory contains higher ash as compared to in-situ theory of formation.

*Managing Director, QA Testing Laboratories Private Limited

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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Identification of the chemical composition of coal has a strong influence on its combustibility. Identification of sulphur content in coal and reducing sulphur in the fuel combusted also will reduce sulphate formation and fine particulate emissions and help to improve visibility by reducing regional haze.

Indian coal is of mostly sub-bituminous rank, followed by bituminous and lignite (brown coal). The ash content in Indian coal ranges from 35% to 50%.

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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. A poor quality coal produces NOx, SOx and fly ash in reasonably large quantity as compared to good quality coal, so the pre-treatment before processing and disposal can enhance the economy of the plant. 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. The optimization of by-products and pollutants not only save environment from poisonous hazards it also enhances the economy of the plant.

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.

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.

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.

References :

I. Publications on the subject in public domain.

ii. Personal experience.

COP26 India's Clean Energy Transition w.r.t Coal Mining Industry

Dr. EVR Raju
Domain Expert,
Environment & Sustainable Development

India's INDC at COP21

- Adopt sustainable living, climate-friendly economic development
- **Reduce emissions by 33-35 % by 2030 from 2005 level**
- **Achieve 40 % electric power from non-fossil fuel based energy resources by 2030**
- **Create additional carbon sink of 2.5-3 billion tonnes of CO_2 equivalent through forest & tree cover by 2030**
- Adapt to climate change by enhancing investments in development programmes
- Mobilize funds to implement mitigation & adaptation actions
- Build capacities, create domestic & international framework

COP26 is important because

- From 2020 onwards, the implementation of the 2015 Paris agreement will be the key driver of international climate action
- Global climate emergency on the agenda
- **All countries are to submit their long-term goals** by 2020
- **Finish work that COP 25 was unable able to conclude** – setting out the rules for a Carbon market between countries
- Event postponed due to COVID-19 pandemic on 1–12 November 2021, at Glasgow, UK

India's Clean Energy Transition

GHG Emissions : India & World

- India's annual emissions at 0.5 tonnes/capita **are one of the lowest** among G-20 countries, well below global average of 1.3 tonnes. **Reduced by 21%** over the period 2005-2014.
- Recently, UN Secretary General called India to give up coal immediately and reduce emissions by 45% by 2030.
- **If India does so, it would lead to low-development trap.**
- India while adhering to the principles of balance between development and environment, must engage developed countries to achieve the target of Paris Accord.

India's Clean Energy Targets

- **Target to install 175 GW of RE capacity by 2022**(100 GW solar, 60 GW wind, 10 GW biomass and 5 GW from small hydro)
- Electric grid-size is 362 GW, RE capacity-82.5 GW (23%)
- According to the Central Electricity Authority, Non-Fossil fuel installed electricity capacity is **38% - two percent short of the 40% of non-fossil fuels by 2030, INDC target**.
- At the UN General Assembly in 2019, India announced **target of 450 GW of RE** (280 GW solar + 140 GW wind + 10 GW bio) and 266 GW thermal capacity to be achieved by 2030, which is 64%, much higher than India's Paris commitment.

COAL vs RENEWABLE ENERGY

India is a Developing Country: Shutting coal based energy will expose India to increasing imports of renewable technology equipment and dependence on external sources.

Is immediate Transition to RE possible?: With India on course for a 285% increase in electricity generation by 2050, traditional energy sources will prove crucial.

What about transition of people who depend on Coal???

Fossil-Fuels energy for Manufacturing: manufacturing industry requires uninterrupted supply of power, renewable energy doesn't really drive manufacturing industry.

Coal is the Base of Power Supply in India: Central Electric Authority predicts that coal will still account for around half of India's power generation in 2030 and remain crucial beyond then.

Coal or RE? The Contradiction

- Target for coal production for 2024 is 1.0 billion tonnes.
- Privatisation of coal mining and recent auctions have given a meaningful thrust to this.
- **These convey contradictory signals and raise the questions: Are our commitments feasible? Are the targets achievable, even desirable? Is there a contradiction between the two? Are we moving towards a huge demand-supply mismatch?**
- We need to make a wise assessment of constraints mixing ambition with feasibility and look at a more realistic pathway.

'JUST TRANSITION' for Indian Coal Mining Industry

Issues of Transition from Coal to RE

- Two-thirds of all coal-fired electricity needs to be phased out by 2030.
- **Whenever a power plant or a coal mine shuts down, jobs are lost and workers, their families, and entire communities suffer.**
- Barriers to transition are economic & political rather than technological.
- **Livelihood impacts**: One million people depend directly or indirectly on coal power. Income from coal royalties constitutes 50 % of total earnings of significant coal-producing states like Jharkhand and Odisha.
- **Stranded assets**: India added 151 GW of new coal power, valued at $100 billion. Coal reserves are also likely to be stranded.
- **Electricity prices**: Cost of electricity from coal power plants is still cheaper than that from renewables.

JUST TRANSITION- JHARKHAND example

- In the **Ramgarh district of Jharkhand**, local fisheries department is trying to convert **mined-out coal mines into lakes** and encourage villagers, former coal industry workers, to form cooperatives and take up fish farming as a new profession.
- In 2015, the Jharkhand government passed legislation requiring each mining district to set up a **District Mineral Foundation** (DMF), to help communities living in mining areas by empowering them and improving their economic situation. The DMFs are responsible for **collecting 10-30% of the Royalty** paid by mining companies, for using those funds to help the people living in those areas.
- Some fossil fuel industry workers **trained to acquire new skills** relevant to the renewable energy industry, which would sustain their families.

Just Transition - Solutions

- **Social compact** between key parties needed to manage the conflicts that can emerge over a transition out of coal.
- **Plan closures** - Phase out coal step by step, oldest plants first.
- **Site remediation** is important way we can restore the local environment quality and create semi and low-skilled jobs.
- **Local RE can be a source of new jobs** but ultimately diversifying the regional economy is the solution for creating new jobs beyond coal.
- **Establish funds** and authority for a just transition

What is the way Forward?

Coal to be made Environmentally Compatible:
Instead of abrupt transition to renewable energy, a range of new technologies (like Coal gasification, Coal beneficiation, Ultra Clean Coal, Pressurised Fluidised Bed Combustion, Carbon Capture & Sequestration, CCU, CMM & CBM utilisation etc.) can be deployed to make coal mining and coal-fired power plants more environmentally compatible.

Engaging With Developed Countries: India can actively engage with developed countries to mobilise funds and technology for Climate mitigation and adaptation.

Suggested way forward

- Build thermal capacity as per CEA estimates and on time. None after 2030. Retire inefficient plants.
- Plan for miner rehabilitation.
- Accelerate Renewable Energy 2030 with storage.
- Develop a battery for Indian conditions.
- Revisit manner of solar generation; Thrust on solar agriculture.
- Plan for Hydrogen economy.
- Implement strong energy demand management system into place with stronger energy efficiency and conservation practices.

Some Initiatives by the Coal Mining industry

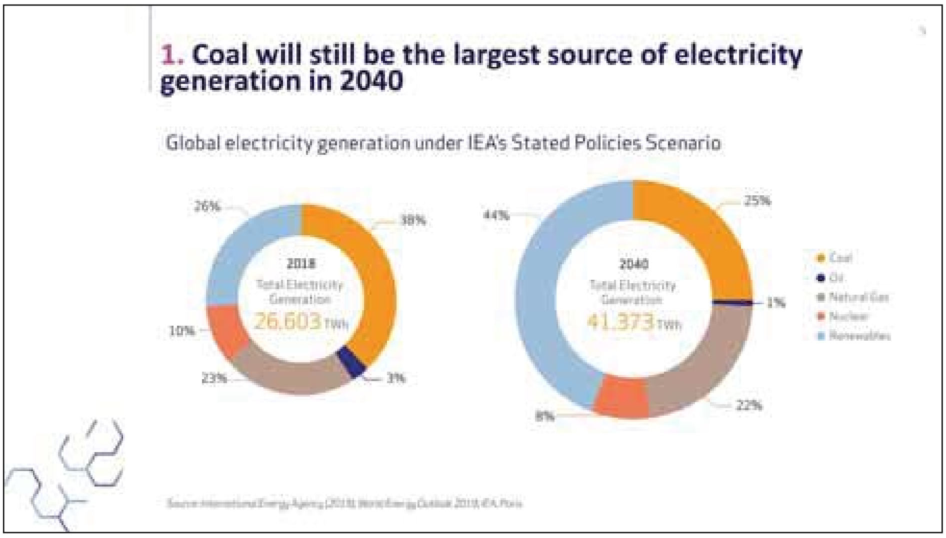
- **India declares 100 million tonnes coal gasification by 2030 with investment of Rs. 4 lakh crores, as per Shri Pralhad Joshi, Union Minister of Coal and Mines.**
- 4.85 MW Solar power capacity installation
- 100 million trees on 40,000 ha. planted
- Rs.9765 crores in Escrow account for Mine closure
- NLCIL Wind power of 51 MW; 1.35 GW solar power
- 600 MW solar power planned by SCCL
- Implementation of CMM/CBM projects
- Coal to Chemicals & Coal to Methanol

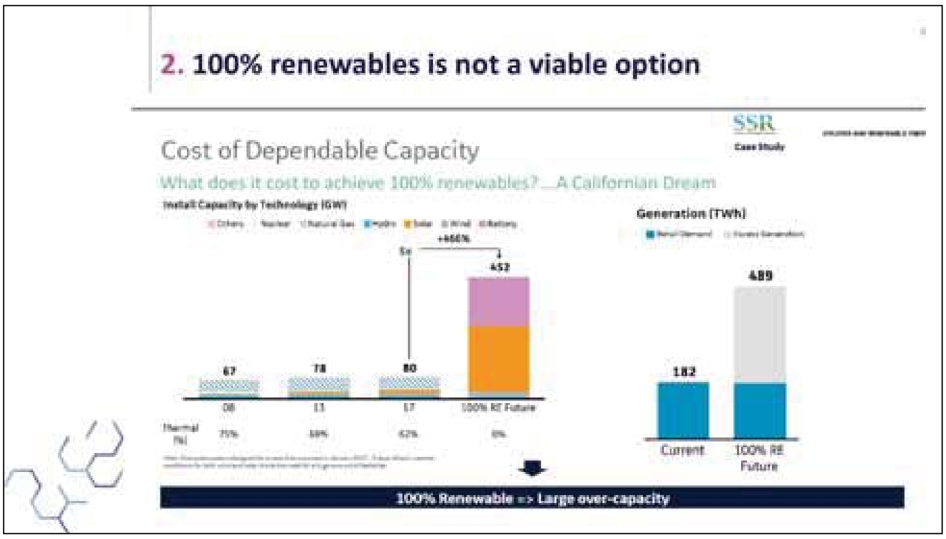

WORLD COAL ASSOCIATION
Evolving Coal – A Journey of Technology, Innovation and Collaboration
Michelle Manook, Chief Executive


Japan: An Industry Leading
Clean Coal Activist

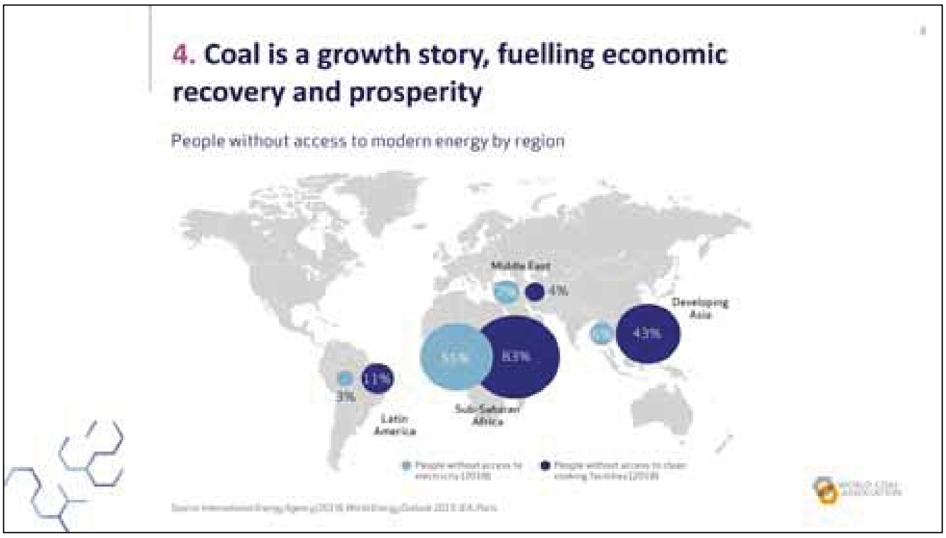

The coal industry, globally
The Global
Coal Industry

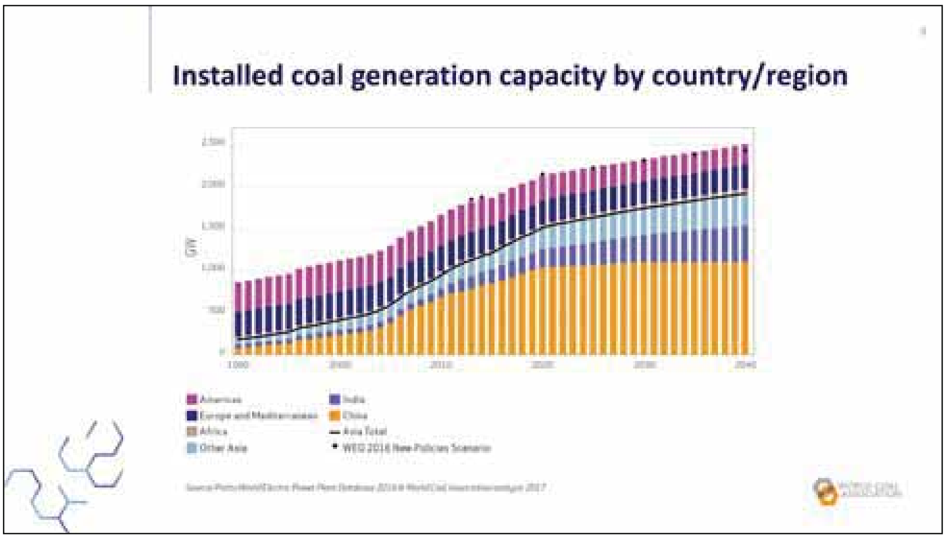

The Playbook of Coal Facts

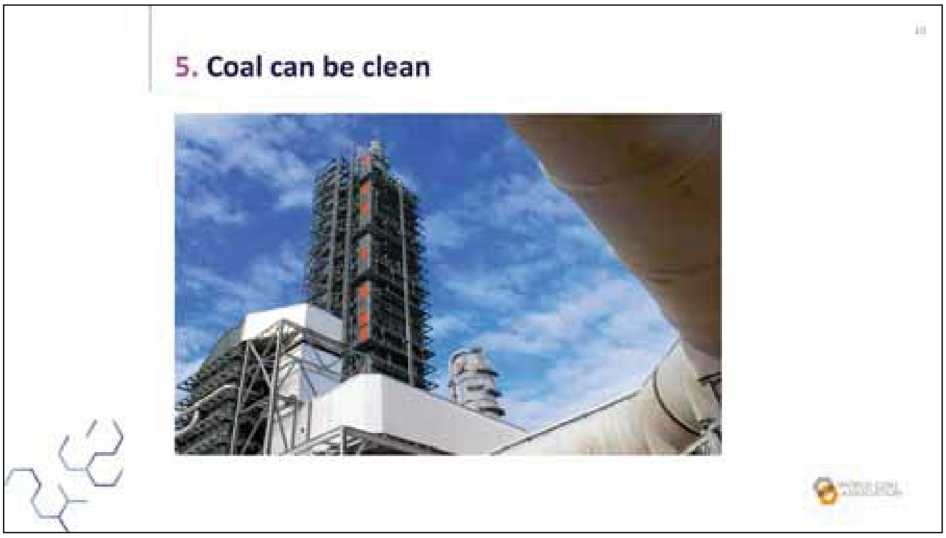

1. Coal will still be the largest source of electricity generation in 2040
Global electricity generation under IEA's Stated Policies Scenario
2018
Total Electricity Generation
26,603 TWh
26%
38%
10%
23%
3%
2040
Total Electricity Generation
41,373 TWh
44%
25%
1%
22%
8%

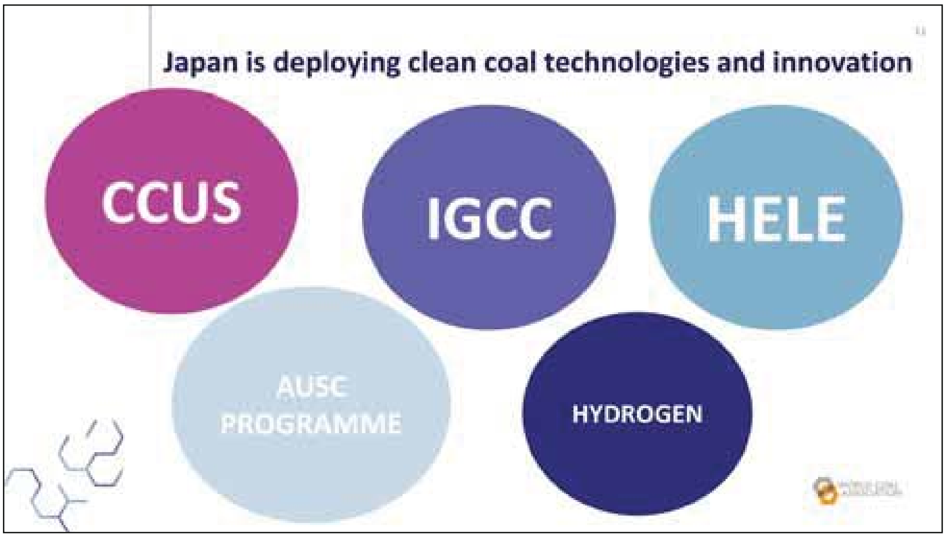

2. 100% renewables is not a viable option
SSR
Cost of Dependable Capacity
What does it cost to achieve 100% renewables? ...A Californian Dream
Install Capacity by Technology (GW)
Generation (TWh)
452
67
78
80
182
489
Current
100% RE Future
100% Renewable => Large over-capacity

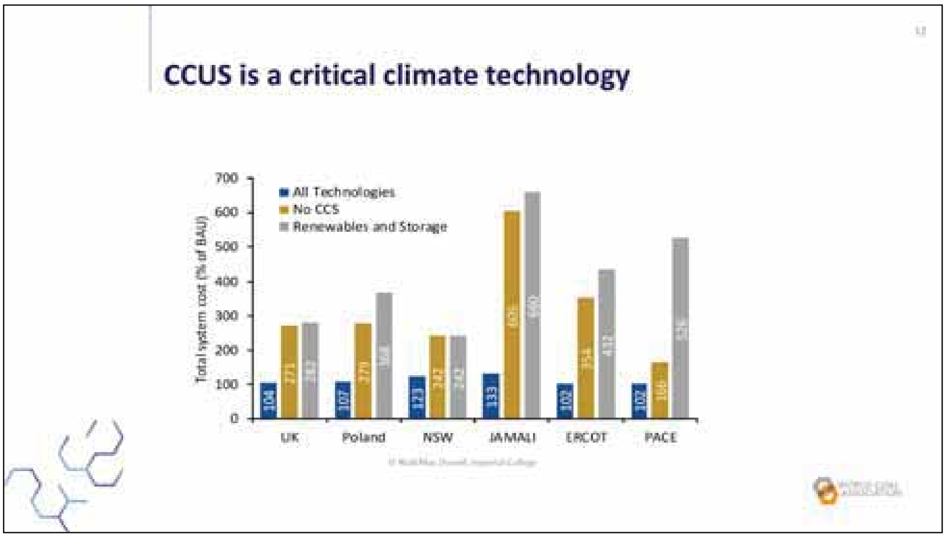

3. 70% of global steel production uses coal, and there is no near-term substitute for coal in steel production


4. Coal is a growth story, fuelling economic recovery and prosperity
People without access to modern energy by region
Middle East
4%
Developing Asia
43%
55%
83%
11%
3%
Latin America
Sub-Saharan Africa


Installed coal generation capacity by country/region
Americas
Europe and Mediterranean
Africa
Other Asia
India
China
Asia Total
WEO 2016 New Policies Scenario

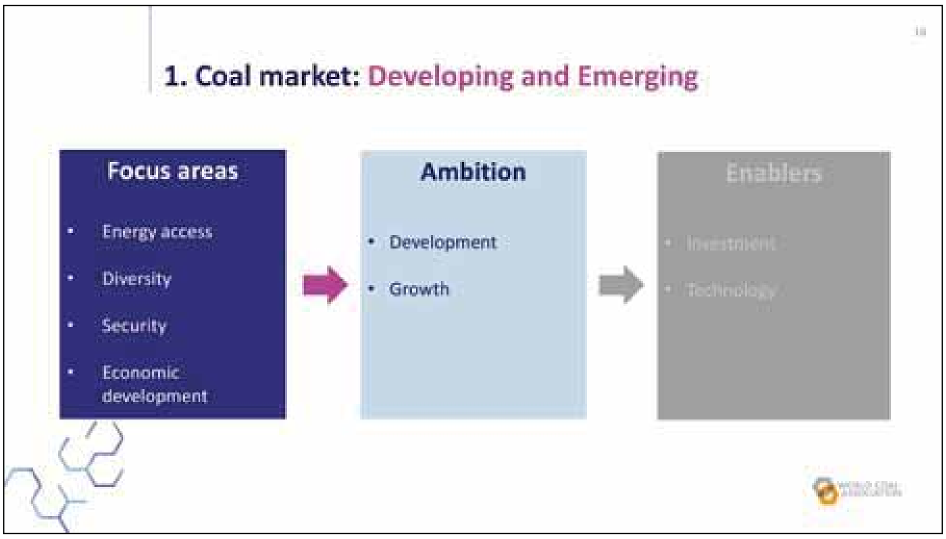

5. Coal can be clean


Japan is deploying clean coal technologies and innovation
CCUS
IGCC
HELE
AUSC PROGRAMME
HYDROGEN


CCUS is a critical climate technology
All Technologies
No CCS
Renewables and Storage
Total system cost (% of BAU)
700
600
500
400
300
200
100
0
UK
Poland
NSW
JAMALI
ERCOT
PACE
104
271
282
107
279
368
123
242
242
133
605
660
102
354
432
102
166
526


'Coal Innovators' – A Promising Trend
Coal Market One:
Developing and Emerging


1. Coal market: Developing and Emerging
Focus areas
Energy access
Diversity
Security
Economic development
Ambition
Enablers


1. Coal market: Developing and Emerging
Focus areas
Energy access
Diversity
Security
Economic development
Ambition
Development
Growth
Enablers
Investment
Technology


1. Coal market: Developing and Emerging
Focus areas
Energy access
Diversity
Security
Economic development
Ambition
Development
Growth
Enablers
Investment
Technology


Coal Market Two:
Developed


2. Coal market: Developed
Focus areas
Affordability
Energy security
Underpinning economies
Ambition
Sustaining the coal industry
Enablers
Investment
Technology
Government policy


2. Coal market: Developed
Focus areas
Affordability
Energy security
Underpinning economies
Ambition
Sustaining the coal industry
Enablers
Investment
Technology
Government policy


2. Coal market: Developed
Focus areas
Affordability
Energy security
Underpinning economies
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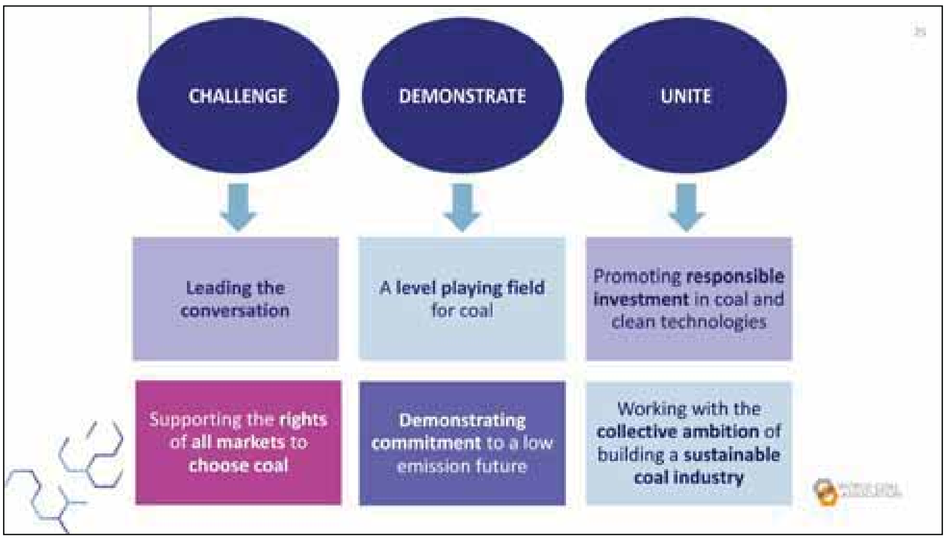
Enablers
Investment
Technology
Government policy

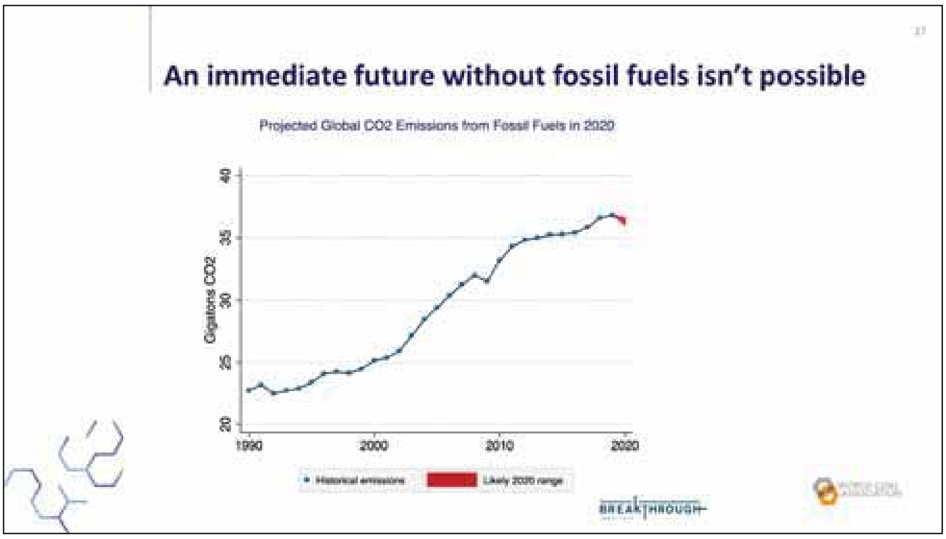

Shared Challenges
=
Shared Opportunities


The coal industry, globally
The Global
Coal Industry

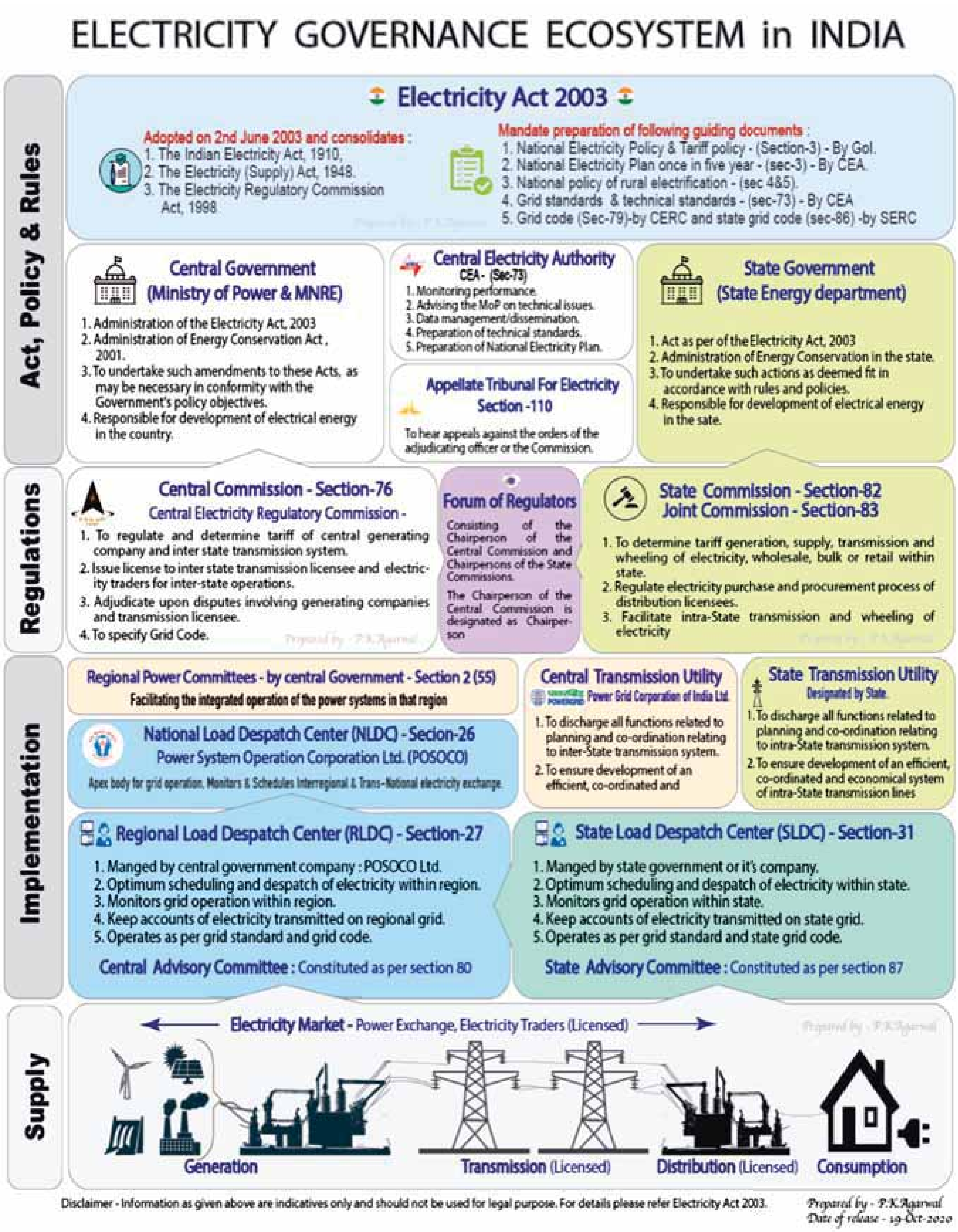

Evolving Coal: Stronger Together


CHALLENGE
DEMONSTRATE
UNITE
Leading the conversation
A level playing field for coal
Promoting responsible investment in coal and clean technologies
Supporting the rights of all markets to choose coal
Demonstrating commitment to a low emission future
Working with the collective ambition of building a sustainable coal industry


Coal is an 'essential service' addressing the real-world challenges presented by COVID-19


An immediate future without fossil fuels isn't possible
Projected Global CO2 Emissions from Fossil Fuels in 2020
Gigatons CO2
20
25
30
35
40
1990
2000
2010
2020
Historical emissions
Likely 2020 range
BREAKTHROUGH


If we are to address these global challenges, we will need a united global response


ELECTRICITY GOVERNANCE ECOSYSTEM in INDIA
Act, Policy & Rules
Electricity Act 2003
Adopted on 2nd June 2003 and consolidates :
1. The Indian Electricity Act, 1910,
2. The Electricity (Supply) Act, 1948.
3. The Electricity Regulatory Commission Act, 1998
Mandate preparation of following guiding documents :
1. National Electricity Policy & Tariff policy - (Section-3) - By GoI.
2. National Electricity Plan once in five year - (sec-3) - By CEA.
3. National policy of rural electrification - (sec 4&5).
4. Grid standards & technical standards - (sec-73) - By CEA
5. Grid code (Sec-79)-by CERC and state grid code (sec-86) -by SERC
Central Government (Ministry of Power & MNRE)
1. Administration of the Electricity Act, 2003
2. Administration of Energy Conservation Act, 2001.
3. To undertake such amendments to these Acts, as may be necessary in conformity with the Government's policy objectives.
4. Responsible for development of electrical energy in the country.
Central Electricity Authority
CEA - (Sec-73)
1. Monitoring performance.
2. Advising the MoP on technical issues.
3. Data management/dissemination.
4. Preparation of technical standards.
5. Preparation of National Electricity Plan.
Appellate Tribunal For Electricity Section -110
To hear appeals against the orders of the adjudicating officer or the Commission.
State Government (State Energy department)
1. Act as per of the Electricity Act, 2003
2. Administration of Energy Conservation in the state.
3. To undertake such actions as deemed fit in accordance with rules and policies.
4. Responsible for development of electrical energy in the sate.
Regulations
Central Commission - Section-76
Central Electricity Regulatory Commission -
1. To regulate and determine tariff of central generating company and inter state transmission system.
2. Issue license to inter state transmission licensee and electricity traders for inter-state operations.
3. Adjudicate upon disputes involving generating companies and transmission licensee.
4. To specify Grid Code.
Forum of Regulators
Consisting of the Chairperson of the Central Commission and Chairpersons of the State Commissions.
The Chairperson of the Central Commission is designated as Chairperson
State Commission - Section-82
Joint Commission - Section-83
1. To determine tariff generation, supply, transmission and wheeling of electricity, wholesale, bulk or retail within state.
2. Regulate electricity purchase and procurement process of distribution licensees.
3. Facilitate intra-State transmission and wheeling of electricity
Implementation
Regional Power Committees - by central Government - Section 2 (55)
Facilitating the integrated operation of the power systems in that region
National Load Despatch Center (NLDC) - Secion-26
Power System Operation Corporation Ltd. (POSOCO)
Apex body for grid operation. Monitors & Schedules Interregional & Trans-National electricity exchange.
Central Transmission Utility
Power Grid Corporation of India Ltd.
1. To discharge all functions related to planning and co-ordination relating to inter-State transmission system.
2. To ensure development of an efficient, co-ordinated and
State Transmission Utility
Designated by State
1. To discharge all functions related to planning and co-ordination relating to intra-State transmission system.
2. To ensure development of an efficient, co-ordinated and economical system of intra-State transmission lines
Regional Load Despatch Center (RLDC) - Section-27
1. Manged by central government company : POSOCO Ltd.
2. Optimum scheduling and despatch of electricity within region.
3. Monitors grid operation within region.
4. Keep accounts of electricity transmitted on regional grid.
5. Operates as per grid standard and grid code.
Central Advisory Committee : Constituted as per section 80
State Load Despatch Center (SLDC) - Section-31
1. Manged by state government or it's company.
2. Optimum scheduling and despatch of electricity within state.
3. Monitors grid operation within state.
4. Keep accounts of electricity transmitted on state grid.
5. Operates as per grid standard and state grid code.
State Advisory Committee : Constituted as per section 87
Supply
Electricity Market - Power Exchange, Electricity Traders (Licensed)
Generation
Transmission (Licensed)
Distribution (Licensed)
Consumption
Disclaimer - Information as given above are indicatives only and should not be used for legal purpose. For details please refer Electricity Act 2003.
Prepared by - P.K.Agarwal
Date of release - 19-Oct-2020

List of Coal Washeries in India as on end of 2019

S.No.	Washery & Operator	State of Location	Capacity (MTY)
	COKING COAL		
1	Dudga-II, CIL	Jharkhand	2.00
2	Bhojudih, CIL	West Bengal	1.70
3	Patherdih, CIL	Jharkhand	1.60
4	Moonidih, CIL	Jharkhand	1.60
5	Sudamdih, CIL	Jharkhand	1.60
6	Mahuda, CIL	Jharkhand	0.63
7	Kathara, CIL	Jharkhand	3.00
8	Swang, CIL	Jharkhand	0.75
9	Rajrappa, CIL	Jharkhand	3.00
10	Kedla, CIL	Jharkhand	2.60
11	Nandan, CIL	Madhya Pradesh	1.20
	(A) CIL		**19.68**
12	Durgapur, SAIL	West Bengal	1.50
13	DCOP, DPL	West Bengal	1.35
14	Chasnala, IISCO	Jharkhand	1.50
15	Jamadoba, TISCO	Jharkhand	0.90
16	West Bokaro-II, TISCO	Jharkhand	1.80
17	West Boakaro-III,TISCO	Jharkhand	2.10
18	Bhelatand	Jharkhand	0.86
	(B) PSU & Private		**10.01**
	TOTAL (A + B)		**29.69**
	NON-COKING COAL		
1	Dugda-I, CIL	Jharkhand	2.50
2	Madhuban, CIL	Jharkhand	2.50
3	Gidi, CIL	Jharkhand	2.50
4	Piparwar, CIL	Jharkhand	6.50
5	Kargali, CIL	Jharkhand	2.72
6	Bina, CIL	Uttar Pradesh	4.50
	(A) CIL		**21.22**

7	Dipka, ACB (India) Ltd.	Chattisgarh	14.00
8	Gevra, ACB (India) Ltd.	Chattisgarh	6.25
9	Binjhri, ACB (India) Limited	Chattisgarh	4.80
10	Chakabura, ACB (India) Limited	Chattisgarh	7.50
11	Ratija, ACB (India) Limited	Chattisgarh	11.00
12	Ratija, Maruti Clean Coal and Power Limited	Chattisgarh	3.00
13	Renki, ACB (India) Limited	Chattisgarh	2.40
14	Kanberi, Swastik Power and Sponge	Chattisgarh	0.90
15	Bhelai, Mahavir Coal Washeries Pvt. Ltd.	Chattisgarh	0.95
16	Belmundi, Mahavir Coal Washeries Pvt. Ltd.	Chattisgarh	0.95
17	Bhelai, Mahavir Coal Washeries Pvt. Ltd.	Chattisgarh	0.96
18	Bhengari, Mahavir Coal Washeries Pvt. Ltd.	Chattisgarh	5.00
19	Beltara, INDERMANI Coal Benefication & Energy Pvt. Ltd.	Chattisgarh	1.20
20	Dhatura, KJSL Coal & Power	Chattisgarh	1.20
21	Gutku, Phil Coal Benefication Pvt. Ltd.	Chattisgarh	2.50
22	Tenda, Phil Coal Benefication Pvt. Ltd.	Chattisgarh	0.96
23	Sirgiti, Chhattisgarh Power and Coal Benefication Ltd.	Chattisgarh	1.25
24	Parsada, Chhattisgarh Power and Coal Benefication Ltd.	Chattisgarh	2.50
25	Dhowrabhata, Chhattisgarh Power and Coal Benefication Ltd.	Chattisgarh	0.96
26	Sirgiti, Maheshwari Coal Benefication and Infrastructure Pvt. Ltd.	Chattisgarh	1.20
27	Baloda, Paras Power & Coal Ben. Ltd.	Chattisgarh	0.96
28	Gutku, Paras Power & Coal Ben. Ltd.	Chattisgarh	0.96
29	Gatori, SATYA Power & Ispat Ltd.	Chattisgarh	1.44
30	Gatori, Sambhavi Energy & Coal benefication Pvt. Ltd.	Chattisgarh	0.96
31	Hindhadih, Hind Energy and Coal Beneficition (India) Pvt. Ltd.	Chattisgarh	2.40
32	Hindhadih, Hind Energy and Coal Beneficition (India) Pvt. Ltd.	Chattisgarh	1.20
33	Baloda, Clean Coal Enterprises Pvt. Ltd.	Chattisgarh	0.90
34	Birgehni, Hind Energy and Coal Beneficition (India) Pvt. Ltd.	Chattisgarh	0.96
35	Gatora, Clean Coal Enterprises Pvt. Ltd.	Chattisgarh	0.96
36	Gatora, Hind Energy and Coal Beneficition (India) Pvt. Ltd.	Chattisgarh	0.96
37	Gatora, Radiant Coal Beneficiation Pvt. Ltd.	Chattisgarh	0.96
38	Surajpur, Hind Multi Services Pvt. Ltd.	Chattisgarh	0.60
39	Tamnar, Jindal Steel & Power Ltd.	Chattisgarh	6.00
40	Bilaspur, Gupta Global Resource Pvt. Ltd.	Chattisgarh	3.50

41	Panderpauni, ACB (India) Ltd.	Maharashtra	2.62
42	Wani, Kartikay Coal washeries Pvt. Ltd.	Maharashtra	2.50
43	Sasti, Gupta Global Resource Pvt. Ltd.	Maharashtra	4.00
44	Wani (Rajur), Gupta Global Resource Pvt. Ltd.	Maharashtra	4.00
45	Umrer, Gupta Global Resource Pvt. Ltd.	Maharashtra	0.75
46	Bhandara, Gupta Global Resource Pvt. Ltd.	Maharashtra	0.75
47	Pimpalgao, Gupta Global Resource Pvt. Ltd.	Maharashtra	4.00
48	Gondegaon, Gupta Global Resource Pvt. Ltd.	Maharashtra	4.80
49	Majri, Gupta Global Resource Pvt. Ltd.	Maharashtra	4.00
50	Ghugus, Gupta Global Resource Pvt. Ltd.	Maharashtra	4.00
51	Wani, Bhatia International Ltd.	Maharashtra	3.73
52	Ghugus, Bhatia International Ltd.	Maharashtra	4.00
53	Wani, Indo Unique Flame Ltd.	Maharashtra	2.40
54	Nagpur, Indo Unique Flame Ltd.	Maharashtra	0.60
55	Punwat, Indo Unique Flame Ltd.	Maharashtra	2.40
56	Ramagundam, Global Coal Mining (P) Ltd.	Andhra Pradesh	1.00
57	Ramagundam, Gupta Global Resource Pvt. Ltd.	Andhra Pradesh	2.40
58	Indaram, Aryan Energy Pvt. Ltd.	Andhra Pradesh	-
59	Talcher, Aryan Energy Pvt. Ltd.	Odisha	2.34
60	Talcher, Global coal Mining (P) Ltd.	Odisha	4.00
61	Ib Valley, Global coal Mining (P) Ltd.	Odisha	4.00
62	Jharsuguda, Bhatia International Ltd.	Odisha	2.50
63	Himgir, ACB(India) Ltd.	Odisha	5.00
64	Talcher, ACB (India) Ltd.	Odisha	11.00
65	Bandabahal, (HIND) Earth Mineral Co. Ltd.	Odisha	4.00
66	Dharamsthal, BLA Industries	Madhya Pradesh	0.33
	(B) Private		**173.36**
	TOTAL (A+B)		**194.58**
	Gross Total (Coking+Non-Coking)		**224.27**

Source: *Office of Coal Controller, Ministry of Coal and Industry sources.*

Knowledge Corner

Raw Material (Minerals/Ore/Coal) Transportation Modes

No	Transportation		Applicability	Merit	Demerit
1	***Road***		1. Almost 70% of raw material transportation is done through roads. 2. Mostly used for transportation of sized material from mine / stocks or pit head to a delivery point.	✓ Provides end to end connectivity i.e. directly from source to end user plant or consumer ✓ Mostly preferred for relatively shorter distance transport i.e. from 10 Kms to 200 Kms	○ Becomes uneconomical with high quantum and large distance transportation (due to high fuel cost) ○ Fines can't be transported ○ Road connectivity is a challenge
2	***Rail***		1. Used for transportation of high quantity of material through larger distance up to 1500 Kms 2. Infrastructure like railway network, railway siding, storage arrangement, loading & unloading arrangement are required	✓ Mostly preferred and cheaper mode of raw material transportation for very large distance ✓ Large quantity of material can be transportation	○ It doesn't always provide end to end connectivity and may require alternate arrangement like trucks or conveyors in combination ○ Dependent on availability of railway infrastructure
3	***Ship***		1. It is mostly suited for end user plants located at coasts and connected through inland waterways 2. Provide cheap transport for heavy, bulky, imperishable commodities	✓ Waterways transport provide the only practical route for difficult, inaccessible terrain or areas of dense tropical forest ✓ Cheapest mode of transport	○ Very slow mode of transportation and takes very high time ○ It is dependent upon port handling or waterways infrastructure for material handling

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

Raw Material (Minerals/Ore/Coal) Transportation Modes

No	Transportation		Applicability	Merit	Demerit
4	***Belt Conveyor***		1. Suitable for short distance material transportation i.e. up to 30 Kms 2. Continuous material transportation system especially deployed for material haulage directly from underground to surface	✓ Faster mode of material transportation ✓ Suitability in difficult to access terrains with changes in elevation	○ High installation cost (CAPEX) ○ Fines can't get transported ○ High O&M Cost
5	***Pipe Conveyor***		1. Suitable for very large distance transportation 50 kms – 100 kms 2. Ability to negotiate sharp turns and steep angles 3. It is environmental friendly	✓ Faster mode of material transportation ✓ Suitability in difficult to access terrains with changes in elevation	○ Very high installation cost (CAPEX) ○ High power requirement to drive the motor
6	***Aerial Ropeway***		1. Aerial ropeway transit is used for very small distance transport i.e. mainly for pit head end user plant 2. It act as a direct haulage form source and provides end to end connectivity	✓ Relatively low capital expenditure is required ✓ It finds its suitability in the difficult terrain i.e. crossing river, valley, etc. as well	○ Limited quantity of raw material can be transported ○ High maintenance is required due to tipping of cable cars
7	***Slurry Pipeline***		1. Slurry pipeline is used for very long-distance material transportation 2. Pipeline is generally buried, the land above it can be used again for other alternate purposes	✓ Low space is required ✓ Terrain advantages ✓ Less supervision needed ✓ Zero discharge ✓ Very low operating cost	✓ Mineral wise size restriction is a challenge ✓ Huge water requirement ✓ High capital Cost

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Industrial Classification of Minerals & Metals

Classification of Minerals & Metals

Ferrous Metals	Non Ferrous Metals	Base Metals	Precious Metals	Rare Earth Metals
1. Iron 2. Cobalt 3. Manganese 4. Chromium 5. Molybdenum 6. Vanadium	1. Aluminium 2. Tin 3. Magnesium 4. Titanium	1. Lead 2. Zinc 3. Copper 4. Nickel	1. Gold 2. Silver 3. Platinum 4. Palladium 5. Rhodium 6. Iridium	1. Scandium 2. Yttrium 3. Lanthanides *(15 minerals)*

1. *Ferrous metals are having high tensile strength, durability & having magnetic effect and their characteristics recognized by their use in tall buildings and long bridges*
2. *Nonferrous metals are non-magnetic having great electrical & thermal conductivity, easy to fabricate and high corrosion resistance*
3. *Base metals is used informally to refer to a metal that oxidizes or corrodes relatively easily and reacts variably with diluted hydrochloric acid to release hydrogen*
4. *Precious metals that are rare and have a high economic value and are tend to be less reactive*
5. *Rare earth metals are of most strategic importance and are used in smartphone, electrical devices and magnets etc.*

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Taxation Issues in Indian Mining Sector

- *Indian mining sector is very highly taxed, and there is significant opportunity to rationalize the tax structure for the long-term sustainability of the mining sector*
- *Indian Corporate Taxes are highest amongst the mining rich countries*
- *Cost to the miner is further increased considering high auction premium of recently concluded mineral auctions*

1 Royalty

- ✓ Royalty is included in the published notified prices (ex-mine) of minerals (iron ore, etc.) by IBM. Application of royalty on this published notified prices
- ✓ GST is again payable on Royalty, DMF & NMET a tax on tax
- ✓ Royalty on highest grade is applicable in place of actual grade
- ✓ Higher rate of royalties as compared countries like Australia, Indonesia, South Africa

2 GST

- ✓ Higher rate of GST on Input Services (18%) w.r.t to GST rate on sale of Mineral/Coal (5%)
- ✓ Unutilized input tax credit (ITC) a cost in the hands of miner
- ✓ In case of captive miners as GST is also applicable on Auction Premium
- ✓ Non-availability of inverted duty structure refund on account of rate of Input Services higher than Output rate
- ✓ Payment for mining leases is regarded as supply attracting GST

3 Others

- ✓ Central Sales Tax is leviable on High Speed Diesel (HSD)
- ✓ Mining lessee can obtain HSD at concessional rate against FORM-C for supplying the same on free of cost basis to mining contractor
- ✓ The lessee transferee must pay upfront transfer fee along with the royalties. The new owner needs to pay exiting royalties + transfer fee (~80% of royalty)
- ✓ Electricity is notifiable goods under the central excise tariff

Taxation in Indian Mining Sector

Royalty

Dead Rent

NMET

DMF

Surface Rent

Other Principle Taxes

- ✓ Direct Taxes such corporate tax or MAT
- ✓ Indirect Taxes like custom duty, service tax, value added tax (for imported material)
- ✓ Stamp Duty
- ✓ Water Tax
- ✓ Forest Related Taxes
- ✓ Mineral Ore Cess (If any)
- ✓ GST compensation cess
- ✓ Electricity duty
- ✓ Freight taxes on fuel

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Coal Washing for Clean Coal Technologies – Part A

India Coal Characteristics

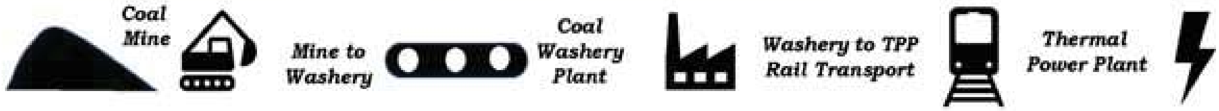
- ✓ India has 13% of total world's proven coal reserve
- ✓ India is 2nd largest coal producer
- ✓ Indian coal has high Ash content from 24% to 55%
- ✓ Indian coal has low Sulphur content 0.4% to 0.7%

Why Coal Washing is Required?

1. Washing of coal is a simple & cost-effective technique
2. It removes extraneous material for reducing the ash content from the coal
3. Post washing coal burns efficiently in power plants boilers with significantly reduced emissions
4. Washing reduces inorganic part of Sulphur in coal & reduces SOx emissions
5. Coal washing is in line with the commitments made for reduction of emission intensity of India's GDP by 33% to 35% in 2030
6. Coal beneficiation is the oldest technology used by coal suppliers across the world

Washed Coal Benefits for TPP

- ✓ Saving in coal transport cost
- ✓ Increase in plant load factor
- ✓ Reduction in specific coal consumption
- ✓ Reduction in breakdown time
- ✓ Increase in overall efficiency
- ✓ Reduction in emissions



Assured supply of washed coal of appropriate quality an adequate volume, will trigger faster implementation of clean coal technologies that will lead to higher energy efficiency of the entire sector (from coal mine to power plant) and result in tariff reductions necessary to enhance the competitiveness of Indian Industry

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Coal Washing for Clean Coal Technologies – Part B

No.	Key Result Areas – After Using Washed Coal with 34% Ash		Benefits of Using Washed Coal at Thermal Power Plant
1#	Improvement in Plant Utilization factor	▲	Improvement in Plant Utilisation Factor ~73% to 96%
2#	Improvement in Power Generation	▲	Power Generation Increased by 16% using Washed Coal
3#	Reduction in Specific Coal Consumption	▼	0.55 to 0.50 kg/kWh (industry norms of 0.65 To 0.75 kg /kwh)
4#	Reduction in coal transport cost	▼	~15% overall savings over 1000 Kms Run
5#	Reduction in CO_2 Emissions	▼	Reduction in CO_2 of 2% - 3% when using washed coal
6#	Decrease in Auxiliary Power	▼	~1% decrease for 1% decrease in coal feed
7#	Decrease in Auxiliary Fuel	▼	50% reduction when using washed coal
8#	Improvement in Plant Load Factor	▲	1.5% improvement for every 10% reduction in feed coal ash.
9#	Reduction in Ash Generation at Thermal Power Plant	▼	Tentative Reduction in Ash Generation by 8.5%
10#	Reduction in O&M costs	▼	20% cost reduction for every 10% reduction in feed coal ash.
11#	Reduction in Capital Investment for New Power Plants	▼	5% reduction in Capital Investment when using coal with 34% ash
12#	Reduced Land Requirement for Ash disposal	▼	Reduces Land requirement by approximately 30%.
13#	Reduced Water Requirement of Ash Disposal	▼	Reduces Water Consumption by approximately 30%.
14#	Improvement in Electrostatic Precipitator Efficiency	▲	ESP Efficiency from 98% to 99% thereby reducing PM2.5 pollutants
15#	Reduction in Plant Breakdown Period	▼	Up to 60% reduction in TPP breakdown period
16#	Improvement in Overall Efficiency of Thermal Power Plant	▲	Improvement in overall efficiency of up to 1.2%

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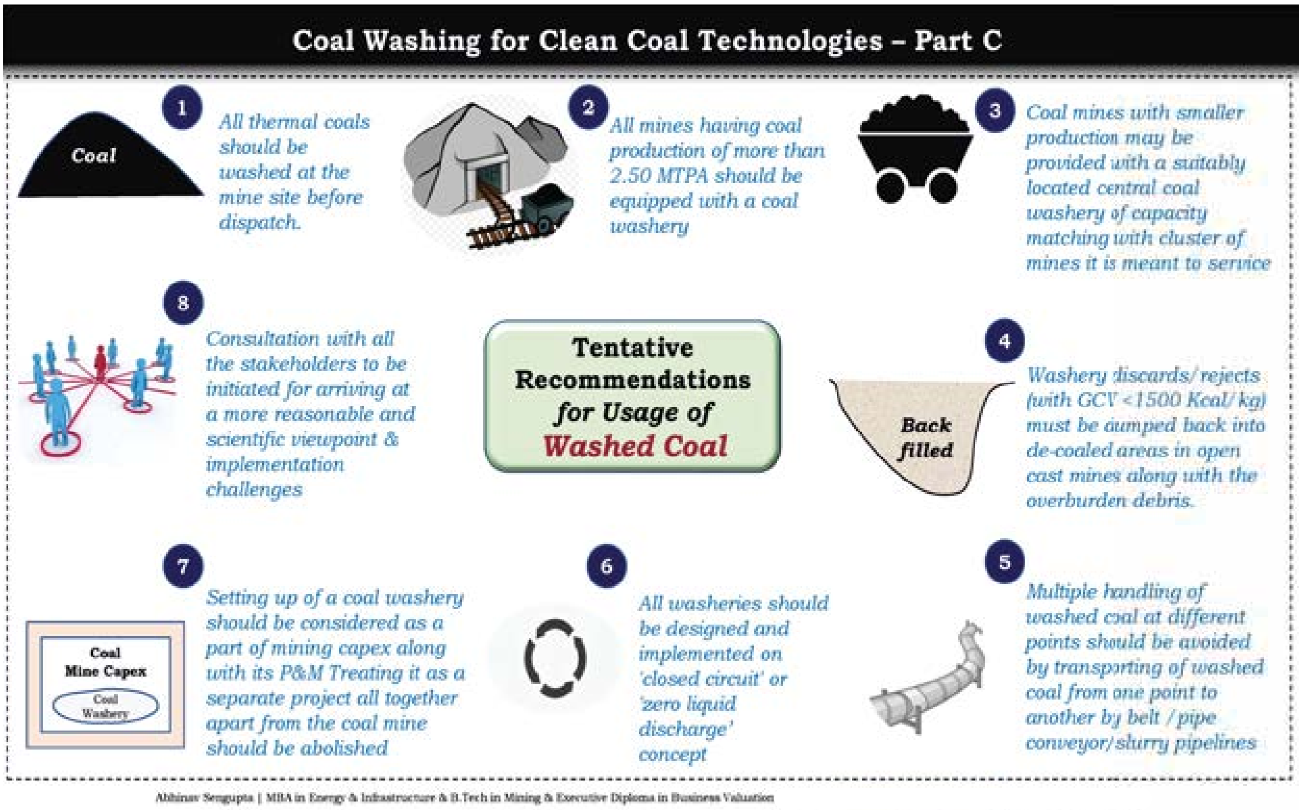
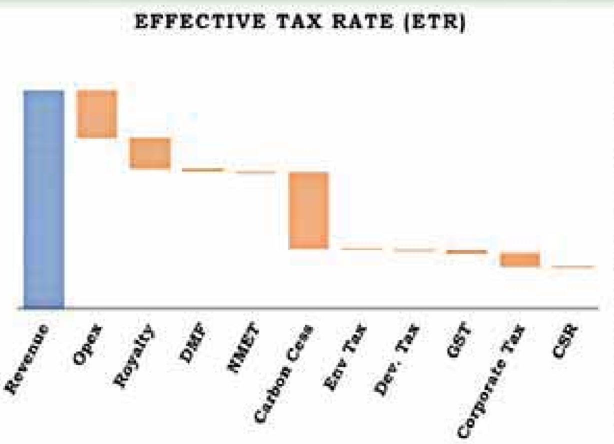


Effective Tax Rate on Commercially Mined Coal

Heads	Rs./Tonne	%	Remarks
Revenue (SP)	1,145.00	100.00%	G11 - Power Grade
Operating Exp	250.00	21.83%	Assumed
Gross Profit	895.00	78.17%	
Royalty	160.30	14.00%	14% of Selling Price
DMF	16.03	1.40%	10% of Royalty
NMET	3.21	0.28%	2% of Royalty
Carbon Cess	400.00	34.93%	As Per Gov. Policy
Env Tax	5.00	0.44%	State wise Calculation
Dev. Tax	5.00	0.44%	State wise Calculation
GST	8.98	0.78%	5% on Assessable Value (Irrecoverable)
PBT	296.49	25.89%	
Corporate Tax	74.63	6.52%	Corporate Tax @ 25.17%
PAT	221.86	19.38%	
CSR	4.44	0.39%	at 2% of PAT
Total Taxes	***677.58***	***59.18%***	***Effective Tax Rate***



- *Indian Mining Effective Tax Rate is **~60%** which is relatively very high as compared to Australia, Mongolia, Canada, Chile, Indonesia, South Africa*
- *ETR does not include auction premium, purchase of Land, GST on Royalty & Premium, NPV paid for Forest area, CA charges, Upfront payment, Performance security & other State based cess and duties*

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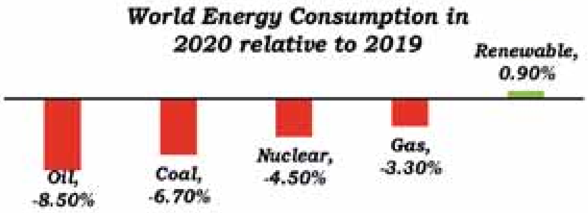
IEA World Energy Outlook 2020

Major Highlights of IEA World Energy Outlook 2020

- ✓ *Solar energy is going to become the next king for the electricity generation followed by onshore & offshore wind*
- ✓ *India to become largest market for utility battery storage by 2040*
- ✓ *The importance of electricity networks for transmission & distribution rises even more with faster energy transitions*
- ✓ *Coal demand does not return to pre-crisis levels by 2030 and further will continue to fall*
- ✓ *Global Oil demand comes to an end within ten years, but the shape of the economic recovery is a key uncertainty*
- ✓ *Natural Gas fares better than other fossil fuels, but different policy contexts produce strong variations*
- ✓ *With today's energy infrastructure continues to operate as it has in the past, it would lock in by itself a temperature rise of 1.65 °C*
- ✓ *Contribution of biomass, biofuels & low carbon hydrogen will increase by 2040 in world energy basket*
- ✓ *Cities see major improvements in air quality by 2030 without disruptions to the economic activity*



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Hydrogen the Next Generation Energy Source!

Why Hydrogen is Important?

Hydrogen is a super-versatile energy carrier with exceptional energy density i.e. more than twice that of natural gas. It can be a fuel to supplement or displace others in transportation, heavy industry and many other applications.

H ***Grey Hydrogen***

It is entirely based on fossil fuels. Around 71% is grey hydrogen through steam methane reformation or SMR

H ***Brown Hydrogen***

It is formed through gasification of coal & lignite. It results it high emissions and carbon generation

H ***Blue Hydrogen***

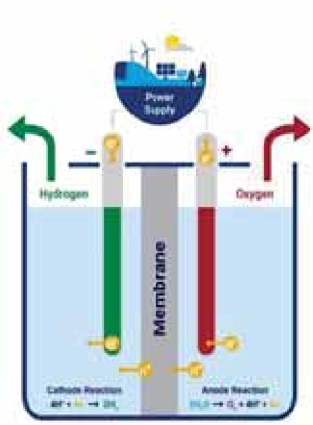
Current technology wherein the hydrogen production process is paired with carbon capture and storage (CCS)

H ***Green Hydrogen***

Produced from water by renewables-powered electrolysis process

- ✓ Globally hydrogen is exclusively produced by hydrocarbons
- ✓ Grey, brown & black hydrogen make up 99.6%
- ✓ Green Hydrogen is barely 0.1% of global hydrogen
- ✓ The top 10 countries account for 70% of hydrogen demand
- ✓ USA & China are the major drivers for the demand
- ✓ Indian Oil is betting on Hydrogen vehicle for transportation
- ✓ RIL is also planning to decarbonize completely by 2035

Hydrogen can provide a supplementary role to renewables and batteries, in a transition to become a carbon neutral economy



Uses: Decarbonization of Steel | Decarbonization of Cement | Methane Blending in Gas Pipelines | In fuel Cell for Electric Vehicles

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Privatisation of Discoms – Is the only respite? - Part A

Raw Material Supplies → Power Generation → Power Transmission → Power Distribution → End User

The distribution sector is the last mile in the power sector value chain, where Discoms directly deal with the consumers. In India it is a combination of commercial business and public service, operating in a highly regulated environment. At present, private utilities are serving a mere 10% of consumers of India, across licensees and franchisees combined, mostly limited to the urban centers.

Indian DISCOM Perennial Issues

1. Week Financial Performance
2. High Operational Losses
3. Poor Customer Service

What is the need for Discom privatization?

1. Rising consumer expectation for providing 24 X 7 power supply, a requirement many states are unable to meet
2. Unsustainable operational losses pointing towards subsidies & borrowings to fill in the gap
3. Covid-19 had further affected the demand and poor collections of bills ultimately leads to high liquidity constraints
4. Govt supports measures like UDAY & Atmanirbhar Bharat liquidity package of (Rs. 90,000 Cr) were just a remedy and not a sustainable solution
5. Sudden spurt in technology adoption in private sector like smart meters, smart grids etc. for improving the efficiency has paved the way for investment through private participation
6. New changes like integration of renewables, proliferation of microgrids and expansion of battery storage has made the task of grid management more technical and complex. Thus it required skilled workforce, technology and R&D infusion

Role of Govt. *is to provide the new successor of the power distribution facility a clean & clear balance sheet with proper addressing of issues like* ***existing baskets of PPAs, asset transfer, treatment of pending dues, other legal issues*** *to attract private sector participation*

Indian government has announced privatisation of the distribution segment in union territories (UTs) as this could lead to standardization of processes; as standard bidding document (SBD) would be in place for other states to adopt. Further selection of UTs for the power distribution reforms has strategic advantages due to presence of large cities under UTs such as Chandigarh, Daman & Diu, Pondicherry along with the status of Discoms are relatively better of. Therefore, successful UTs privatization would set an example for other states to emulate the same.

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Privatisation of Discoms – Is the only respite? - Part B

Challenges faced by the Government

1. Proper treatment of the past liabilities
2. Tackling employee resistance
3. Lack of policy framework
4. Lack of competition
5. Defining the roles & responsibility of regulatory commission
6. Managing the transition support towards privatisation
7. Redefining the tariff subsidy support provided by the government

Challenges faced by the Private Players

1. Uncertainty in allowance of expenditures by regulators
2. Treatment of capital expenditures
3. Issues of regulatory assets its ownerships, transfer, management & monetization
4. Accuracy of baseline data provided by govt. for bid submission
5. Realistic estimation of loss reduction trajectory
6. Flexibility against power purchase cost

The biggest challenge in discoms is posed by missing linkage between the performance and rewards/penalties, including the monetary incentives which are often available with private players. Mismanagement of Utilities over time has resulted in :

- ▲ Lack of accountability
- ▲ Distorted internal communication
- ▲ Role obscurity amongst employees
- ▲ Management apathy towards capacity building of staff
- ▲ Obsoleteness of technology and inefficiency in business processes

Tentative Models for Privatization Plan

Based on who is the driving force behind the process

1. Complete Privatisation

- ✓ ***Transfer of assets to investor :*** *Wherein the assets are transferred at a value to the bidder. E.g. Odisha discom privatization exercise*
- ✓ ***Right to use model :*** *Wherein existing assets remain with the incumbent and an annual fees is paid for the usage. Bidding variations can be based upon:*
  - i. *Efficiency parameters like reduction in AT&C losses*
  - ii. *Equity valuation-based bidding*
  - iii. *AT&C loss reduction commitment-based bidding*
  - iv. *Availing the viability gap funding (VGF) parameter*
  - v. *Subsidy reduction and replacement of DG sets*

2. Distribution Franchise

- ✓ *Distribution Franchise (DF) is a contracting based business and it doesn't give DF the right to undertake capital investment. There is a lack for regulatory purview as the DF focuses mainly upon collection efficiency while consumer service takes a back seat*

3. Outsourcing

- ✓ *Segregated activities for distribution segment like metering, billing and collections are outsourced to the private players*

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POLSKIE TOWARZYSTWO PRZERÓBKI KOPALIN

POLISH MINERAL ENGINEERING SOCIETY

Al. Mickiewicza 30, 30-059 Kraków, Poland

Cracow, 2020, Oct. 27

Mr. Raj Kumar Sachdev
President
Coal Preparation Society of India
1332 A/B, Vasant Knuj
New Delhi-110070
India

Dear President

On the occasion of the 20th anniversary of the Coal Preparation Society of India (CPSI), on behalf of the Council, the Board and members of the Polish Mineral Engineering Society, I would like to ask the Honorable President to accept sincere congratulations and wishes for further development.

CPSI as a non-profit non-governmental organization associating members from the hard coal, energy and iron as well as steel mining sectors is now a well-known organization, not only in India but also abroad, promoting deep coal enrichment technologies and its environmentally friendly use as an energy source.

Daily hard work and commitment resulted in a well-established position of CPSI in India and in the world, a tangible example of which was the 19th International Coal Preparation Congress in New Delhi, organized with great success in 2019.

Expressing satisfaction with the fact of many years of cooperation, innovative experiences and personal acquaintances, I hope that in the coming years we will be able to strengthen mutual contacts and jointly implement new ideas supporting the development and transformation of Indian and Polish economy.

I kindly ask you to pass to all CPSI members my sincere congratulations and wishes of health (especially in the era of the global COVID-19 pandemic), personal well-being and many successes for the years to come.

Yours sincerely
Wieslaw BLASCHKE
IOC/ICPC Member

Yours sincerely
Ireneusz BAIC
President PMES
IOC/ICPC Member

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27 1020 2906 0000 1102 0186 8553

Greetings from Ukraine

Dear Colleagues,

Coal Preparation Society of Ukraine sends its warmest congratulations to the Coal Preparation Society of India as it celebrates its 20th Year.

We admire the dedication of the CPSI over the all years of the many inspiring and thought provoking conferences and events they provide to the sector professionals, working hard to offer the platform for coal, power, iron and steel industries targeted to introduction of clean coal technologies.

CPSU recognises that the CPSI plays a key role in promoting washing of domestic coal to improve the quality that leads to more environment friendly usage of coal as a source of energy.

We send our very best wishes to all at CPSU in its 20th Year and wish you further success for many years to come.

— Dr. Oleksandr Yehurnov.
CEO Coal Preparation Society of Ukraine

Congratulations Sir. Mining industry really benefited by professional like you sir. May god bless you for good health and continue your journey further milestones sir.

— Vignesh

Sir, many congratulations and best wishes

— Brij Gandhi
Finance Professional

R N Sharma, Former Chairman of Coal India Ltd. congratulates CPSI

Congratulations... The society under your leadership has served the coal preparation segment. It has brought to forefront the importance of the issue. News bulletin has been informative... Impact of persistent advocacy is already showing in the rising number of beneficiation plants growth.

To the Coal Preparation Society of India (CPSI)

Greetings and salutations from the Coal Preparation Society of America (CPSA) on the occasion of your 20th anniversary! We applaud you for your excellent journal, which has become a must-read publication, and for executing the 19th International Coal Preparation Congress in New Delhi in 2019 with great success. The proceedings of the Congress will certainly become a valuable reference.

With great regards,

— Barbara J. Arnold, Ph.D., P.E.
Coal Preparation Society of America
Secretary and ICPC International Organizing Committee Representative

CPSI is truly dedicated and unbiased in its mission. It has exhibited its missionary zeal for rightful causes in its domain in the best national interest over last two decades under the leadership of Mr. Sachdev. The good thing is that the society has its feet firmly on the ground in believing that coal shall remain the affordable, accessible and available fuel for power generation for foreseeable future. Renewables progressing to grid parity is most welcome, must receive all encouragement and gain larger share in the energy mix. It can exist with coal power and thus two are not in competition but supplementary to each other to meet staggering power demand. In this context, the theme of the upcoming conference 'Coal to dominate India's Energy Mix: Preparing it for responsible usage is imperative' is timely and topical. Wish it a larger responsive audience and meaningful deliberation.

— P.K. Patnaik
Corporate Counsel & Independent Director

Congratulations for your perseverance and competence in bringing CPSI to this stage your contribution is laudable soon you should become International President.

— Dr. M P Narayanan
Past Chairman, Coal India Ltd.

Congratulations, Mr. Sachdev.

— Nick Mellor,
General Manager (Rest of Asia),
Prince Intentional Corporation,
Bangkok, Malyasia.

Well deserved!

— Bart Malan,
International Business Development Manager,
Multotec, Pty Ltd, South Africa.

Inspiring contribution!

— R Ramakrishnan,
Cofounder of CoResources and
MD, aXYKno Pvt Ltd.

Congratulation.

— Kassim Gokal
Commercial Director,
PT Sulawesi Bunker Terminal,
Jakarta, Indonesia.

Great efforts at your individual level, kudos to you sir!

— Avdesh Sharma,
MD, Eleven Group of Companies and
Director, IREC.

Inspiring journey. Congratulations Sir!

— Dipankar Khan,
GM (Geology), Hindalco Ltd.

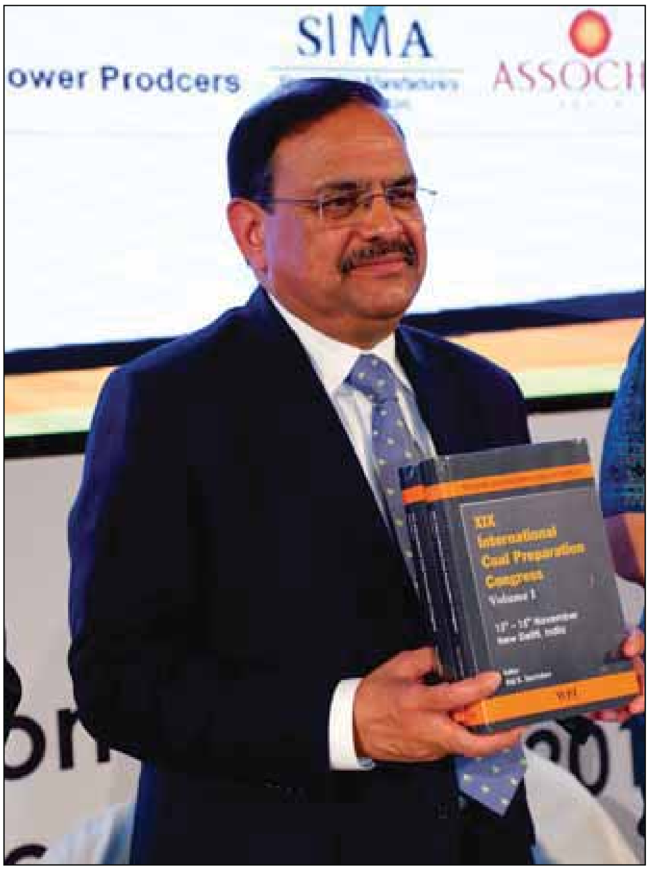
Many congratulations sir! Eninrac wishes you and the team of Coal Preparation Society of India very all the best for future and look forward to your continued knowledge contribution in the field on coal and energy. Best regards,

— Eninrac Consulting Pvt Ltd.

Some Nostalgic Pictures of Important Activities in last 10 years

XIX International Coal Preparation Congress & Expo (ICPC)

13-15th November 2019, New Delhi - India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Organised by
CPSi
Coal Preparation Society of In
XIX ICPC
New Delhi
XIX International Coal Preparation Congress & Expo 2019
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Supported by


Coal resources
Production and consumption statistics
Coal grading and Coal pricing
Coal quality
Washing of coal
Coal policy
India's low carbon approach
Concluding remarks


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PARTITION ENTERPRISES


WEIHAI HAIWANG HYDROCYCLONE

Glimpses of the Roundtable Conference on Coal Washeries

held at **MoEFCC, Indira Paryavaran Bhawan, New Delhi on 16th October, 2018**

5th International Conference on Coal Washing

Theme : Coal Washing – a sustainable approach towards greener environment

6th and 7th November 2017, New Delhi


5th International Conference & Exhibition
'Coal Washing : A Sustainable Approach Towards Greener Environment'
6 - 7 November, 2017 India Habitat Centre, New Delhi
Organised by : COAL PREPARATION SOCIETY OF INDIA
in association with : ASSOCHAM


5th International Conference & Exhibition


ASSOCHAM
Sponsors
Shri C K Mishra

1st International Workshop on Coal Quality

held at **New Delhi** on the **9th and 10th November, 2016**

International Conference on

"Sustainable Energy Development: Opportunities and Innovation for Indian Coal"

18th October, 2016 at New Delhi

Glimpses of XVIII International Coal Preparation Congress 2016

Saint Petersburg, Russia from 28th to 30th June'16

Mr. A B Yanovskiy Dy. Minister of Energy, Mr. L A Weisberg IOC Chairman of 18th ICPC, Mr. R K Sachdev President Coal Preparation Society of India and Mr. V S Litvinenko Rector of the St. Petersburg University and Dy. Chairman of National Organising Committee joining hands and passing on the Congress responsibility to India.

Indian Delegation

Glimpses of International Conference on Coal Washing

16th - 17th April, 2015 at **Hotel Ashok, New Delhi**

Glimpses of XVII International Coal Preparation Congress

October 1-6, 2013

Indian Team with Chairperson of International Organising Committee (IOC) of 17th ICPC

Opening Ceremony of 17th ICPC

Shri R.K. Sachdev, President, CPSI presenting the Country Report at the Opening Session

Shri R.K. Sachdev, President, CPSI addressing the participants

Members of International Organising Committee (IOC)

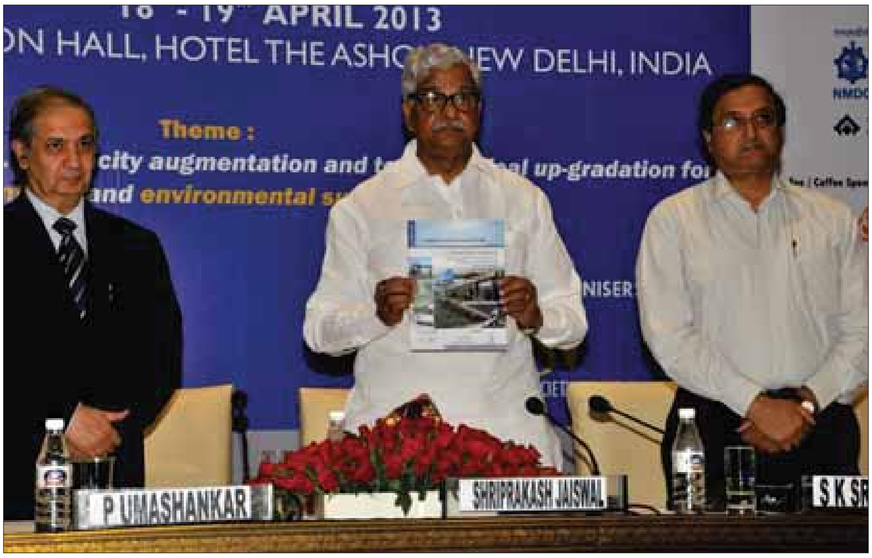
Indian team at 17th ICPC

12th Clean Coal Forum 2013

held on **4 and 5 December 2013 at Jakarta, Indonesia**

International Conference & Expo on Coal Beneficiation

18-19 April 2013, New Delhi


APRIL 2013
Theme :
P UMASHANKAR
SHRIPRAKASH JAISWAL


Beneficiation


CONVENTION

International Conference on Enhancement of Washery Capacity – a priority for the Indian Coal Industry

November 25-26, 2011, New Delhi - India

Two-day International Conference on
"Enhancement of Washery Capacity - a priority for the Indian coal industry"

November 25-26, 2010 • ***Venue :*** Jacaranda Hall, India Habitat Centre, Lodhi Road, New Delhi


COAL PREPARATION SOCIETY OF INDIA
P. UMA SHANKA
ONAB SEN
R.K. SA


Opportuniti
gupta

Meeting of International Organising Committee (IOC) for XVI International Coal Preparation Congress

held in April, 2009 at Lexington, Ky. USA

PARTICIPANTS

Separate sessions for technical presentation by slides and projection of technical films were also held.

All the 36 technical papers bound in elegant book form and printed in 4 languages, English, Russian, French and German, were made available to the delegates in advance and during registration.

D. N. Prasad

D.N. Prasad, a Mining Engineer from the 1978 batch of College of Engineering, OU, was the topper of his batch and obtained two gold medals. He holds First Class Mine Manger's Certificate of Competency to manage Coal Mines under the Mines Act, 1952. He did his MBA from the University of Hull, UK.

Mr Prasad has an overall experience of about 42 years comprising both Operation and Management of Coal Mines and Development Policy Planning for Coal and Lignite in the Government of India. He served Coal India Ltd., and Singareni Collieries Co. Ltd for about eleven years before joining Govt. of India in 1990. He had served the then Planning Commission in the Power & Energy Division and Project Appraisal Division for about 15 years and shifted to the Ministry of Coal as Director (Technical) and got elevated as Adviser and served the Ministry for about 12 years dealing with all technical matters of the sector. Post superannuation, Mr Prasad has joined SCCL as Adviser (Mining) and continuing as such.

His work experience covers development of coal and lignite resources encompassing exploration, production, techno economic appraisals of projects, project planning and monitoring, environmental management, development of clean coal technologies, infrastructure planning, energy planning etc.

He is of Prof. IKI award from Japan Coal Energy Centre (JCOAL), Tokyo, Japan for his contribution in development of coal sector of India and bilateral co-operation for development of coal sector of Japan.

Devendra Arolkar

Devendra Arolkar, Director & Board Member, Mohit Minerals Limited (a 2200 Cr Company) is a well-known industry professional and a regular speaker at various business events. Mr. Arolkar has over three decades of experience; 2 decades in L&T-Caterpillar JV for Mining Equipment and thereafter one and half decade in Coal & Power Business Division of L&T, last role being GM & Head- Fuel Sourcing & Management at 2X700 MW Nabha Power Limited, Punjab.

Avid learner, excellent academics- Topper of Bombay University in Mechanical Engg, Board Topper for HSC, Board Rank holder for SSC; has Master's Degree in Management from NMIMS, Advanced Diploma in ProE from Somaiya, Diploma in Foreign Trade from Welingkar etc. He is a certified Lead Auditor for QMS and EMS, has successfully completed online courses in Financial Engineering and Risk Management of Columbia University and more recently on Sustainable Tourism from University of Copenhagen.

Global exposure includes multiple business visits to USA, China, Korea, Japan, Australia, Europe etc.

He is currently involved in commercial mining initiative, guiding a prospective Bidder.

Andrew Swanson

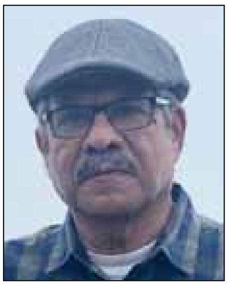
Executive Consultant, Ausenco QCC Resources Pty Ltd, Australia.
BE in Chemical Engineering, University of Newcastle.
ME in Mining Engineering (Mineral Processing), University of NSW.

Andrew has around 40 years' experience in coal preparation and technology, and has held a range of technical, business development and senior management roles.

He has participated in the establishment of many CHPP projects in Australia and has undertaken coal processing related studies in many countries, as well as Australia. Andrew has held a range of executive and committee positions with the Australian Coal Preparation Society.

Amit Kumar Sinha

Amit Kumar Sinha obtained his B. Tech degree in Mineral Processing from the prestigious IIT (ISM), Dhanbad and has specialised in the field of coal preparation. He has an overall field experience of over six years including 3 years at Tega Industries. For the last three years he has been working in Engineering and Projects Department of Tata Steel Ltd.



Padu S. Padmanaban

Padu S. Padmanaban is the former Program Director of the South Asia Regional Initiative for Energy (SARI/E) and Senior Energy Advisor for USAID/India's bilateral program. He has served with the World Bank, Washington DC as an Energy Efficiency Specialist and is a visiting fellow with the King Abdullah Petroleum Studies and Research Center (KAPSARC), Riyadh, Saudi Arabia.

Padmanaban is the recipient of several international and national awards in energy management and efficiency. These include: The Regional Energy Manager of the Year 2019 Award by the United States Association of Energy Engineers; the World Clean Energy Award, 2007 by the Swiss based Transatlantic 21 in global recognition of his achievements in advancing energy efficiency and renewable energy. Recipient of the Hall of Fame Award by the Indian Green Building Council in 2013, the All India Power award in 2010, the Energy Professional Development award, 2008 by the Association of Energy Engineers, India.

Padmanaban taught at the School for Advanced International Studies (SAIS), Johns Hopkins University, Washington DC. He has a B.E. in Mechanical Engg from the University of Madras (1973), a PG certificate in Fuel Efficiency (1974-76) from NPC, India and Diplomas in Energy Management from UCTI-IRI, Rome (1981) and ILO, Turino (1983), Italy.

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.

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)

Saunak Dey

Saunak Dey has done full time MBA from Indian Institute of Management - Calcutta (IIM-C), and B.Tech (Power Engineering) from National Power Training Institute (Under Ministry of Power - GOI). His ten plus years long career (experience in both Domestic & International Market) has endowed him with an end-to-end understanding of Power Projects & Operations. Currently, he is working as Senior General Manager - Corporate & Regulatory Affairs and Coal Commercial Strategy for Jindal India Thermal Power Ltd. and engaged in aligning functional strategies to overall business strategy, and Developing and Ensuring the effective implementation of functional business plans.

As a business professional, his key competencies are Strategy & Business Planning, Corporate & Regulatory Affairs, Project Management, Operations Management, Supply Chain Management, Process Enhancement, and Team Management.

Previously, he has been associated with Vedanta Group, The West Bengal Power Development Corporation Ltd. (Govt. of West Bengal), and African Industries Group.

Bhargav Dhavala

Bhargav Dhavala is a B. Tech in Mineral Engineering and M. Tech in Mineral Resource Management from Indian School of Mines Dhanbad. He is currently working as a Senior Technologist in the Coal Beneficiation domain of Process Technology Group of Tata Steel since 2011. His areas of expertise include process audit, plant optimization, process instrumentation, metallurgical testwork, data analytics, technology selection and flowsheet development. He has worked on technologies related to gravity separation, flotation, solid & liquid separation, comminution and smart coal washery.

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.

Dr. Pradeep Kumar Singh

Dr. Pradeep Kumar Singh did his Doctor of Engineering Degree from the Technical University, Clausthal, Germany. Dr. Singh also worked at Lossande Institute of Geosciences, University of Toronto, Canada as Post Doctoral Fellow. He joined this Institute in 1990 as Scientist 'B' and by his hard work and dedication, rose to the present coveted post of Director at the Central Intsitute of Mining and Fuel Research. (CIMFR).

Dr. Singh has made notable contributions in Explosives Science and Blasting Technologies to solve practical problems in the mining industry. He has authored 274 technical reports sponsored by different organizations and 9 S&T reports funded by Ministry of Coal, Government of India. There are 114 published papers in referred National and International Journals/Symposia to his credit. He is also the author of 3 books.

Dr. Singh is recipient of prestigious National Mineral Award, Raman Research Award, Fellow of German Academy, etc. etc.

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.

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"

Michelle Manook

Michelle Manook is Chief Executive of the World Coal Association. She has held the role since July 2019, based in London. Previously, she was Head of Strategy, Government and Communications for Europe, Asia and Africa for the multinational company, Orica, based in Perth, Australia.

Michelle has a diverse range of experience under her belt, with over 25 years in senior roles in the energy and mining industry. She has also held non-exec director positions in the voluntary and healthcare sectors and early in her career, worked in policy and public affairs for the Government of Western Australia.

She is passionate about coal's role in powering sustainable economic development, and how this can transform the lives and livelihoods of our global communities. She is looking to foster international collaboration and promote real solutions to the world's energy challenges.

Michelle was born in Dhaka in Bangladesh and has a BA degree in Psychology from the University of Western Australia.

Praveen Kumar Agarwal

Former Director & CISO, POSOCO Ltd.

An accomplished power system professional with 39 yrs. of experience in diverse areas of power sector – 24 yrs. amongst them focused on electricity market, regulatory affairs, grid operation, renewal integration, its automation, SCADA systems, and cyber security.

- Played key role in development of electricity regulations and polices including Open Access in Transmission, Automatic Generation Control (AGC), Ancillary Services (RRAS), Security Constraint Economic Dispatch (SCED), Power Market Regulations, Real Time Market (RTM), National open Access Registry (NOAR), Communication Regulations, Renewable Energy Certificate (REC) Regulations, Cross Border Trading Regulations.
- Has been instrumental in development of electricity market in India, from its inception with the Availability Based Tariff (ABT) in 2002 and Open Access in 2008, followed by Power Exchange, Day Ahead Market, Cross Border Energy Trading and recent launch of Real Time Market.

Worked in NTPC, POWERGRID, POSOCO. Superannuated from POSOCO ltd in June 2020 form the post of Director (Market operations) & Chief Information Security Officer.

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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 :

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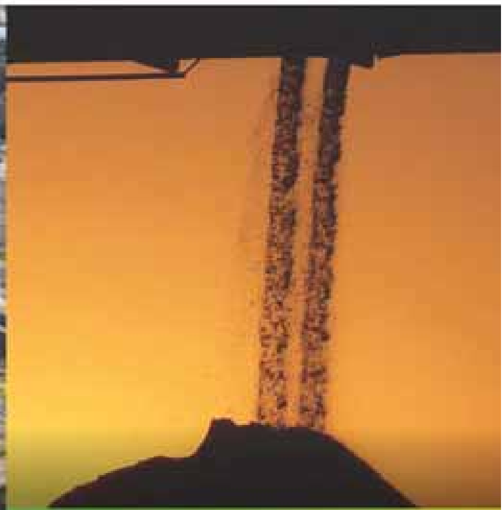
Mobile : +91 98103 02360
Web site : www.cpsi-india.org.in

XX ICPC
AUSTRALIA 2022

ADVANCING TECHNOLOGY BEYOND BEST PRACTICE

10th – 13th October 2022

Gold Coast Convention and Exhibition Centre (GCCEC)



The Australian Coal Preparation Society (ACPS) would like to invite you to join us on Queensland's Gold Coast for the 20th International Coal Preparation Congress in October 2022

The Gold Coast region of Australia is just south of Brisbane and provides both world class accommodation and conference facilities.

Australia is the world's fourth largest coal producer with rates of approximately 570 Mt/y and is also a leading seaborne exporter of over 390 Mt/y. Our coal industry prides itself on utilising world best practice in relation to our coal processing.

On behalf of the Australian Coal Preparation Society and our Local Organising Committee, I look forward to warmly welcoming you to the Gold Coast in October 2022 to participate in the 20th International Coal Preparation Congress and Exhibition.

Luke Vidal
ACPS National Chairman

SCHEDULE

MONDAY 10TH
Evening Cocktail Function
Exhibition Opening

TUESDAY 11TH
Opening Ceremony
Key Note Address
Technical Sessions
Evening Welcome Function

WEDNESDAY 12TH
Cultural Visit
Technical Sessions
Evening Conference Dinner

THURSDAY 13TH
Technical Sessions
Closing Ceremony

FRIDAY 14TH
Plant Visits
Post conference tours

Call for papers commences in March 2021, closes September 2021.

Registration available from February 2022.

All non-resident delegates will require a Visa to enter Australia. Further information and Visa applications are available at:
www.eta.immi.gov.au

Contact:
Julie-Anne Homan
National Secretariat

P: +61 2 49264870
E: acpsnational@acps.com.au

Further conference info go to:
www.acps.com.au