Prof R. Srikanth

Enhancing Domestic Coking Coal Availability to Reduce the Import of Coking Coal

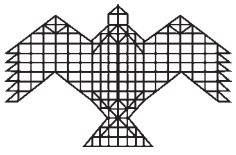
National Institute of Advanced Studies
Bengaluru, India

Research Report NIAS/NSE/EECP/U/RR/01/2024

Enhancing Domestic Coking Coal Availability to Reduce the Import of Coking Coal

(A Research Report Submitted to NITI Aayog)

R Srikanth
Professor and Dean
School of Natural Sciences & Engineering



Energy, Environment, and Climate Change Program
National Institute of Advanced Studies
Bengaluru, India

Published by
National Institute of Advanced Studies
Indian Institute of Science Campus
Bengaluru - 560 012
Tel: 2218 5000, Fax: 2218 5028
E-mail: publications@nias.res.in

NIAS Report: NIAS/NSE/EECP/U/RR/01/2024

Cover photo: Front cover
A coking coal washery in South Africa

Back cover
A modern coking coal mining complex in Australia

Typeset & Printed by
Aditi Enterprises
aditiprints@gmail.com

Acknowledgements

The author acknowledges the leadership and motivation provided by Dr. V K Saraswat, Hon Member (NITI Aayog) to complete this study. The author also acknowledges the support provided by Dr. Rakesh Sarwal during the discussions leading to this award of this research study by NITI Aayog. The author is grateful to Sri Rajnath Ram, Advisor (Energy) and Sri Jawahar Lal, General Manager (Energy) from NITI Aayog for their support and contributions during this study. Specifically, the author thanks them for organising the vital stakeholder consultation workshop with wholehearted participation from the relevant ministries and industry (coal and steel). The author is also grateful to the Ministry of Coal and the Ministry of Steel for the participation of their representatives during the stakeholder consultation meeting. The author thanks Tata Steel – the only private coking coal miner in India, for providing data on the performance of their captive coal mines and washeries. Last but not the least, the author is grateful to all the industry participants and the industry associations for their valuable comments and suggestions during the stakeholder consultation meeting.

Disclaimer

The National Institute of Advanced Studies, Bengaluru has received financial assistance under the Research Scheme of NITI Aayog to prepare the report. While due care has been exercised to prepare the report using the data from various sources, NITI Aayog does not confirm the authenticity of data and accuracy of the methodology to prepare the report. NITI Aayog shall not be held responsible for the findings or opinions expressed in the document. This responsibility completely rests with NIAS.

डॉ. वी.के. सारस्वत
Dr. V.K. Saraswat
सदस्य
Member
Tele : 23096566, 23096567
Fax : 23096603
E-mail : vk.saraswat@gov.in

सत्यमेव जयते

भारत सरकार
नीति आयोग, संसद मार्ग
नई दिल्ली - 110 001
Government of India
National Institution for Transforming India
NITI Aayog, Parliament Street,
New Delhi - 110 001

FOREWARD

The Indian steel industry is a key driver of economic growth and contributed 2% of the country's GDP in FY 2021-22. Steel demand is likely to increase manifold as India needs steel to build different kinds of infrastructure like roads, buildings, railways, pipelines, transmission lines, etc for the country's development. While good quality coking coal plays a vital role in the production of steel. The Indian steel industry is meeting its coking coal requirements largely through imports. In FY 2023-24, India's steel industry imported a record 57 Mt of coking coal in addition to 3.73 Mt of coke and 16.7 Mt of low-ash non-coking coal for direct injection. While coal imports accounted for 23.5 percent (56 MT) of 238 Mt of coal imported into India during FY 2022-23, the total value of coking coal imports into India exceeded Rs. 1.53 Lakh Crores which is more than 40 percent of the total coal import bill of 3.84 Lakh crores.

Government of India notified the National Steel Policy (NSP) 2017 to raise crude steel production to 255 MT to meet the projected demand of 230 MT of finished steel by FY 2030-31. This is necessary to raise the per capita steel consumption in India to 158 kg by FY 2030-31 as against the FY 2022-23 level of 86.7 kg. In the NSP, GoI has projected the need for 161 MT of coking coal to achieve the NSP targets.

India is the 2nd largest steel producer in the World and the steel companies in the public and private sectors are implementing ambitious expansion plans on the path to *Viksit Bharat 2047*. India has ample reserves of medium coking coal that can be washed to bring down ash content of 17-18% for supplying metallurgical coal to Integrated Steel Plants (ISPs). Therefore, there is an urgent need to enhance the supply of domestic metallurgical coal to stamp-charged coke oven batteries in ISPs in India to maintain the competitiveness of India's growing steel industry by reversing the growing trend in coking coal imports.

NITI Aayog involved the National Institute of Advanced Studies (NIAS), Bengaluru to carry out this study to suggest the way forward to enhance the domestic supply of medium coking coal to stamp-charged coke oven batteries in ISPs.

स्वच्छ भारत
एक कदम स्वच्छता की ओर

The West Bokaro coalfield in Jharkhand contains 3 billion tons of proven medium coking coal reserves up to 300 m depth. To maximise the yield of washed coking coal from 'extremely difficult to wash' medium coking coal reserves in this coalfield, the key activities of exploration & coal characterization, mining operations, beneficiation, and logistics must be optimized in an integrated manner. This requires huge capital investments as well as best practices in exploration, mining, beneficiation, and logistics which can be achieved through Public-Private Partnerships.

The recommendations made in the report are found to be extremely relevant and have also been discussed extensively in a stakeholder consultation meeting organised by NITI Aayog. If these recommendations are implemented progressively in other coalfields containing medium coking coal, the country has a hope of becoming *Atmanirbhar* in coking coal.

I congratulate the NIAS team, especially Prof. R. Srikanth and the Energy team of NITI Aayog for conducting a thorough study and bringing out this timely and important report.

(Dr. V K Saraswat)

New Delhi
31.05.2024

Table of Contents

List of Figures

List of Tables

Executive Summary

1. India is the second largest steel producer in the World after China. India produced 125 MT of steel in 2022 while China produced 1018 MT (WSA, 2023). While India is a net steel exporter, it is also the second largest importer of metallurgical coal in the World. India's steel industry is a vital source of competitive advantage for India's flourishing automobile & white goods industries besides being a critical factor in India's infrastructure development.

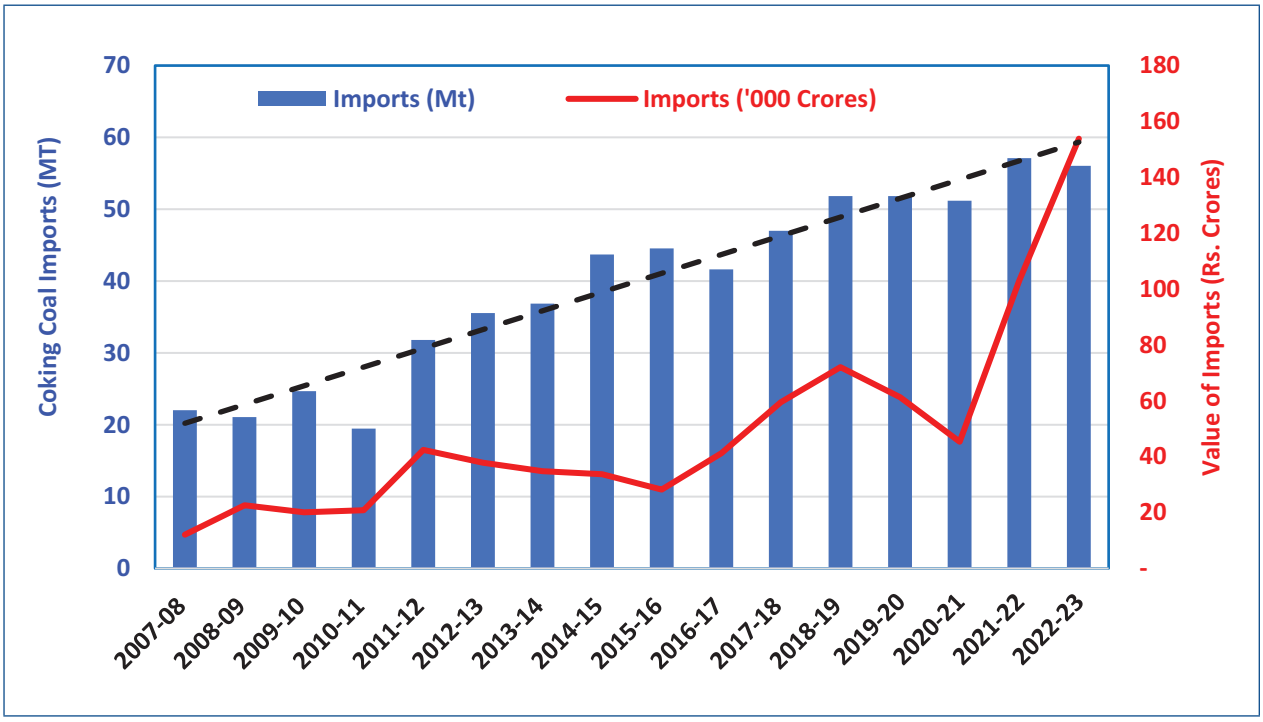
2. As of 1 April 2023, India's proved geological resources of prime coking coal and medium coking coal are estimated to be 5.13 BT and 16.5 BT, respectively (CMPDI, 2023). However, out of the 238 MT of coal imported into India during FY23, coking coal alone accounted for 56 MT (Coal Controller, 2024). In FY 24, coking coal imports set a record of 58 Mt with Russia and the United States (US) gaining market share at the expense of Australia (Business line, 2024). While non-coking coal imports have crossed 182 MT in FY 2022-23, coking coal dominates India's coal imports in value terms (Coal Controller, 2024). Specifically, during the last five years, coking coal imports accounted for 22 percent to 27 percent of the total coal imported into India in terms of tonnage, while the value of coking coal imports varied between 39 percent to 45 percent of the total value of imported coal.

3. Further, the prices of coking coal are highly volatile due to the dominance of a few countries (mainly, Australia) and companies in the supply of prime coking coal to India. For example, the price of prime hard coking coal loaded in Australia, a benchmark for global seaborne supply, shot up to an all-time high of $670 per ton (Free-on-Board or FOB) in March 2022, from $460 per tonne at the end of February 2022 (EU, 2022). In May 2023, the spot prices of Australia's premium hard coking coal declined to $223 per ton (FOB) but rose to a level of $366 per ton in October 2023 before closing the year at $327 per ton (Argus, 2024; EU, 2022).

4. The total value of coking coal imports into India crossed Rs. 1 trillion for the first time in FY 2021-22. As shown in Figure E1, the total value of India's coking coal imports exceeded Rs.1.5 trillion in 2022-23 though the total coking coal imported into India in FY 2022-23 decreased marginally from 57 MT (in FY 2022-23) to 56 MT (Coal Controller, 2024). Therefore, the average landed price of coking coal increased from approximately Rs.18,000 per ton in FY 2022-23 to just over Rs.27,000 per ton in FY 2023-24 due to the mismatch in supply and demand for metallurgical coal in the Australasian market (Coal Controller, 2024).

5. Australia, with its geographical advantage over other major coking coal exporters (USA, Russia, and Canada), supplied 54% of India's coking coal imports (56 MT) in FY 2022-23 (Coal Controller, 2023). Since coking coal accounted for approximately 42% of the cost of steel produced in India at the prices prevailing in FY 2021-22, the Ministry of Steel is making efforts to reduce the import bill on coking coal by diversifying the import sources (Lok Sabha, 2023a). While a Memorandum of Understanding

Figure E1. Volume and value of coking coal imported into India by the iron & steel sector.



(MoU) has been signed by the Minister of Steel, Government of India (GoI) and the Minister of Energy, Russian Federation on Cooperation regarding coking coal, the complete replacement of Australian coking coal with coking coal imports from Russia is also challenging due to the difficulties in logistics and geopolitical conditions (Lok Sabha, 2023a). However, Indian steel makers could diversify the import basket to reduce the dependence on Australia for coking coal from 71% (of 57 MT) in FY 2021-22 to 54% (of 56 MT) in FY 2022-23 (Coal Controller, 2022; 2023). The U.S. and Russia are now the second and third largest suppliers of coking coal (after Australia) and have taken significant market shares at the expense of Australia (Business Line, 2024).

6. In FY 2022-23, coal accounted for 82% of the total cost of materials consumed by SAIL. Further, 49% of SAIL's total revenue from operations was spent on coal despite the availability of 2.3 MT of washed coking coal from domestic sources, including 0.37 MT of washed coking coal from their captive coal mines (SAIL, 2023a). Therefore, there is an urgent need to enhance the supply of domestic metallurgical coal to Integrated Steel Plants (ISPs) in India to maintain the competitiveness of India's growing steel industry in the world market besides reducing the prices of finished steel products critical for infrastructure development in India.

7. Due to its legacy ownership of captive coking coal mines and linked washeries, Tata Steel is the only company in the private sector that continues to mine and wash coking coal in India. This is the major reason for the competitive advantage of its Jamshedpur steel works over other integrated steel plants

in India, particularly when the coking coal prices go up sharply. Unfortunately, neither Coal India Ltd. (CIL) nor Steel Authority of India Ltd. (SAIL) has been able to supply adequate volumes of metallurgical coal (suitable for coke making) from their ample reserves of coking coal though 50 years have passed since the nationalisation of the coking coal mines in the Jharia coalfield followed by other coal mines shortly thereafter. As per the Coal Controller's statistics, the highest raw coal throughput that SAIL has been able to achieve in its own Chas Nala washery (2 MT capacity) in the last 12 years is only 1.258 MT (in FY 2016-17) though SAIL owns captive coal mines and can also source raw coking coal from the coking coal mines of Bharat Coking Coal Ltd. (BCCL) in the vicinity of its washeries.

8. In FY 2023-24, CIL dispatched only 3.27 MT of coal to the steel sector, which amounts to only 0.4 percent of the total coal dispatches by CIL in the same year (MoC, 2024a). This is because 85 percent of CIL's coking coal dispatches are received by the power sector (MoC, 2023a; 2024). To arrest this declining trend in domestic production of coking coal in the face of rising demand for coking coal, BCCL has commissioned the Dahibari (1.6 MT), Patherdih-I (5 MT), and the Madhuband (5 MT) washeries since 2018 (MoC, 2021; PIB, 2023b). BCCL is also constructing two washeries (Patherdih II – 2.5 MT and Bhojudih 2 MT), while a Letter of Intent (LoI) has been issued for the Moonidih (2.5 MT) washery (BCCL, 2023). The commissioning of these three washeries will increase BCCL's raw coking coal washing capacity to 18.6 MT (BCCL, 2023).

9. SAIL has also awarded a Mine Developer & Operator (MDO) contract for the much-delayed Tasra washery (3.5 MT) in their captive Tasra coal block in the Jharia coalfield (SAIL, 2023b).

10. Therefore, the total coking coal washing capacity owned by BCCL and SAIL in the Jharia coalfield will exceed 22 MT once these coal washeries commence commercial operations.

11. In March 2024, BCCL has invited Requests for Proposal (RFP) for the selection of a Washery Developer-cum-Operator (WDO) from Integrated Steel Plants (ISPs) for the obsolete Dugda coal washery along with the entire washery site of more than 300 acres. The WDO is free to design, construct, and operate a modern washery with an option to set up a power plant to use the washery rejects as per Government policy. BCCL has committed to supply a total of 2 Mt of Washery Grade IV coal per year from five different mining patches till 2030 and an equivalent quality of coal for the next 20 years.

12. BCCL and Tata Steel have signed a MOU to wash a part of the raw coking coal mined by BCCL in Tata Steel's Jamadoba washery (2 MT capacity) in the Jharia coalfield for supplying washed coking coal for metallurgical use in SAIL's ISPs. According to BCCL (2023), the volume of BCCL raw coal washed in Tata Steel's washeries has increased to 1.59 MT in FY 2022-23, thereby enabling BCCL to supply 0.85 MT of metallurgical coal (@18.5% ash) to SAIL through this Public-Private-Partnership (PPP).

13. As indicated in paras 8-11 above, BCCL and SAIL are adding washery capacities in their existing mines or sites over the next few years. Therefore, there may not be any necessity to

add washing capacity in the Jharia coalfield till the existing and proposed washeries are utilised to a level of at least 85%

14. However, the situation in the medium coking coalfields (primarily, the West Bokaro, East Bokaro, and Ramgarh coalfields) is not so encouraging. In FY 2022-23, Central Coalfields Limited (CCL) processed only 1.658 MT of raw coal through their washeries (out of CCL's total coking coal production of 19.74 MT) and produced only 0.722 MT of washed coking coal (CCL, 2023). After analysing the data published in the Coal Controller's reports, it is evident that the total washed coal produced by CCL's coking coal washeries does not amount to even 10 percent of the raw coking coal dispatched from their mines in the last 12 years. This is because CCL's coking coal washeries have become obsolete and lack the capability to beneficiate the 'difficult-to-wash' coking coal seams extracted by CCL from the West Bokaro and East Bokaro coalfields (CCL, 2023). CCL has floated tenders for setting up five new coking coal washeries with a total washing capacity of 14.5 MT on the Build-Own-Operate (BOO) concept (CCL, 2023). These include the New Rajrappa (3 MT), Dhori (3 MT), New Sawang (1.5 Mt), Basantpur Tapin (4 MT), and New Kathara (3 MT). Of these, CCL has finalised the tenders and awarded the New Rajrappa and Dhori washeries.

15. All the new CCL washeries are proposed to be set up on a BOO basis by washery operators who have no control over the quality (primarily, ash and washability characteristics) of raw coking coal supplied to them by the miners who are independent contractors engaged by BCCL/CCL. Tata Steel's experience with 'difficult-to-wash' medium coking coals indicates that the lack of integration between the miner and washery operator coupled with the paucity of data related to the washability and flotation characteristics of the raw coal (in advance of beneficiation) will result in sub-optimal yields of washed coking coal from these washeries, particularly because the residual coking coal reserves in the West Bokaro and East Bokaro coalfields are classified as 'difficult-to-wash' or 'extremely difficult to wash'.

16. On the other hand, Integrated Steel Plants (ISPs) in the private and public sectors are implementing ambitious expansion plans to meet India's own needs as well as the global demand for affordable, high-quality steel products as per the National Steel Policy (MOS, 2017). For example, SAIL is expanding its hot metal production capacity from the FY 23 production level of 19.4 MT to 35 MT by FY 31 with a plan to expand further to 50 MT. JSW Steel is planning to expand its production to 50 MT by 2030, while Tata Steel's ongoing expansion plans will take its total production to 40 MT of steel by 2030. JSPL has announced its plans to expand to 50 MT by 2030, while Arcelor Mittal - Nippon Steel (AM/NS) is planning to set up greenfield steel plants with a total capacity of 21 MT in Odisha besides expanding their existing steel plant in Hazira. Therefore, all major integrated steel producers in India are making huge investments to expand their capacities which will in turn increase their coking coal requirements.

17. SAIL has projected a coking coal requirement of 26 MT to produce 35 MT of hot metal. By the time this expansion is completed, SAIL also plans to use only stamp-charging

technology in its coke ovens by progressively replacing its ageing top charged coke ovens with stamp charged batteries. The key advantage of stamp charged coke oven battery technology is that it enables more readily available and cheaper imported semi-soft coking coals to be blended with domestic medium coking coal (@ 17%-18% ash) to produce coke of a superior quality (Coke Strength after Reaction or CSR of 65-66%) for blast furnace ironmaking. Out of SAIL's total coking coal requirement of 26 MT during FY 2030-31, it is projecting a total domestic coking coal requirement of only 7 MT (27%) in the blend proportion even with stamp charged batteries with the balance of 19 MT being imported.

18. However, experts and practitioners of stamp charged coke making technology in Tata Steel have demonstrated that (Prasad et al., 2001):

    - *"It is possible to use 30–35% low-volatile semi-soft coal along with domestic coals and produce good quality coke (CSR of 65-66%) by stamp charging technology under Indian conditions.*
    - *The use of semi-soft coals in the stamp charging coal blend has been beneficial to produce coke with strength characteristics of international standard at lower cost.*"

19. Since semi-soft coking coal is cheaper than prime (or hard) coking coal in India as well as in Australia, the switchover to stamp charged batteries will enable SAIL to reduce the amount of prime coking coal in the coke oven blend without affecting coal quality. Further, Tiwari et al. (2017) have documented that the washing of medium coking coal from the West Bokaro coalfield to 16.8% ash before blending it to the extent of 55% with 35% imported semi-soft coal and 10% hard coking coal produces coke with optimal properties (CSR >= 65% with coke ash of 16-16.5%) in the stamp charged batteries.

20. During the Stakeholder Consultation meeting organised in NITI Aayog on 1 March 2024, Tata Steel confirmed that they produce superior-quality coke in their stamp charged batteries at Jamshedpur by optimizing the use of low-cost, domestic medium coking coal (washed down to 15- 17% ash) to the extent of 50%-67% in the coal blend and are constrained to reduce the share of domestic coking coal, mainly due to the shortage of captive coal reserves (Annexure 1).

21. The quality of coke produced from stamp-charged batteries in Tata Steel's Jamshedpur steel plant demonstrates the importance of enhancing the production of washed medium coking coal (@16-18% ash) from the West Bokaro coalfield to reduce the cost of coke without compromising on coke quality or blast furnace productivity. Tata Steel's experience indicates that the optimal use of medium coking coal (17 - 18% ash) from the West Bokaro coalfield in stamp charged batteries will reduce the cost of coke (and hot metal) by increasing the proportion of low-ash, imported semi-soft coals that are cheaper than imported hard coking coal from Australia. One of the recommendations of the Stakeholder Consultation meeting organised by NITI Aayog is for SAIL and CMPDIL to collaborate on a study to assess the coking properties of various coal blends of washed domestic coking coal to optimize the coking properties while maximizing the use of domestic coking coal (Annexure 1).

22. While the washeries in the Jharia coalfield will cater to the prime coking coal needs of SAIL, they can substitute only a part of SAIL's imported coal requirements even at full capacity. The West Bokaro Coalfield (WBCF) in Jharkhand contains approximately 3.58 billion tons (BT) of measured coking coal reserves, which equals 22% of India's 16.5 BT of measured (Category 331) resources of medium coking coal (CMPDI, 2023). Eighty-four percent of the measured coal reserves in the WBCF (3 billion tons) are at less than 300 metres depth, which makes it possible to ramp up the coal production in this coalfield quickly once all necessary clearances (including, environmental & forest clearances and mining lease & surface rights) are granted by GOI and the Government of Jharkhand.

23. The case study of Tata Steel's integrated coal mining, beneficiation, and logistics complex in the West Bokaro coalfield (detailed in Chapter 4) demonstrates the potential to enhance the use of domestic coking coal if policies are developed to persuade CIL/CCL to form Special Purpose Vehicles (SPVs) with ISPs to maximise the production of washed medium coking coal (@16-18% ash) from CCL's existing coal mines and blocks in the West Bokaro coalfield.

24. As per the data extracted from the Coal Directory of India published by the Coal Controller, the annual raw coking coal dispatched from all coking coal mines owned by CCL has varied between 10 MT and 31 MT in the last 12 years. However, the washed coking coal production from CCL's washeries during the same period has declined from a peak of 1.648 MT in FY 2014-15 to only 0.722 MT in FY 2022-23 (Figure 5.6). This is in stark contrast to TSL's production of 1.99 MT of washed medium coking coal (@16% ash) from only two coal mines and washeries (total RC capacity of 6.5 MT) in the WBCF (Figure 4.3). This is a key driver for NIAS's projection that the raw coal production capacity in the WBCF can be increased by more than 20 MT per annum by opening additional coal mines and modern washeries in this coalfield if CIL forms two SPVs with Integrated Steel Plants (ISPs) which will bring in private sector capital as well as project management skills and operating efficiencies.

25. When the medium coking coal produced from these mines is washed down to 16-18% ash in washeries to be put up and operated in an integrated manner with the coal mines, 7-8 MT of metallurgical coal can be supplied to stamp-charged coke batteries. This will double the domestic supply of metallurgical coal to the steel plants in India from the current level and enhance their competitiveness while reducing steel costs which have a knock-on impact on the downstream sector. The cost of metallurgical coal (to the ISP) will be reduced by passing on the credits derived from the profits on the sale of by-products (middlings, tailings, and rejects) dispatched from the washeries to the power sector (captive/utilities).

26. In 2021, the Ministry of Coal (MoC) set up an Inter-ministerial Committee (IMC) chaired by the Additional Secretary in the MoC and including members from the Ministry of Steel, Coal India Ltd. (CIL), and representatives of large integrated steel plants in India (MOC, 2021a; PIB, 2023a). The IMC proposed "Mission Coking Coal" to augment the raw coking coal production in the country from the current level of 45 MT to 140 MT by FY 2029-30. Under this

mission, MoC/CIL had committed to set up six washeries (Madhuband, Patherdih II, Bhojudih, Moonidih, New Kathara, and Basantpur Tapin) with a total RC capacity of 19 MT by November 2022 and three more washeries (New Rajrappa, Karo, and Topa) with a combined capacity of 11 MT by November 2024 (MoC, 2021a).

27. Of these nine new washeries, only the Madhuband washery with a RC capacity of 5 MT was commissioned by November 2023 and all other washeries are delayed by at least two years from the expected Commercial Operation Date (COD) published in the 'Mission Coking Coal' report (MoC, 2021). Besides auctioning coking coal blocks for commercial coal mining, MoC has announced a policy to monetize the existing (but, obsolete) coking coal washeries to ISPs along with coal linkages so that the ISP can set up a modern coking coal washery (PIB, 2023a). Based on this policy, BCCL has issued tenders for the selection of a Washery Developer-cum-Operator (WDO) for its obsolete Dugda coal washery.

28. As per the report and action plan published by MoC's report on Mission Coking Coal, raw coal production is expected to reach a level of 140 MT by 2030. After beneficiation, this amount of raw coal is projected to yield 48 MT of washed coking coal to meet the coking coal demand projected in the National Steel Policy of 2017 (PIB, 2023a). These targets appear to be unrealistic given the delays in setting up washeries by the PSUs as well as the allocation of coking coal blocks with sub-optimal production capacities to the private sector as explained below.

29. While allocations of coal blocks for captive/commercial coal mining have succeeded in ramping up coal production to 153.57 MT in FY 2023-24, only 16 coking coal blocks with total geological resources of 2 BT have been allocated to date out of a total proved geological resource of more than 21.6 BT of coking coal in India. Till date, only 10 percent of the proved prime coking coal resources (5.13 BT) and 9 percent of the proved medium coking coal resources (16.5 BT) of the country have been allocated to private/public sector companies between 1996 and 2023 and CIL still retains a strong hold on the coking coal reserves in the country. Besides these proved medium coking coal resources, the country's indicated resources of medium coking coal are estimated to be 10.27 BT which can also be planned for integrated mining & beneficiation projects after completing the necessary detailed exploration and assessment of surface constraints (CMPDI, 2023). This indicates that the availability of coking coal resources is not a constraint for meeting the requirements of India's integrated steel plants fitted with stamp charged batteries. Rather, the huge shortfall in the supply of domestic metallurgical coal in India is due to the chronic failure of CIL and SAIL to add value to domestic coking coal reserves by using detailed quality assessment, mine planning, and scientific mining practices along with modern beneficiation techniques in an integrated manner. These failures have been compounded by the Hon Supreme Court's cancellation of the captive coking coal blocks allocated to the private sector in its 2014 judgement in the coal block allocation case.

30. Since the launch of commercial coal block auctions in June 2020, 104 coal blocks have been successfully auctioned with a total annual Peak Rated Capacity (PRC) of 226 MT (PIB, 2024). This is in addition to the coal blocks allotted to PSUs and those

auctioned to private sector companies for captive use. As a result of the policy initiatives implemented by GOI to enhance the energy security of the country, coal mines allocated for captive/commercial use have produced more than 153 MT of coal during FY 2023-24. Since coal block auctions for commercial mining commenced only in June 2020, the production from these commercial coal blocks will increase further in future years.

31. However, the total PRC of the 16 allocated coking coal blocks (to PSUs/private companies) till December 2023 is only 27.32 MT (Table E1). Further, the coal blocks with higher production capacities, *viz.*, Tasra, Kotre Basantpur & Pachmo (KBP), and Rohne have been allotted to SAIL, CCL, and NMDC, respectively. These four coal blocks allotted to PSUs have a total annual peak rated capacity (PRC) of 17 MT, but, except for some intermittent mining operations in Tasra coal block (allotted to SAIL in February 1996), mining operations have not commenced in the KBP and Rohne coal blocks (due to various reasons.

32. On the other hand, only one of the 11 coking coal blocks allocated to the private sector has a PRC exceeding 1 MT per annum, though some of these coal blocks have substantial geological resources. For example, the Moitra and Choritand Tilaiya coal blocks auctioned to private sector companies have large geological resources of 215 MT and 97 MT, respectively. However, due to geological complexities and surface constraints, the PRCs of these two coal blocks are declared to be only 1 MT and 0.78 MT, respectively. Further, the Basantpur and Beheraband North Extension coal blocks auctioned to private sector companies with estimated geological resources of 200 MT and 170 MT respectively have PRCs of only 1 MT (each) due to the constraints imposed by their geological structure and proximity to wildlife habitats and/or dense reserve forests (MOC, 2021a). Therefore, the 11 coking coal blocks auctioned to private companies till 2023 have a combined PRC of only 10.17 MT. Even though five coking coal blocks have been auctioned to private mining companies in March 2024, these coal blocks are also rife with surface constraints and/or geological complexities due to which their PRCs could not be determined even at the time of their auction (PIB, 2024). Therefore, these coal blocks are not included in Table E1.

33. The WBCF in Jharkhand contains 3.58 MT of proved medium coking coal resources (CMPDI, 2023) which is sufficient to cater to the domestic coking coal requirements of two (or more) ISPs if the right policy interventions are implemented as suggested in this report.

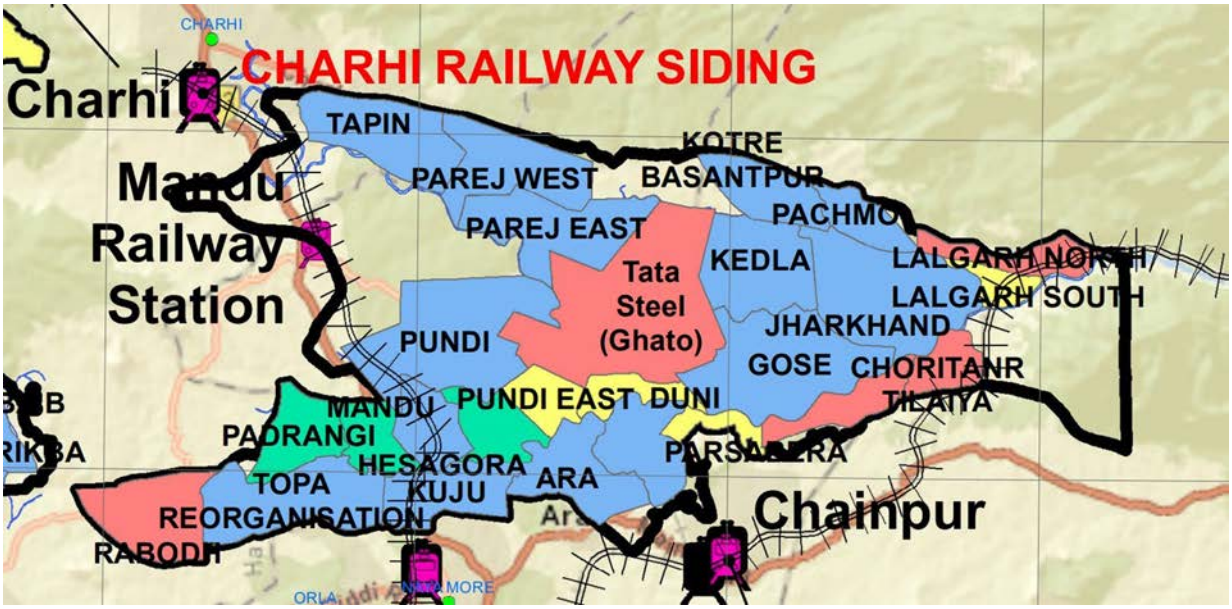
34. Seven of the 16 allocated coking coal blocks are in the WBCF as shown in Figure E2. The PRCs of the KBP, Jogeshwar & Khas Jogeshwar, Lalgarh North, Choritand Tilaiya, and Rabodih coal blocks are, 5 MT, 0.6 MT, 1 MT, 0.78 MT, and 2.50 MT, respectively (MOC, 2023b). CCL has been allotted the Kotre Basantpur & Pachmo (KBP) coal blocks under the Coal Mines (Special Provisions) Act after the Hon Supreme Court cancelled the earlier allocation to Tata Steel in the omnibus coal block allocation judgement of 2014. These two coal blocks have a total geological resource of 250 MT, and a PRC of 5 MT. CCL has already outsourced the mining operations in the KBP coal blocks through the MDO route while the order for the Basantpur Tapin washery is yet to be awarded (CCL, 2023).

Table E1. Key details of Coking coal Blocks allocated between 2015 and 2023.

Name of Coal Mine (blocks in italics allotted to PSUs)	Coalfield/State	Allotted to	Allotment / Vesting order date	Peak Capacity Mtpa	Geological Resources, Mt
1. Moitra	North Karanpura	JSW Steel	22-04-2015	**1.0**	215
2-3. Kotre Basantpur & Pachmo	*West Bokaro*	*CIL (PSU)*	*19-04-2018*	*5.0*	*250*
4. Brahmdiha	*Giridih*	*APMDCL (PSU)*	*02-03-2021*	*0.15*	*5*
5. Urtan North	Sohagpur	JMS Mining	03-03-2021	**0.6**	70
6. Urtan				**0.65**	55
7. Jogeshwar, Khas Jogeshwar	West Bokaro	SW Pinnacle Exploration	18-11-2021	**0.6**	84
8. Rohne	*North Karanpura*	*NMDC (PSU)*	*18-06-2021*	*8.0*	*242*
9. Lalgarh North	West Bokaro	Adhunik Power & Resources	24-12-2021	**1.0**	27
10. Basantpur		Gangaramchak Mining	12-12-2022	1.0	200
11. Beheraband (N) Extn.	Sohagpur	Auro Coal Pvt. Ltd.	10-10-2022	1.0	120
12. Sitanala	Jharia	JSW Steel Ltd.	08-06-2023	**0.3**	109
13. Parbatpur Central				**0.74**	147.0
14. Choritand Tiliaya	West Bokaro	Rungta Metals	08-06-2023	**0.78**	97
15. Rabodih		21st Century Mining Pvt. Ltd.	31-03-2022	**2.5**	133
16. Tasra	*Jharia*	*SAIL (PSU)*	*26.02.1996*	*4.0*	*251*
			Public Sector	**17.15**	**748**
			Private Sector	**10.17**	**1257**
			Total	**27.32**	**2005**

Note: Barring the Rabodih coal block, none of other 11 coal blocks allotted to the private sector has an annual production capacity exceeding 2 Mt. Hence, none of these coal blocks have the required scale to set up the coking coal washeries required to produce metallurgical coal (@17% - 18% ash) suitable for stamp-charged coke oven batteries in ISPs. While five more coking coal blocks have been auctioned to private companies in March 2024, they are not included in this table since their PRCs have not been declared till they were auctioned in March 2024. Their production capacities are also not likely to exceed 1 MT per annum due to surface constraints and/or complex geology.

Figure E2. Schematic of the West Bokaro coalfield in the state of Jharkhand (CMPDI, 2022)



35. On December 20, 2023, GOI put up two more coal blocks (Lalgarh South and Duni) in the WBCF for auction under the Mines & Minerals (Development & Regulation) or MMDR Act, though they are only partially explored and are also constrained by surface features like railways, public roads, the Bokaro river, and a modern pipe conveyor carrying coking coal, which will limit the production potential of any standalone coal mining & beneficiation operation in these coal blocks (MSTC, 2023). While these two blocks were successfully auctioned in March 2024, their PRCs have not been declared till date due to these reasons.

36. Each of the seven coal blocks allocated in the WBCF till date has been allocated to a different company. Except the Rabodih coal block (auctioned to a private company), none of the other four coal blocks (Basantpur, Choritand Tilaiya, Jogeshwar & Khas Jogeshwar, Lalgarh North) auctioned to the private sector in the WBCF till December 2023 have the optimal scale of operations (2 MT per annum) necessary to set up a modern washery to produce metallurgical coal fit for stamp-charged batteries after washing the 'extremely-difficult-to-wash' raw coal (containing 34% - 38% ash) in these coal blocks to 16-18% ash.

37. While GOI has announced a rebate of 50 percent on the final offer for the coal used for gasification and liquefaction, there is no incentive for producing metallurgical coal suitable for coke oven batteries by washing (to 16-18% ash) the raw coking coal (34-38% ash) mined from the commercial coal blocks. Absent such incentives to ensure the appropriate use of India's coking coal reserves, the newly auctioned commercial blocks will sell the raw coking coal without making the investments in modern coking coal washeries required to wash the raw coking coal to 16-18% ash for supplying

metallurgical coal to steel plants or coke ovens.

38. To sum up, the production of metallurgical coal after beneficiating the medium coking coal mined from the commercial coal mines in the WBCF will be hampered due to the sub-optimal scale of future operations in eight of the nine coking coal blocks (barring Rabodih coal block) auctioned to the private sector in the coal block auction process. This implies that the country must depend on the residual coking coal reserves in the West Bokaro coalfield to produce metallurgical coal suitable for stamp charged batteries in the National Interest. This is the key rationale for the recommending the formation of two Special Purpose Vehicles (SPVs) in the PPP model to maximise the production potential of the coking coal blocks and mines owned by CCL in the WBCF. The SPV model can be extended to the coal blocks/mines owned by CCL in the East Bokaro coalfield also once the SPVs in the WBCF are set up in the PPP mode.

39. Considering India's commitments to Net Zero by 2070, the country's interests would be better served by fully utilising the proved reserves of medium coking coal (16.5 BT) in India for metallurgical purposes by ramping up the production of washed medium coking coal in India by ensuring the allocation of contiguous coal blocks which are conducive for a PRC of 5-10 MT of raw coking coal per annum.

40. This scale of operations is necessary to ensure the viability of an integrated coal mining complex consisting of coal mines extracting complex geological deposits, a modern washery designed to wash extremely difficult-to-wash coals, a pithead power plant (based on proven technology) to utilise the coarser size (+0.50 mm), high ash (ash content > 62%) washery rejects, and an environment-friendly, high-capacity logistics system. It is possible to set up two such integrated mining complexes (set by the aforesaid SPVs) with a PRC of 10 MT each in the West Bokaro coalfield (having a proved geological reserve exceeding 3.5 BT) with a life of 30-50 years, even after excluding the coal blocks allocated to private companies in this coalfield. One of these two SPVs in CCL's current coal mining leases in the WBCF can mine all CCL coal blocks/mines on the eastern & northern sides of the Bokaro river, and the other SPV can mine all CCL coal blocks/mines on the western & southern sides of the Bokaro river.

41. Together, these two SPVs can produce about 7-8 MT per annum metallurgical coal suitable for stamp-charged coke oven batteries if the policy changes in this report are implemented in a timely manner. This will quadruple the current production of washed medium coking coal suitable for metallurgical use in stamp charged batteries from the WBCF. The amendments in the mineral law and Forest Conservation rules are justified by the high import dependence of India's steel sector for metallurgical coal which should now be declared a critical mineral as has been done in the European Union.

42. The European Commission (EC) carries out a criticality assessment at the European Union (EU) level on a wide range of raw materials every three years. In 2014, the EC included coking coal in the Critical Raw Materials list (CRM) for the first time (Sivek and Jir'asek, 2023). The CRM list was

updated in 2017 and 2020, and coking coal remains on the CRM list in the most recent update in 2023 (Blengini et al., 2020; Duda and Valverde, 2021; EC, 2023). The EU recognizes the indispensable role of coking coal during the steel industry's transition to climate neutrality (EC, 2021). Critical raw materials are classified as such because (CRM Alliance, 2023):

- *They have significant economic importance for key sectors in the national economy.*
- *They have a high-supply risk due to the very-high import dependence and high level of concentration of set critical raw materials in particular countries.*
- *There is a lack of (viable) substitutes, due to the unique and reliable properties of these materials for existing, as well as future applications.*

43. Since coking coal meets all these criteria in India, NITI Aayog can convince the Government of India to declare coking coal as a 'critical mineral' for India as a precursor to making several policy changes for ramping up the production of domestic metallurgical coal to enhance the competitiveness of India's booming steel sector which will create thousands of well-paid, skilled manufacturing jobs directly & indirectly, reduce infrastructure costs in India, and earn precious foreign exchange.

44. To alleviate the perennial shortage of domestic metallurgical supplies despite huge reserves of medium coking coal in the country, NITI Aayog must facilitate a 'whole-of-government' approach including the Ministries of Coal, Steel, Environment & Forests in the Government of India (GoI), and the Government of Jharkhand (GoJ) to form Special Purpose Vehicles (SPVs) in the PPP mode. These SPVs must be vested with the sole mining rights to all blocks in the West Bokaro coalfield currently under CCL's control. The WBCF has been chosen since the reserves in this coalfield are not blocked by major surface features (rivers, railway lines, power plants, and large settlements) which is the case in the East Bokaro coalfield in the CCL command area. Similar SPVs can be formed in the East Bokaro coalfield based on the experience of the SPVs in the WBCF.

45. The core mission of these SPVs (with majority stakes owned by two ISPs from the private sector) must be to mine, beneficiate, and sell the clean coal and washery by-products from all the coking coal mines and blocks not allocated to the private sector in the West Bokaro coalfield.

46. The capital investments to put up a 10 MT modern coking coal washery designed to optimise the clean coal yields from the extremely-difficult-to-wash coal reserves in the West Bokaro coalfield are estimated to be about Rs. 1900 crores (Tata Steel, 2022). According to CMPDI's comments on the draft report, these costs appear to be higher. However, as shown in Figure 4.1, the proposed Tata Steel washery is a complex washery, with a coarse coal circuit, intermediate gravity separation circuit, fines circuit, belt filters, and concrete silos for coal products since it is designed to maximise the recovery of washed metallurgical coal from the 'extremely difficult-to-wash' medium coking coal reserves in the West Bokaro coalfield. Further, the cost estimates for the Tata Steel washery include the costs related to forest clearance for the washery, the construction of raw coal and washed coal conveying systems and other infrastructure as well as the augmentation of railway dispatch facilities.

47. As explained in Chapter 3, teamwork between mine planners, geologists, mining engineers, and washery operators, backed by effective management systems is critical to optimizing the production of metallurgical coal from the extremely, difficult-to-wash coal seams in the WBCF. This is also one of the key reasons for recommending the handover of the CCL coal blocks in the WBCF to a SPV in the PPP mode. CCL and the Government of Jharkhand together can hold a minority stake in this SPV, since the entire investment to develop and operate the integrated coal mining and washery complexes owned by this SPV must come from the private sector. However, the SPV will be responsible for bearing all its costs as well as all government taxes & levies including the annual auction premium payments. This will ensure that private sector capital and managerial expertise are harnessed to expedite the development and operation of the integrated coal mining and washery complexes required to maximize the recovery of metallurgical coal (@17% ash) fit for stamp charged batteries.

48. As a consideration for the equity to be held by CCL and the Government of Jharkhand in this JV, they must hand over the surface rights with the overlying assets, mining leases, geological and other information, land, forest, and environment clearances, government-owned non-forest land (for mining, infrastructure development, and compensatory afforestation), subject to the payment of the auction premium, royalty, and other government levies. This will require amendments in the MMDR Act of 1957, the Coal Bearing Areas (CBA) Act of 1957, the Coal Mines Special Provisions (CMSP) Act of 2015, and the associated rules including the Coal Block Auction Rules (India Code, 1957a, b; 2015; 2017).

49. It is critical to ensure the buy-in of the Government of Jharkhand (GoJ) in this JV since significant amounts of coking coal reserves are locked up under government-owned forest and non-forest land in this coalfield. Specifically, the Ministry of Environment, Forest and Climate Change (MoEFCC) and GoJ must work together with the selected JV partner to progressively divert the forest land for mining & allied purposes in return for paying compensatory afforestation over double the area of land to be diverted in small but reasonably sized parcels linked to the approved Mining Plan. Further, the Net Present Value (NPV) of the forest produce based on the extent of the forest land to be diverted temporarily for non-forest use in the WBCF will run into hundreds of crores. Therefore, MoEFCC must amend the Forest (Conservation) Rules and related procedures/guidelines to permit the NPV of the forest produce on the forest land to be diverted for the mining & beneficiation projects for increasing the domestic supply of coking coal (a 'critical mineral'), to be paid in annual instalments (with annual escalation) and secured through appropriate bank guarantees. These enablers require amendment of the Forest Conservation Rules of 2022 as well as the extant guidelines & procedures of the forest departments in MoEFCC and GOJ (MoEFCC, 2019; 2022).

50. All investments required to be made by the SPV for the Resettlement & Rehabilitation (R & R) of project-affected-persons, mine development and operations, construction

of the washery and logistics infrastructure, captive power plant, and residential colonies for the employees must be the sole responsibility of the private sector partner in the SPV who can be selected by GOI through an auction process.

51. However, the auction process must be limited to the Integrated Steel Plants (ISPs) in India who must be permitted to sell the washed coking coal only to steel plants at prices benchmarked with the National Coal Index while only the washery by-products (middlings, tailings, and other washery rejects after meeting the captive needs) must be sold exclusively to the core sector as per mutually negotiated prices between the JV and buyer. This company must not be permitted to sell raw coal in any form after the first three years of the grant of the mining lease and surface rights since this time is required to construct a modern coking coal washery in this coalfield.

52. CIL has approximately 19 BT of coking coal resources out of which 3 BT cannot be extracted due to identified technical or other constraints. Non-CIL Blocks are estimated to contain another 9.6 BT of coal resources as of 1 April 2020, while SAIL and Tata Steel together hold only 300 MT of resources as per the IMC report on 'Mission Coking Coal' (MOC, 2021). Out of CCL's total raw coal offtake of 75.02 MT in FY 2022-23, only 1.658 MT was supplied to its coking coal washeries since CCL's focus is on the supply of coal to the power sector (both coking & non-coking). Therefore, the recommendations of this report if successfully implemented can be extended to other coking coal blocks owned by CCL. This will enable the country to utilise a major portion of India's extractable medium coking coal reserves in stamp-charged batteries before we reach Net Zero by 2070 rather than missing out on opportunities to enhance the competitiveness of steel industry by using private sector driven SPVs to enhance domestic coking coal production.

53. NIAS presented the findings of this report in a Stakeholder Consultation meeting organized by NITI Aayog on 1 March 2024 under the Chairmanship of Dr. V.K. Saraswat, Member, NITI Aayog. Dr. Saraswat highlighted the need for demarcating clusters of coking coal blocks before auctioning them since a minimum scale of operations is required for setting up viable coking coal washeries near the blocks. He stressed the importance of implementing a close integration between mining geology, coal quality assessment, mine planning, mining operations, beneficiation, and logistics backed by a strong Quality Assurance (QA) system and a continuous-improvement culture to maximise the production of washed medium coking coal suitable for metallurgical use in integrated steel plants in India. He also emphasized the key role of the Government of Jharkhand in expediting various statutory clearances and facilitating land acquisition to mobilize the coking coal blocks in Jharkhand.

54. The Record of Discussions (RoD) held during this stakeholder meeting is enclosed as Annexure 1, while the NIAS presentation during this meeting is enclosed as Annexure 2.

Chapter 1

Supply Demand Scenario for metallurgical coal in India in the context of the National Steel Policy

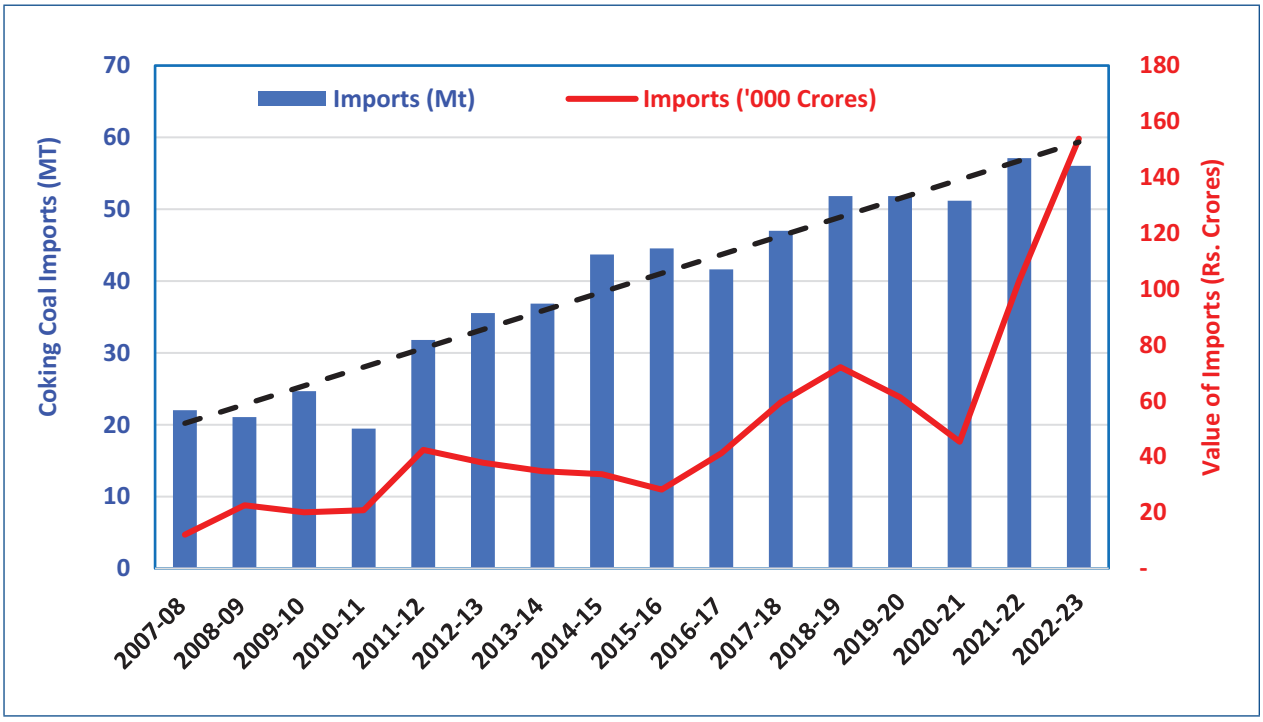
1. On May 8, 2017, GOI notified the National Steel Policy (NSP) 2017 with the primary goal of enhancing India's crude steel capacity to 300 MT (from the current capacity of 126 MT) by 2031 (MOS, 2017). This expansion is required to meet the projected demand of 230 MT of finished steel, with per capita consumption of 158 kg by FY 2030-31 against the FY 2019-20 level of 75 kg. In the NSP, GoI has projected requirements of 161 MT of coking coal and 31 MT of low-ash non-coking coal (for pulverized coal injection (PCI) into the blast furnace), to achieve the target of finished steel production of 230 MT by FY 2030-31. According to the report of the Mission Coking Coal inter-ministerial task force set up by the Government, the annual demand for washed metallurgical coal in India would rise to 56 MT by FY 30 if stamp-charging technology is used, and 40 MT per annum if stamp-charged coke oven batteries are not adopted in future.

2. For example, the requirement of coking coal to meet the growth plans of the Steel Authority of India Ltd. (SAIL) will increase to 31 MT by 2031 of which at least 7 MT of coking coal (@18% ash) can be sourced from domestic sources. Against this, SAIL produced only 0.62 MT of washed coking coal in FY 2022-23.

3. India is the largest importer of metallurgical coal in the World. In FY 2022-23, India imported 56 MT of coking coal & coke for metallurgical purposes. The National Coal Index (Base FY 2017-18) for imported coal which was less than 100 up to July 2021 more than doubled to 234 by the end of FY 2021-22 and reached a record high of 309 in May 2022 before coming down to 203 in March 2024 (MoC, 2024b).

4. Therefore, the total value of coking coal imports into India crossed Rs. 1 lakh crores for the first time in FY 2021-22 due to the sharp hike in prices of imported coal after the start of the war between Russia and Ukraine (Figure 1.1). While the total volume of coking coal imported into India has marginally reduced in FY 2022-23, India's total coking coal import bill exceeded 1.5 lakh crores for the 1st time last year. Since the cost of coking coal accounts for approximately 42 percent of the total cost of steel produced in India, steep increases in the landed price of imported coking coal have a major impact on the cost of steel. This impacts the financial performance and competitiveness of India's steel sector and affects the price of a vital input to the automotive and infrastructure sectors. While the Government has

Figure 1.1. Volume and value of coking coal imported into India by the iron & steel sector.



several priorities for public expenditure, increasing costs of steel also impact the infrastructure development required to make India a developed country with a 30 trillion-dollar economy by 2047 (PIB, 2023c).

Chapter 2

Coking properties suitable for Integrated Steel Plants in India and the availability of coking coal reserves with such properties in India

1. As of 1 April 2023, India's measured reserves of prime coking coal and medium coking coal are estimated to be 5.1 BT and 16.5 BT, respectively (CMPDI, 2023). Therefore, the country has adequate reserves of coking coal that can be washed down to 16-18% ash for supplying metallurgical coal to integrated steel plants and coke oven batteries.

2. The Jharia coalfield has been the hub of coking coal production in India for more than 100 years since it contains prime coking coal reserves that are eminently suited for use in top-charged coke oven batteries. All top charged batteries in Tata Steel's Jamshedpur steel plant have been replaced with stamp-charged batteries and even SAIL is progressively replacing its top-charged batteries with stamp charged batteries.

3. All the PSU washeries installed before 2018 (when the Dahibari washery was commissioned) in BCCL and SAIL lack froth flotation circuits necessary for fines treatment and are fitted with obsolete systems designed to wash coals from the upper seams which had superior washing characteristics. Therefore, these washeries are unable to consistently produce metallurgical grade coking coal (with less than 18% ash) from the raw coal mined from the mines of (BCCL) today. Therefore, BCCL is setting up modern coking coal washeries in the Jharia coal field besides amalgamating various smaller coal mines to form larger units to feed 12 MT of raw coking coal to these washeries. Of these four washeries, the much-delayed Madhuband washery (5 MT) was commissioned in November 2023 (PIB, 2023). BCCL is constructing three more coking coal washeries (Patherdih-II, Bhojudih, and Moonidih New) with an incremental throughput capacity of 7 MT per annum (MOC, 2022a). SAIL is also constructing a 3.5 MT pithead coal washery in its captive Tasra coal block.

4. Along with Tata Steel which operates two coal washeries with a combined throughput capacity of 3.5 MT in the Jharia coalfield, the total raw coal processing capacity of these seven (7) coking coal washeries will exceed 18 MT per annum in the next 3-5 years. These washeries will be able to produce more than 7 MT of washed coking coal for the steel sector if they are supplied with adequate volumes of raw coal coking coal possessing the washability characteristics for which they were designed. This is in addition to proposals (under consideration) to renovate

the obsolete washeries of BCCL. It is therefore prudent to hold further investments in washeries in the Jharia coalfield till then.

5. On the other hand, experts and practitioners of stamp charged coke making technology in Tata Steel have demonstrated that (Prasad et al., 2001):

    - *"It is possible to use 30–35% low-volatile semi-soft coal along with domestic coals and produce good quality coke (CSR of 65-66%) by stamp charging technology under Indian conditions.*

    - *The use of semi-soft coals in the stamp charging coal blend has been beneficial to produce coke with strength characteristics of international standard at lower cost.*"

1. Since semi-soft coking coal is cheaper than prime (or hard) coking coal in India as well as in Australia, the switchover to stamp charged batteries will enable ISPs to reduce the amount of prime coking coal in the coke oven blend without affecting coal quality. Further, Tiwari et al. (2017) have documented that the washing of medium coking coal from the West Bokaro coalfield to 16.8% ash before blending it to the extent of 55% with 35% imported semi-soft coal and 10% hard coking coal produces coke with optimal properties (CSR >= 65% with coke ash of 16-16.5%) in the stamp charged batteries.

2. According to the Mission Coking Coal document, the demand for domestic coking coal is higher if stamp-charged coke oven batteries are used since this technology enables the coke ovens to accept a higher share of semi-soft/medium coking coal compared to the top-charged coke oven batteries. Specifically, the share of domestic coking coal in the coke oven blend can be increased from 10% to 35% by using stamp charging technology which is already used in TSL's steel plants and is also planned to be deployed in all units of the Steel Authority of India Ltd.

3. The quality of coke produced from stamp-charged batteries in Tata Steel's Jamshedpur steel plant demonstrates the importance of enhancing the production of washed medium coking coal (@16-18% ash) from the West Bokaro coalfield to reduce the cost of coke without compromising on coke quality or blast furnace productivity. Tata Steel's experience indicates that the optimal use of medium coking coal (+/- 17% ash) from the West Bokaro coalfield in stamp charged batteries will reduce the cost of coke (and hot metal) by increasing the proportion of low-ash, imported semi-soft coals that are cheaper than hard coking coals though both coals may be imported from Australia.

4. Further, coking coals with similar properties from other countries may also be used to sweeten the blend after conducting trials in pilot coke ovens. This illustration also applies to other ISPs who use the BF-BOF technology to produce iron & steel in India.

5. While the washeries in the Jharia coalfield will cater to the prime coking coal needs of SAIL, they can substitute only a part of SAIL's imported coal requirements even at full capacity. The West Bokaro Coalfield (WBCF) in Jharkhand contains approximately 22% (3.58 billion tons) of India's 16.5 BT of measured (Category 331) resources of medium coking coal (CMPDI, 2023). Eighty-four percent of these measured coal reserves (3 billion tons) are at a depth of less than 300 m, which makes it possible to ramp up the coal production in this coalfield quickly

once all necessary clearances (including, environmental & forest clearances and mining lease & surface rights) are granted by GOI and the Government of Jharkhand.

6. Therefore, it is possible to quadruple the production of metallurgical-grade coking coal suitable for stamp-charged batteries from the West Bokaro coalfield in the next 10 years if the recommendations regarding the setting up two integrated mining & beneficiation complexes in the PPP mode in this coalfield are implemented by the synergistic actions of MoC and the Government of Jharkhand with a whole-of-government approach.

Chapter 3

Best practices adopted by coking coal mines globally and in India and gaps in exploration, operation & management adopted in Indian coking coal mines

3.1. Exploration and geological modelling

1. Unlike the coking coal deposits in Australia (which is the biggest supplier of coking coal to India), the virgin medium-coking coal reserves in India have very difficult geo-mining conditions (faulted deposits with multiple, steeply dipping thin seams) while the coal seams are categorized as "difficult-to-wash" due to the high percentage of "near-gravity material." However, the technology, operating skills, and management practices required to scientifically mine and wash medium coking coal to produce metallurgical coal for integrated steel plants are already demonstrated in India, albeit in the private sector. This can be replicated across the entire coking coal sector with a determination to succeed.

2. In general, the coalfields containing proved coking coal reserves in India have been explored with a broad pattern of boreholes for overall resource assessment and structural definition. Furthermore, considerable data exists for basic coal quality assessment (ash content). However, numerous geological uncertainties remain, especially associated with the structural interpretation (precise seam dip, specific delineation of fault position, fault attitude and characteristics etc.), weathering limits, and the basal seam occurrence. Further, inadequate sampling and test work have been conducted to collect representative washability data which is critical for integrating mine planning with washery design and equipment selection. In some cases, the borehole surveys may not have the desired level of accuracy which becomes evident at the stage of building the geological model. In other cases, the core recovery may be inadequate to ensure a clear definition of seam roof and floor boundaries. This requires a fresh drilling campaign, with directional drilling (in deposits with complex geology) to iron out any discrepancies and build an accurate geological model suitable for detailed mine planning.

3. The acquisition of new drilling data and detailed geotechnical investigations will facilitate renewed scrutiny and validation of pre-existing data. Critical consideration of the individual borehole data in an integrated manner through modelling is a most powerful validation tool. During geological modelling, the pre-existing interpretation of the coal blocks must be reviewed and where

necessary modified, to ensure consistency with the latest available data.

4. Band-by-band coal quality analysis is essential for coking coal deposits since this will be used to determine coal quality cutoffs at the time of geological modelling and mine planning. Coal quality modelling based on the pre-existing and fresh data will lead to improved correlation and modelling of the extractable partings within seams. This can be achieved by collecting and analyzing representative samples of all coal seams in virgin coal blocks as well as operating coking coal mines to refine the geological model and update the washability and flotation characteristics.

5. Besides modern exploration technologies, coking coal mines in India must implement a rigorous approach to data validation and data management to build geological models that are updated at regular intervals (once a year or longer intervals depending on the complexity of the geology and progress of mining operations) to ensure that accurate mine plans and production schedules with seam-wise as-mined coal quality can be prepared on an annual, quarterly, and monthly basis.

6. In India, the washability characteristics of coking coal vary from seam to seam and even from borehole to borehole within the same seam. Hence, the performance of a washery can be optimized only by companies with the technical and operating skills as well as the financial strength and management expertise required to develop and operate Mega Projects using high-technology and human innovation with a long-term vision for value creation.

3.2. Mine planning

7. In FY 2022-23, CIL dispatched 43 MT of coking coal to the power sector mainly due to the lack of modern washeries and the delays in modernising their existing washeries (MoC, 2023a). The success of Tata Steel Limited (India's only coking coal producer in the private sector) in utilizing its captive coal blocks is due to the use of scientific mining practices to optimize the value of its coal reserves, the continual modernization of its washeries to suit the deteriorating washability characteristics of its residual reserves, all knit together by effective management systems. The best practices used by Tata Steel in its West Bokaro coalfield where it operates two coking coal washeries that have been continually modernised to maximise the yield of metallurgical grade coal are summarised as follows:

8. The key customers (coke ovens and captive power plants) specify their requirements for the forthcoming year, and an MOU is signed between the Head of the Customer department (Coke Oven/Power Plant) and the General Manager of the area/division operating the integrated captive coal mining complex (mines, washeries, and logistics). This MoU specifies the monthly tonnage of clean coal (or middlings as the case may be) and the corresponding quality parameters (average and standard deviation of ash & moisture). In addition, other critical requirements (e.g., covering railway wagons during monsoon) and response time to customer feedback are also included in the MoU. This MoU then forms the key input to the overall Annual Business Plan of the area/division operating the integrated captive coal mining complex

(mines, washeries, and logistics), and is cascaded downwards by the area General Manager to the agent of each mine and the head of the coal beneficiation & logistics department.

9. The in-house Geological Services (GS) department in the coalfield is equipped with the requisite number of skilled geologists and chemists as well as a well-equipped laboratory with all the instruments & facilities to conduct washability and flotation tests promptly.

10. The GS department designs the exploration plan and manages the work of the outsourced drilling and survey teams to ensure that the reserves in the coal block are brought into the 'Measured Mineral Resource' category (331) as per the UNFC classification.

11. Once the survey and exploration activities are completed in the coal block, the GS department builds a geological model of the coal block using standard software like SURPAC. The GS department then works with the Mine Planning department to build the block model of the mine so that mine design and planning can commence. In cases involving large investments, geology and mine planning experts from Australia and the United States of America are also invited to prepare a detailed project report for the mine. These experts also advise on the further exploration required based on the geological structure of the coal block and the need for geotechnical data for validating the mine design.

12. The GS department is the repository not only of the borehole data in the coalfield but also the washability characteristics (float-sink results as well as flotation characteristics) determined from representative borehole samples of each seam collected at 200 – 400 m intervals in advance of mining. This drilling campaign can also be useful to verify the geological structure and geotechnical properties of the strata in advance of mining. This is particularly important for underground coal mines as well as deep opencast mines.

13. Since the washability tests require a minimum sample size, large-diameter boreholes (HQ size) must be drilled to collect adequate sample volumes even from thin seams (which are quite prevalent in the West Bokaro coalfield). This requires mobile drilling rigs which are readily available in India. More importantly, the selection of core samples (post logging) must be undertaken by the departmental geologists to ensure data integrity.

14. Based on their database, the GS department provides sufficient borehole data to the Mine Planning department in the coalfield to plan the monthly coal production and excavation (overburden removal) targets of each mine as per their annual production targets.

15. Based on the monthly excavation plans, the Mine Planning department works with the Agent and the Mine Manager to prepare the detailed seam-wise coal production schedule and overburden removal schedule, keeping in mind the mineable reserves, monsoon preparation, and major constraints related to safety, environment, forest, and land availability.

16. The Mine Planning department then works with the Land department to identify the specific land (including a 100 m safety zone

around the margins of the excavation) to be taken into possession free of encumbrances. This will culminate in an MoU between the Planning & Land departments and the Agent of the mine to ensure agreement on specific land parcels to be handed over for mining as per the ABP requirements.

17. Based on the monthly seam-wise raw coal production schedule prepared by the Mine Planning department in collaboration with the Agent of the Mine, the Coal Beneficiation (CB) group estimates the monthly clean coal (quality and quantity).

18. If the predicted clean coal quality and quantities estimated in Step VII, do not meet customer requirements in terms of quantity and quality, the entire planning & scheduling exercise is repeated till they match or exceed the requirement. This step culminates in an MoU between the Agent of the mine and the Head of the CB group in the area.

19. Once the seam-wise production schedule and corresponding overburden excavation schedule are prepared for the year (Step 6), the mine Manager works with the Excavation department head in each mine to draw out the major equipment requirements. This will help the Excavation department to plan the major overhauls of the major mining equipment (e.g., shovels, dumpers, drills, and dozers) and assess whether there is enough departmental excavation capacity in each month of the forthcoming year to meet the production requirement. If there is a shortfall in the departmental excavation capacity vis a vis the mining requirement, the mine Manager and the Excavation head consult the Agent of the coal mine, either to hire (wet lease) equipment from third parties or examine the possibility of shifting equipment (and manpower) from other coal mines in the company.

20. The mine Manager and Head of the Excavation department then sign an MoU between themselves to formalize their commitment. This MoU includes key performance indicators (KPIs) like the availability & utilization of major equipment (month-wise) based on pre-fixed productivity norms as well as unscheduled downtime, diesel consumption, and costs due to damages (including, maloperation).

21. The Mine Planning department works with the mining operations and excavation teams to prepare an Approved Annual Production Plan (AAPP), Rolling Annual Production Plan (RAPP), and Rolling Monthly Production Plans (RMPP). These plans will each ensure that the required coal quality specifications are specified in advance of mining. The RMPP will be further split into weekly plans which will be communicated to the production team at the weekly production meeting. In addition, daily production meetings involving relevant technical and production staff will ensure that the weekly plan is maintained.

22. The Geology and Mine Planning teams work together to ensure that the seam-wise coal quality models are regularly updated with the latest coal quality data as well as the washability data obtained from the coal samples collected during the infill drilling or blasthole drilling.

3.3. Coal mining operations

23. Since coking coal is much more valuable compared to thermal coal, the minimum thickness of mineable coal is set at 200 mm. Partings greater than 50 mm are separated from the coal and mined as waste material. Partings less than 50 mm are mined with coal. The GS department is responsible for determining and identifying the coal thickness and the parting thickness and communicating this information to the mine Manager in advance of blasthole drilling in the coal seam.

24. Raw Coal is mined as per the plan and ripper-dozers are used to extract thin seams and remove any shale bands on the coal bench before blasting. To ensure coal quality during the night shift, sufficient lighting will be provided on the coal excavators and in the form of standalone lighting towers to supplement the lighting on the coal mining machines. This is particularly important to ensure the planned coal quality in thin seams by avoiding dilution of the coal mined with inter-burden.

25. A GPS-based Truck Dispatch System is used to control the mining operations in real-time to ensure that the availability, utilization, productivity, and shift-wise deployment of equipment, are monitored daily. The output from the TDS is also input into a computerized production reporting system which keeps track of all daily, weekly, monthly, and annual production data including equipment hours, productivity, and production. Daily, monthly, and yearly proforma reports will be developed to monitor production progress. Daily production reporting enables immediate feedback to the operations and maintenance teams to make any required production adjustments to ensure that the mine plan remains on track. The seam-wise production of coal is also monitored by the Geological Services department who liaise with the washery team on a shift-wise basis so that the washery operating parameters are optimized to extract the maximum clean coal yield from the raw coal supplied.

26. Blasthole gumming samples are also collected by the Geological Services department from each coal seam every week to update and calibrate the washability data obtained from the borehole samples used to prepare the annual production schedule. The coal seam quality models are regularly updated with the latest coal quality drilling data to ensure that the information on the mining reserves is constantly updated with the latest and relevant quality data.

3.4. Mine reconciliation

27. The key purpose of mine reconciliation is to ensure that as-mined quantities are reconciled against the current rolling Monthly Production Plan and the current Approved Annual Production Plan to determine production performance against targets. In addition to overburden quantity surveys, quarterly reconciliations of coal mined against coal reserves from the geological model are conducted to check for the accuracy of the geological model and identify any future infill drilling programs.

28. A detailed pit survey will be completed at the end of each month and the mine survey model updated. Quantities of coal and waste mined during the period will subsequently be determined accurately. In addition, dump

surveys will also be conducted to ensure that the dumps are maintained properly based on safety and conservation considerations. The revised pit model will be compared against the AAPP and where differences arise changes will be made to the next RMPP.

29. Depending on the areal extent of the mine, the latest survey equipment (e.g., total stations, dedicated Differential GPS systems, and/or laser scanners) is used to conduct accurate bench, pit, and dump surveys at monthly intervals. The survey instruments will download field data directly onto a dedicated survey package and will thus be immediately available for mine planning purposes. Each surveyor will use a dedicated personal computer for data processing and calculation. Processed survey data will be stored on a dedicated server as per the mine planning data. Survey data will thus be readily available to the mine planning team. Additional offsite support will be available to the geology & mine planning team from the corporate/area office.

30. A detailed monthly report will be issued by the Mine Planning department to the management at the mine level and the area level which shows how the mine plan is progressing against the AAPP and RMPP. A Non-Conformance Report (NCR) can be issued as an internal control measure where compliance with the mine plan has deviated.

31. In this manner, the mine reconciliation process closes the cycle and ensures that improvements happen in all unit operations from planning to operations and washing.

3.5. Coal beneficiation

32. Once the likely production from each coal seam connected to a specific washery is available from the Mine Planning department based on the ABP, the Geological Services (GS) department briefs the Coal Beneficiation (CB) department with the expected seam-wise production from each mine and the washability characteristics of each coal seam (or group of seams) to be fed to the washery in each month.

33. Once the seam-wise washability characteristics of the raw coal and the raw coal production schedule are provided by the Geological Services, the Coal Beneficiation (CB) department decides the washery operating parameters based on the technology & equipment deployed, and the washery operating strategy. The operating strategy for the integrated raw coal logistics system and the washery are then decided by the CB department depending on whether it is optimal (in terms of clean coal yield at the desired ash level) to wash each seam (or group of seams) in a batch or washing a blend of coal seams received from the mine/coal handling plant.

34. The GS department conducts Float & Sink tests on the seam-wise raw coal, clean coal, middling & rejects to determine misplacements.

35. A consistent supply of reliable data related to the washability characteristics of each coal seam to be supplied to the washeries from the GS department to the washeries enables

the CB engineers to fine-tune the process parameters to maximize clean coal yield without compromising on product quality.

36. The GS department computes a weekly Compliance Index to monitor the schedule adherence of both raw coal and clean coal production. A non-conformance Report (NCR) can be issued as an internal control measure where compliance with the mine plan or the product quality parameters deviates from the plan.

37. Each railway rake of washed coal is sampled as per standard procedures to determine the ash, moisture, and VM contents of the coal, and this information is e-mailed to the customer before the rake reaches his yard. Other quality parameters (e.g., Ro, Phosphorus, Fluidity) are also monitored at the customer end and the data is shared with GS department to update the mine model.

38. The customer is informed about the coal quality by e-mail or other electronic means as soon as the clean coal or byproduct (middling) rake leaves the siding in the area.

39. Monthly customer feedback is obtained in a specified format with precise dimensions such as quality, quantity, fulfillment, response to emergencies, and special requirements.

40. All the above steps must be documented in the company's management system and compliance must be monitored by the company so that they are followed rigorously. These parameters must also feed into the performance measurement system. As the popular adage states, "*What gets measured, gets done*."

Chapter 4

Advanced technologies for beneficiation of coking coal and conceptual flowsheets for setting up modern coking coal washeries to maximise the production of metallurgical coal suitable for stamp-charged coke oven batteries with blending

1. While several studies have been conducted on the beneficiation of prime coking coal reserves in the Jharia coalfield where BCCL continues to implement its washery expansion & modernisation projects, very few studies have been conducted to develop the flowsheets and equipment configuration for the medium coking coal reserves. Further, CCL has not set up any washery in the last 20 years (or more) though the Rajrappa and Kedla washeries have outlived their useful economic life and are not designed to handle the characteristics of the present raw coking coal feed into these washeries.

2. On the other hand, Tata Steel Ltd. (TSL) has continually modernised its washeries to optimise the yield of washed coking coal to match the variable coal characteristics in its coal mining lease in the West Bokaro Coalfield (WBCF) when they changed with time. Based on TSL's experience and plans for a new washery in the WBCF, a conceptual flowsheet and process design parameters for a modern coking coal washery with an annual raw coal throughput capacity of 8 MT are described in this Chapter.

4.1. Coal washery objectives

3. The primary objective of the plant design is to maximize clean coal yield, even at the expense of middling quality. The secondary objectives are:

- To produce middling coal for sale to power plants
- Tailings for sale and/or for blending with the coarse rejects as a "sweetener"
- Coarse rejects for a pithead power station based on Fluidized Bed Combustion technology.

4. To maximize the production of metallurgical coal suitable for blending with imported coal in the feed to coke ovens using stamp charging technology, the following product qualities can be targeted. The entire washery must be designed & operated as a Zero-liquid discharge washery and operated so that the

consumption of magnetite and frother is minimized.

- Clean Coal: -13mm size, 17 - 18% ash (air-dried basis)
- Middlings: -13mm +0.25mm size, 38-41% ash (air-dried basis)
- Coarse Reject: -70mm +13mm size, ~65% ash (air-dried basis)
- Tailings Filter Cake: -0.25mm size.

4.2. Washery scheme

5. The over-riding design and equipment selection concept must be to provide large throughput process units with as simple a layout and operation mode as possible to ensure a high plant availability and utilization. The entire coal washery and associated raw coal feed systems, and the product handling & storage system (up to the product silos), are designed to treat the mine output on a 24/7 basis for 6800 "on coal" hours per annum. The washery design must be finalized only after extensive test work on representative samples of each coal seam drawn from various locations spread over the entire coal-bearing area of the coal block(s) as explained in Chapter 3. While the test work and simulations by reputed washery designers will indicate the optimal ash content (and yield) for each seam, the average clean coal yield from a blend of medium coking coals in the north-eastern part of West Bokaro Coalfield (WBCF) is expected to be approximately 33% (on air dried basis) at 17% ash with best-in-class washery design & equipment, world-class operating practices, and an optimal liberation size of 13 mm.

6. A conceptual washery circuit suitable to produce metallurgical coal (@16% ash +/-2%) from the "extremely difficult to wash" coking coal seams in the West Bokaro Coalfield (WBCF) is represented schematically in Figure 4.1 and briefly explained in this Chapter.

4.3. Raw coal crushing and transportation:

7. Crushed coal (-75 mm) is stored in the silos with a sufficient buffer to decouple the intermittent mining operation from the coal handling system. The crushed coal is transported to the tertiary crushing section in the washeries via belt conveyors.

8. Crushed coal from the storage silo is fed to a closed-circuit tertiary crushing system where -75 mm is screened in a feed screen (13mm aperture size) and the oversize of this screen reports to the tertiary crusher to crush the coal down to -13 mm. The product of the tertiary crusher along with the feed screen undersize is conveyed to the washery feed bin.

9. The crushed coal storage system and tertiary crusher should be located near the washery. The raw coal of -13 mm size will be stored in the Plant Feed Bins required to decouple CHP operation from the washery.

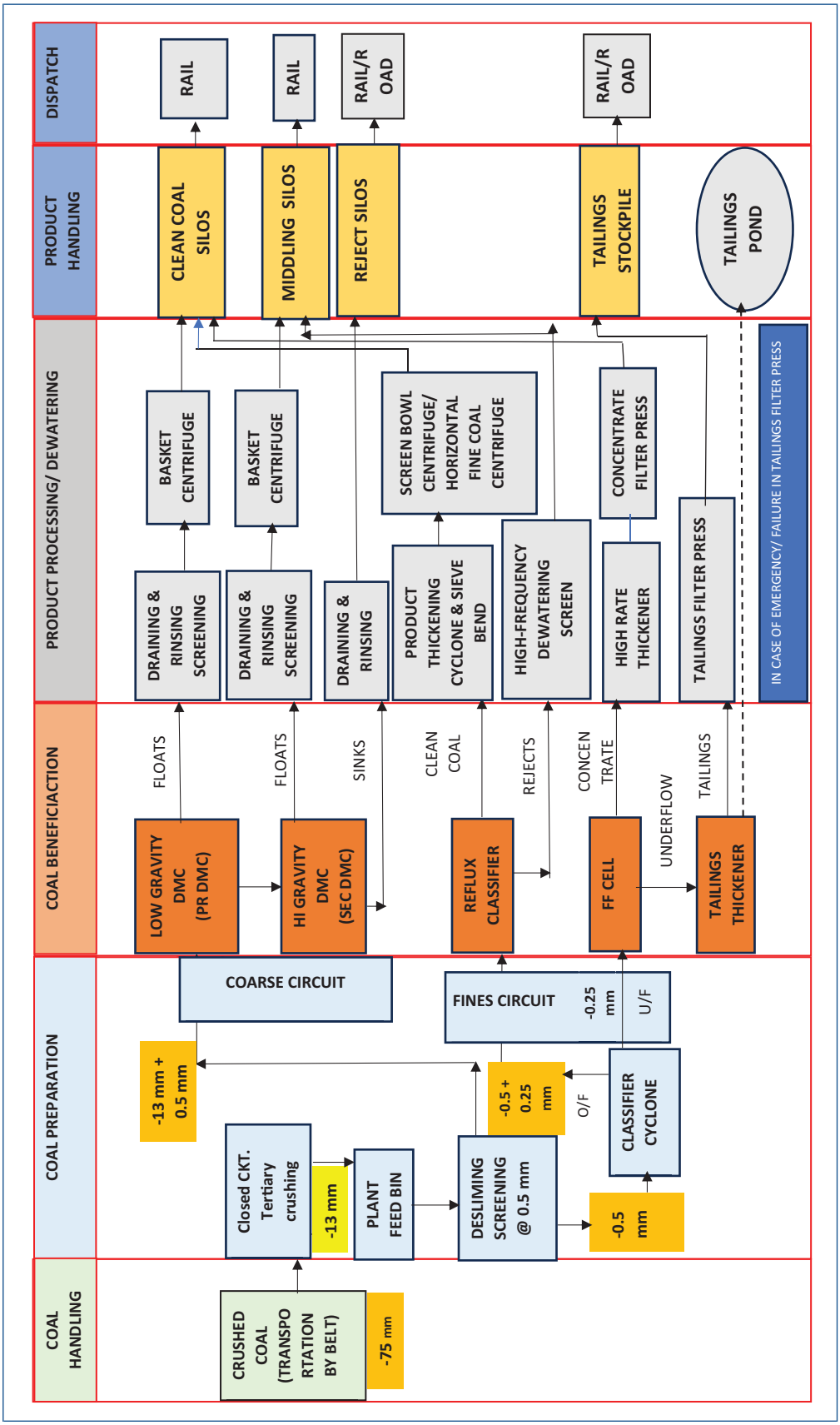


Figure 4.1. Process-flow diagram of a coking coal washery to beneficiate 'extremely difficult to wash' medium coking coal in the West Bokaro coalfield and the associated logistics systems.

4.4. Washery:

10. In the washery, the coal (-13mm) which comes from the coal plant feed bin is de- slimed at 0.5 mm. The oversize coal (+0.5mm) of the screen, coarse coal processed in Dense Media Cyclones whereas the -0.5mm fraction from the undersize of the desliming screen will pass through a classifying cyclone to separate in two size envelopes; -(0.5+0.25) mm and -0.25mm. These sizes of coal particles are processed in the Intermediate and Flotation Circuit respectively. Hence, there will be three streams as mentioned below:

    a) Coarse coal circuit: size (-13 + 0.5) mm

    b) Intermediate circuit: Size (-0.5 + 0.25) mm

    c) Fines circuit: Size -0.25 mm

4.4.1. Coarse Circuit:

11. All seams in the WBCF contain an exceptionally high proportion of material with a density close to the required separation density. With this amount of Near Gravity (NG) content, the coal can be categorized as "extremely difficult" to separate. Because of the high NG proportion, product yield will be severely influenced by the sharpness of separation (measured as Epm). The higher the Epm, the larger the carry-over of sink material into the floats and vice versa. Therefore, the equipment selected must provide as sharp a separation as possible over the full range of particle sizes being treated.

5. The oversize (-13+0.5) mm of the de-sliming screen is treated in two stages of washing in Dense Media Cyclones (DMC). The Primary DMC operates at lower cut gravity and the secondary one is operated at higher cut to separate three products - Coarse Clean Coal, Middling and Rejects. The coarse circuit also includes a media charging and recovery circuit where the media from the coal slurry coming from the DMC passes through a Sieve Bend, Drain and rinse screen and is recovered from the Primary and Secondary Drum Magnetic Separator. Dewatering of coarse coal products is done in a Centrifuge after passing through Draining & Rinsing Screens.

4.4.2. Intermediate Circuit:

6. Clean coal yield in the West Bokaro coalfield is significantly influenced by flotation performance. This is particularly relevant when the washery processes coal at a small top size of 13mm, having approximately 20% of raw feed in the -0.5mm size fraction. Not only does poor flotation circuit performance misplace product directly to tails, but the ability to produce a low ash product is crucial as discussed earlier. Since the flotation characteristics of the residual coal reserves in the West Bokaro coalfield are also poor, the effect of this on overall coking yield can be reduced by:

- Minimizing the proportion of plant feed reporting to flotation.
- Reducing the particle size range treated by flotation to improve float efficiency.

7. These two objectives can be achieved by reducing the top size reporting to the flotation circuit from 0.5mm to 0.25mm and allowing the Reflux circuit to receive the -0.5mm to +0.25mm for separation. The coal particles of (-0.5+0.25) mm size fraction coming from the classifying cyclone underflow are treated in Reflux Classifier (RC). The clean

coal obtained from RC is dewatered through a combination of dewatering cyclones with a sieve bend and finally through a Screen Bowl Centrifuge. Fines Clean Coal obtained from the centrifuge is mixed on the conveyor carrying coarse clean coal. The rejects obtained through the Reflux Classifier underflow are fed to a High-frequency screen for dewatering and mixed on the conveyor carrying coarse Middling/Rejects based on the quality specifications of the by-products.

4.4.3. Fine Circuit:

8. The fine coal (-0.25 mm) coming from the overflow of the classifying cyclones is treated in a flotation cell, where clean coal is collected with froth and tailings as discard. Dewatering of clean coal fines is done through a combination of concentrate High-Rate Thickener (HRT) and Filter Press. Clean Coal cake obtained from the filter press is mixed on the conveyor carrying coarse Intermediate size clean coal. Filtration of Tailings is done through a combination of a Tailings HRT and a Filter Press. The overflow water from the tailings HRT is recycled for use in the washery through the process water tank.

4.4..4. Conveying facility for coal and by-products

9. The crushed coal -75 mm will be transported from the coal mine area through conveyor belts to the tertiary crushing unit and subsequently to the washery. The clean coal and by products from the washery will be transported to the railway siding or the respective storage facilities by conveyor system. Storage facility of the final products is to be designed as follows.

4.4.5. Product and Byproduct storage & dispatch system

10. The quality of each of the four washery products is described below:
    a) Clean Coal: -13mm size, 13 to 18 % Ash (air dry basis)
    b) Middling: -13mm +0.25mm size, 34-42% Ash (air dry basis)
    c) Tailings Filter Cake: -0.25mm size, >32% Ash (air dry basis)
    d) Rejects: -13mm +0.25mm size, >55% Ash (air dry basis)

11. Clean Coal Storage & Transportation
Clean coal yield from the washery shall be conveyed and stored in the clean coal storage silos. Clean coal from silos shall be evacuated by bin extractors and conveyed to the Rapid Loading Station (RLS) as per the availability of railway rakes.

12. Middling Storage & Transportation
Middling coal yield from the washery shall be conveyed and stored in the Middling coal storage silos. Middling coal from silos shall be evacuated by bin extractors and conveyed to RLS as per the availability of railway rakes to meet customer demand.

13. Tailing Storage & Transportation
Tailings filter cakes from the washery shall be conveyed and stored on the ground for natural drying. Tailings shall be mixed with middling or rejects (as and when required) and shall be loaded in railway / trucks and dispatched to buyers.

14. Reject Storage & Transportation
Reject coal from the washery shall be conveyed and stored in the reject coal storage silos.

Reject coal from silos shall be evacuated by bin extractors and conveyed to the RLS or loaded into trucks for dispatch to customers on a case-to-case basis. Due to its high ash content, the economics of rail/road dispatch may not be favourable. Therefore, these coarse rejects should be ideally fired in an onsite power plant based on the proven circulating fluidised-bed combustion technology.

15. Loading and Dispatch System
For uninterrupted dispatch of product coal to the RLS, coal silos are required. These silos will receive material from different streams (clean coal, middling, and rejects) in the washery and convey them to the truck dispatch system or the RLS for dispatch through rail.

16. Tailing Pond
The underflow of the thickener will be pumped to the tailings filter press for further dewatering. The filter cake discharged from the tailings filter press is envisaged to be stored in the tailings stockpile. In case the tailings filtration unit is down due to any issue, the underflow of this thickener will be pumped to the tailings pond.

17. Resource Optimisation
Any new washery or modernization of an existing coal washery must ensure that the new plant is a zero liquid discharge plant. Coal supplied from various sources is fed to the plant. The washery operates in the variable density mode to cater to the beneficiation requirement based on the coal characteristics and customer requirements. Thus, the plant can handle all types of coal fed to it. The proposed washery under the consideration of TSL for their mining lease in the WBCF will incorporate a reflux circuit to recover clean coal from tailings, which will result in resource optimization. Water from the tailing dewatering plant and the tailings ponds will be recycled back to the washery circuit as process water.

18. As explained in this Chapter, a washery capable of producing metallurgical grade coking coal by washing medium coking coal (@17% ash) from the West Bokaro coalfield has multiple, interconnected circuits to treat various size fractions of the raw coal using the appropriate technology for each size fraction. Therefore, the washery engineers must update their knowledge to keep abreast of the latest technologies & practices in coking coal washing. The results achieved by Tata Steel in their integrated mining-beneficiation-logistics complex in the West Bokaro coalfield are depicted in Figures 4.2 and 4.3.

19. As shown in Figure 4.2, TSL's captive coal mines in the West Bokaro coalfield have managed to maintain the average ash content of the raw coal supplied by them to the two washeries between 33% and 35.8% by following best practices in coal mining to minimise raw coal dilution even from thin seams. While the washability characteristics of the coal seams mined in the WBCF vary widely and variations are seen even within the same seam, advance sample collection and test work helps the mine planning and geological services (GS) departments to predict the washability yields of the raw coal (seam wise/blend) supplied to the washeries on a daily basis to enable the washeries to optimise their performance. Therefore, TSL's operations in the WBCF illustrate best-in-class mining practices, mine planning, quality control, washery upgradation to suit changing coal characteristics, equipment selection based on controlled trials, and technology management, backed by trained and motivated personnel at all levels.

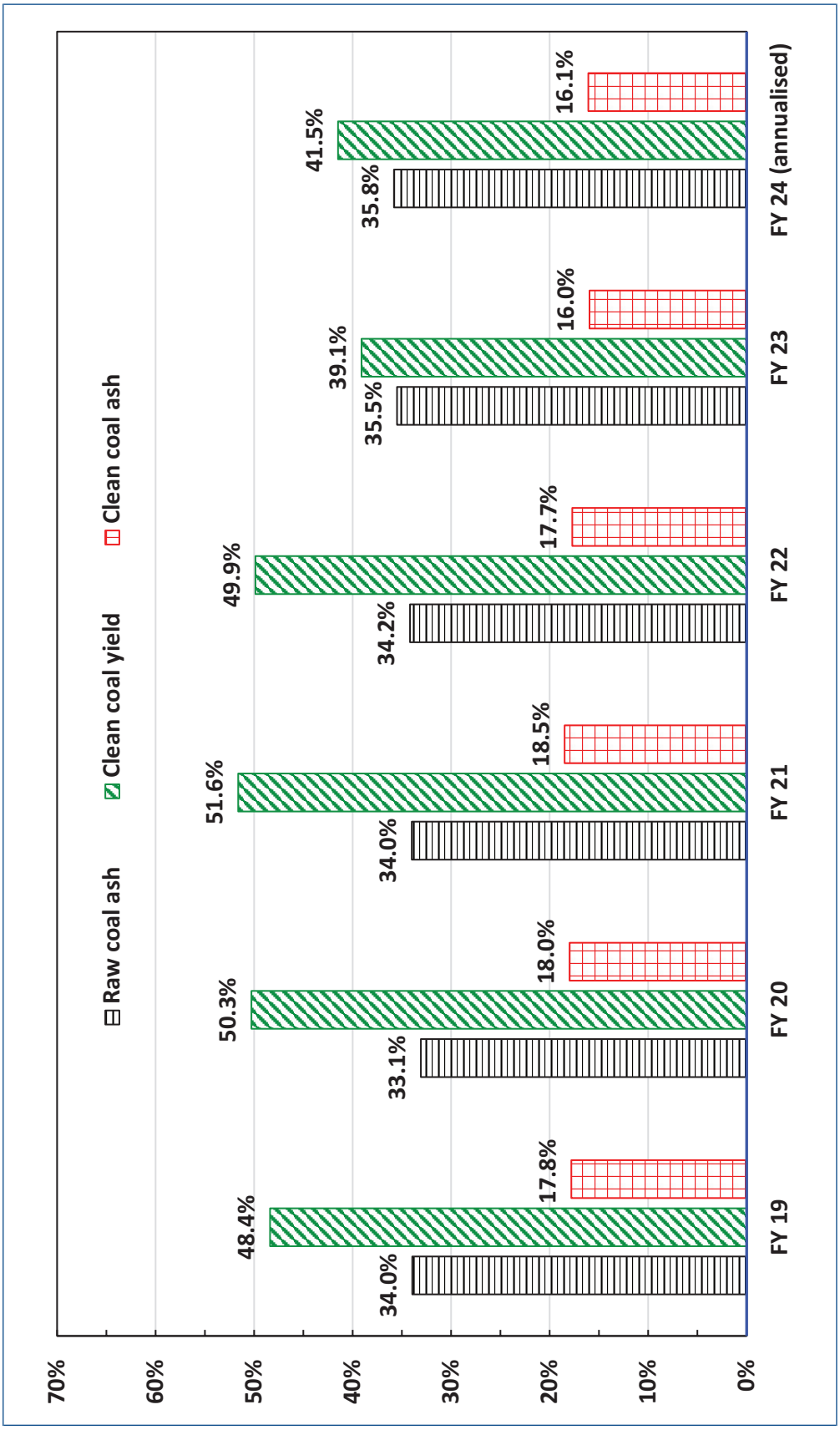


Figure 4.2. Washed (clean) coal yields at various ash contents of Raw coal throughput and Washed coal achieved by Tata Steel's washeries in the West Bokaro coalfield.

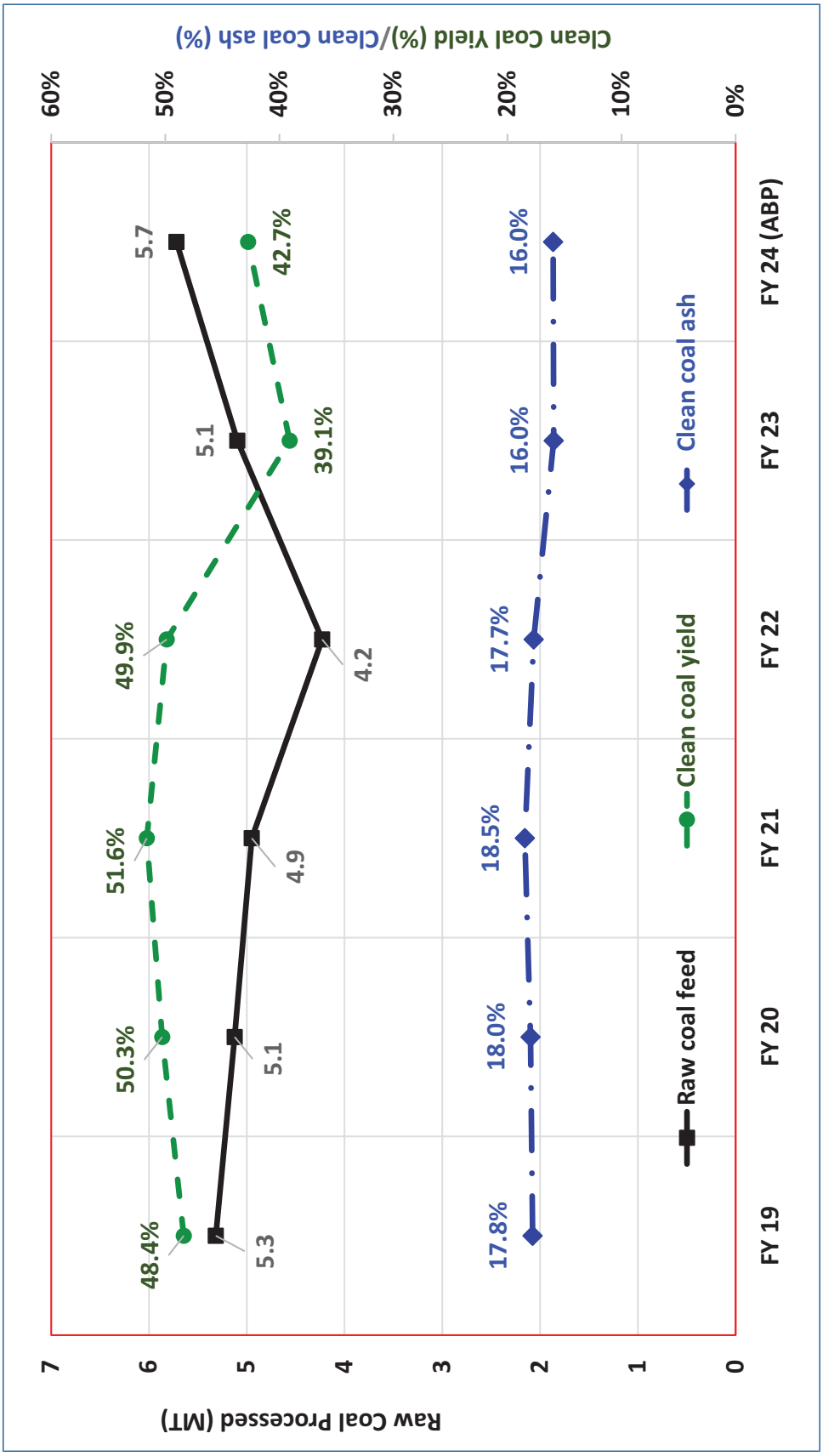


Figure 4.3. Washed (clean) coal yields at 16-18.5% clean coal ash achieved by Tata Steel's captive coal mines and washeries in the West Bokaro coalfield.

Chapter 5

Potential for increasing the domestic production of washed coking coal to enhance the share of domestic metallurgical coal suitable for stamp-charged coke ovens

1. As of 1 April 2023, India has 5.1 billion tons (BT) of proved geological resources of prime coking coal and 16.5 BT of proved geological resources of medium coking coal. Jharkhand holds 100% of India's prime coking coal reserves besides 94% of the country's medium coking coal reserves (CMPDI, 2023). Due to the high ash content of Indian coking coal, it can be blended with imported, low-ash coking coal for coke-making only after washing the domestic coal to a range of 16-18% ash.

2. As shown in Figure 5.1, the raw coking coal mined in India has climbed back to 61 MT in FY 2022-23 after six years. However, the washed (clean) coking coal production of 6.2 MT in FY 2022-23 is lesser than the level attained in FY 2016-17. While the raw coal feed to the PSU (CIL & SAIL) coking coal washeries has reached a level of 8 MT in FY 2022-23 for the first time after FY 2010-11, the raw coal throughput to private sector coking coal washeries also attained a level of 7.6 MT for the first time after 10 years (Figure 5.2).

3. The details of the coking coal washeries in operation and under active construction are shown in Table 5.1. While the total throughput capacity of PSU coking coal washeries is 28 MT, private coking coal washeries have a combined rated capacity of 10.5 MT after their modernisation.

4. As shown in Table 5.1, except for the Dahibari and Patherdih-I washeries, all other coking coal washeries of CIL are obsolete. Moreover, these obsolete washeries were designed for washing W-I & W-II grade coals and to some extent W-III/IV coals while the ash content of raw coal feed to these washeries has increased as the better quality coal seams are depleted.

5. As shown in Figure 5.2, all PSU coking coal washeries with a combined raw coal throughput capacity of 28 MT processed only 8 MT of raw coking coal in FY 2022-23 after the commissioning of two new washeries (Dahibari and Patherdih-I) with a capacity of 6.6 MT. On the other hand, TSL's coal washeries in the Jharia coalfield and the West Bokaro coalfield with a total throughput capacity of 10.5 MT washed 7.6 MT of raw coking coal in FY 2022-23 including, 1.59 MT of BCCL's raw coking coal that was supplied to TSL for supplying washed metallurgical coal to SAIL.

Figure 5.1. Production of raw coking coal and washed coking coal in India (CCO, 2024)

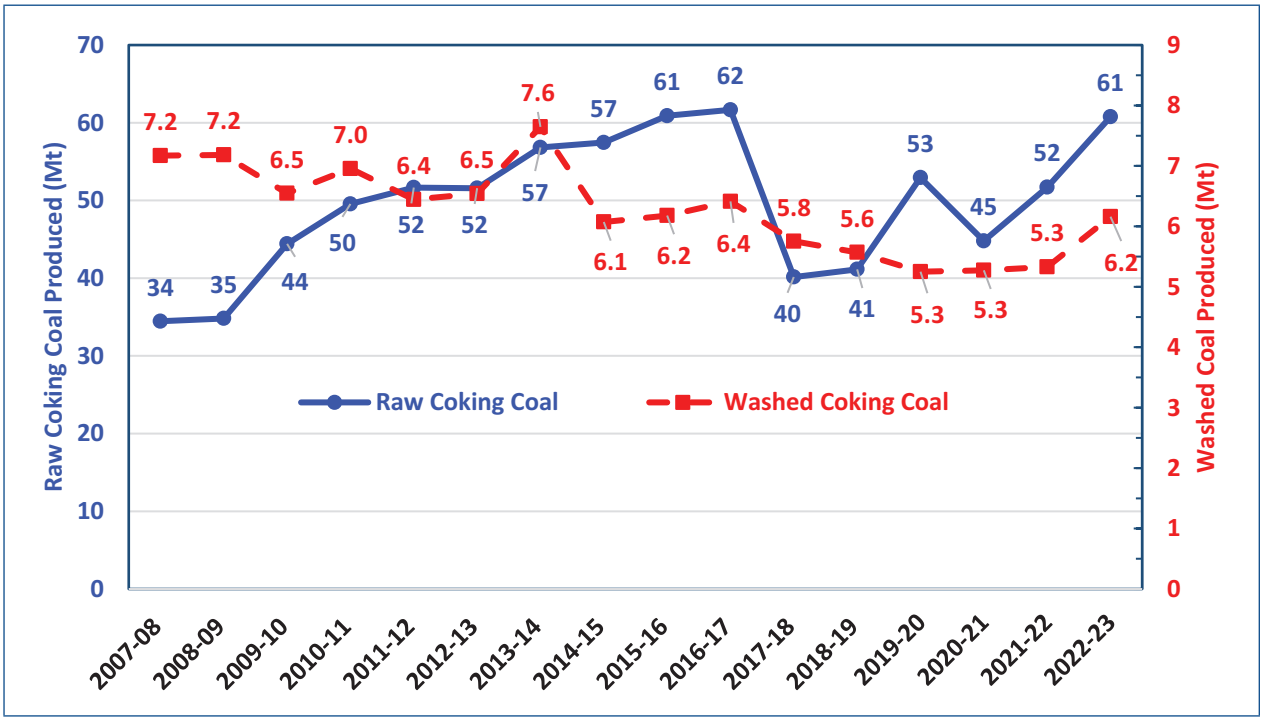


Figure 5.2. Raw coking coal throughput in Public & Private Sector washeries in India)

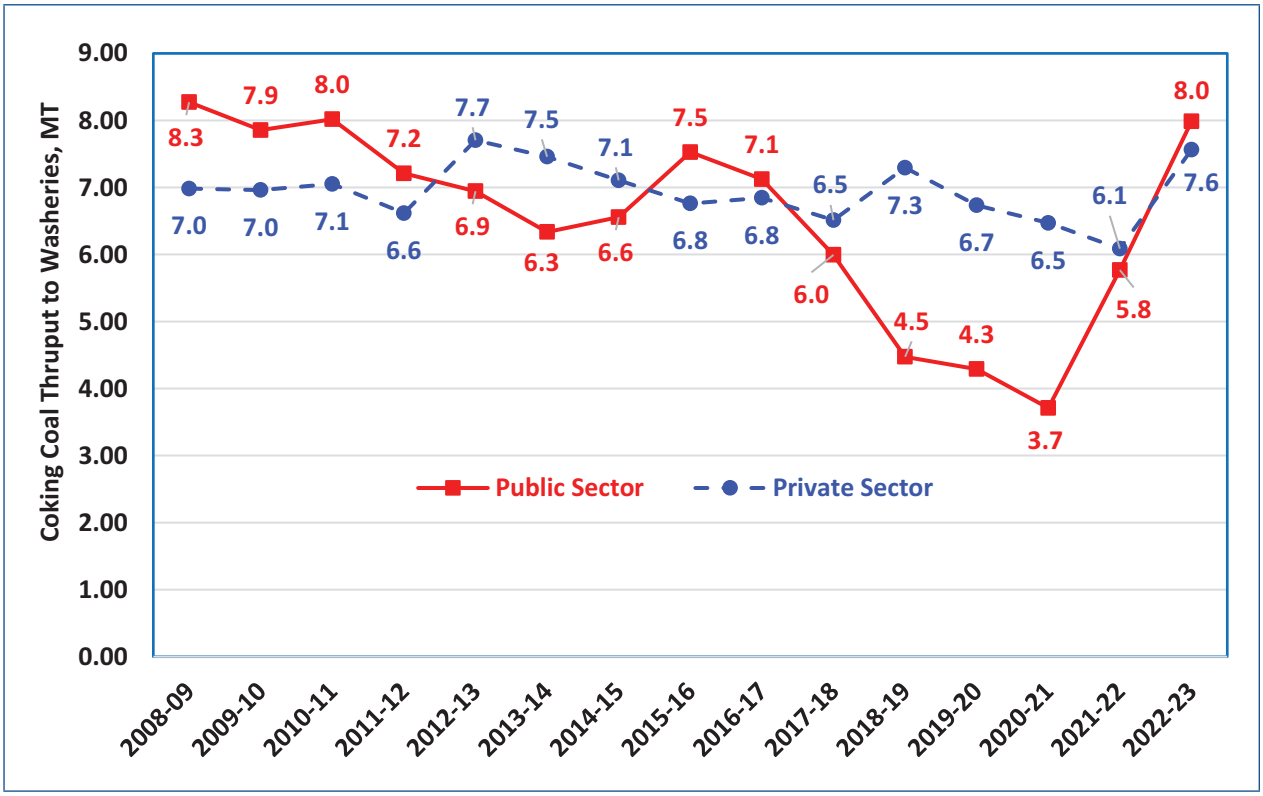


Table 5.1. Details of Coking Coal Washeries in India

Company	Washery	Prime/ Medium Coking Coal	Raw Coal Throughput capacity	Year of Commissioning
Bharat Coking Coal Ltd. (BCCL)	Dugda	Prime	2.00	1968
	Bhojudih		1.70	1962/1964
	Moonidih		1.60	1983
	Sudamdih		1.60	1981
	Mahuda		0.63	1990
	Madhuband		2.50	1998
	Dahibari		1.60	2018
	Patherdih-I		5.00	2020
	Operating Washeries		**16.63**	
	Madhuband (NLW)		5.00	November 2023
	Patherdih-II		2.50	January 2024 (P)
	Bhojudih (new)		2.00	June 2023 (P)
	Moonidih (new)		2.50	June 2026 (P)
Total BCCL			**16.63 + 12 = 28.63**	
Central Coalfields Ltd.	Kathara	Medium	3.0	1969
	Sawang		0.75	1970
	Rajrappa		3.0	1987
	Kedla		2.6	1997
Total CCL			**9.35**	
SAIL	Chas Nala	Prime	**2.00**	1969
Total Public Sector (MT)			**27.98 + 12 = 39.98**	
Tata Steel	Jamadoba	Prime	2.0	1952/2021
	Bhelatand		1.5	1995
	West Bokaro Washery II	Medium	2.5	1984
	West Bokaro Washery III		4.5	1994
Total Private Sector (MT)			**10.5**	

6. Since the easy-to-wash coal seams are exhausted in the Jharia coalfield, the washeries must be modernised regularly to optimise the clean coal yield depending on the washability characteristics of the coals to be beneficiated to the desired level of ash (and moisture content) set by the coke oven plant which is the key customer for a coking coal washery. These modernisation projects also require continuous updating of the washability database through systematic infill drilling by collecting representative samples of various coal seams across the residual reserves of the mining lease and conducting washability and coking test work of individual samples from separate blocks of different seams in the mining lease. This is critical to optimise the design & operation of the washery since the washability and coking characteristics can vary even within the same coal seam.

7. However, none of the PSU washeries except the Dahibari, Patherdih-I, and Madhuband washeries commissioned in 2018, 2020, and 2023, respectively, beneficiate the coal fines (which constitute about 20% of the total crushed raw coal throughput to the washery) since this requires a froth flotation system which has not been installed in these washeries. Therefore, while CIL's coking coal production has increased from 46.6 MT in FY 2021-22 to 54.6 MT in FY 2022-23, the total production of washed coking coal from CIL in FY 2022-23 (1.43 MT from BCCL and 0.72 MT from CCL) was only 2.155 MT, while SAIL produced only 0.62 MT from its captive Chas Nala washery (Coal Controller, 2024).

8. On the other hand, in 2021, Tata Steel practically rebuilt the 2 MT Jamadoba Washery which was the oldest running washery in Asia (in operation since 1952) to commission one of the most modern washeries across the globe (Tata Steel, 2021). To enhance the clean coal yield at 18.5% ash, the new Jamadoba washery incorporates a Dense Media Cyclone (DMC) circuit for coarse coal, an intermediate circuit for a reflux classifier and a flotation circuit to treat the fines. This is the first washery in India with a 100% dewatering facility built within its plant, thereby eliminating the need for tailing ponds, auto sprinklers and dry fog systems.

9. The Reflux™ Classifier is preferred due to its ability to produce concentrate at low specific gravity cut points, less floor space requirement, robust operation, consistency in product grade, high separation efficiency and high throughput (Prasad et al., 2019, 2020). Through trials on lab & pilot scale, it was established that an intermediate circuit is essential at West Bokaro Washery#3 for beneficiation of 1.5 mm - 0.25 mm size fraction of coal. The reflux classifier has been successfully installed in this Washery which treats high-ash (35% on an average) medium coking coal with extremely difficult-to-wash washability characteristics to mitigate the inefficiencies of Dense media cyclones & Flotation cells in processing this intermediate size fraction of coal.

10. As shown in Figures 5.3 and 5.4, the PSU coking coal washeries with a combined raw coal throughput capacity of 29.6 MT washed 8 MT of raw coal and produced 2.78 MT of washed coal with a clean coal yield of 36%. TSL coal washeries with a total raw coal throughput capacity of 10.5 MT beneficiated 7.56 MT of raw coal in FY 2022-23 with a clean coal yield of 45% though the ash content of washed coal produced from

the TSL washeries was much less than that in PSU washeries (Coal Controller, 2024; Private communication). Therefore, the total production of washed coking coal from the PSU washeries in FY 2022-23 was only 2.78 MT compared to 3.39 MT from TSL's washeries. The trends in the production of washed coking coal by the PSU and TSL washeries during the last 15 years are shown in Fig. 5.3 while the yields of washed coking coal in the PSU and TSL washeries are shown in Fig. 5.4.

11. However, these figures do not compare the performance of TSL & PSU washeries on a like-to-like basis since clean coal yields depend on the washability characteristics of raw coal throughput to the washeries, the technology & operating efficiency of the washery and the clean coal ash. For example, TSL maintains the ash content of clean coal from its Jamadoba and Bhelatand washeries in the Jharia coalfield at (18.5% +/-0.2%) while the ash content of the clean coal produced in TSL's two washeries in the West Bokaro coalfield (WBCF) was reduced from (18% +/- 0.5%) to 16% in FY 2022-23 (Figure 5.3). Specifically, the drop in clean coal yield by more than 10% between FY 2021-22 to FY 2022-23 is due to the reduction in washed clean coal ash from 17.7% in FY 2021-22 to 16% in FY 2022-23.

12. The bulk of TSL's metallurgical coal production is from their two washeries in the WBCF which beneficiate extremely difficult-to-wash medium coking coal and still maintain clean coal ash at 18% (or less) with yields in the sub-40% range. While the cost of coking coal is subsidized by the credits from the by-product sales, the overall management objective is to optimize the value of the coking coal reserves by maximizing clean coal yield.

13. The West Bokaro Coalfield (WBCF) in Jharkhand contains three (3) billion tons (BT) of measured (331 category) resources of medium-coking coal up to 300 m depth (CMPDI, 2023). While the East Bokaro coalfield, the Ramgarh coalfield, and the North Karanpura coalfield in the Central Coalfields Ltd. (CCL) command area contain 2.9, 0.7, and 0.56 BT of medium coking coal reserves up to 300 m (CMPDI, 2023), respectively, this report focuses on the WBCF (Figure 5.5) due to the following reasons:

14. The WBCF contains the maximum coal reserves with the best coking properties amongst all the explored coking coal blocks in the CCL command area. As shown in Figure 5.5, out of the 25 identified coal blocks in the WBCF, 18 coal blocks belong to CIL/CCL, and the remaining seven coal blocks (Basantpur, Choritand Tilaiya, Jogeshwar & Khas Jogeshwar, Lalgarh North, Rabodih, Duni, and Lalgarh South) have been auctioned to private miners for commercial coal mining till March 2024 (CMPDI, 2022; MSTC, 2023; PIB, 2024).

15. This coalfield is largely left unexploited by CCL due to various reasons. Out of CCL's total raw coal offtake of 75.02 MT in FY 2022-23, only 1.658 MT was supplied to its coking coal washeries since CCL's focus is on the supply of coal to the power sector (both coking & non-coking). Most of the coking coal seams in the WBCF are classified as difficult-to-wash or extremely-difficult-to-wash due to high percentages of 'Near-Gravity Material' which requires a highly complex (and expensive) washery not set up by CCL till date.

Figure 5.3. Production of Washed (clean) coking coal in PSU & Private washeries.

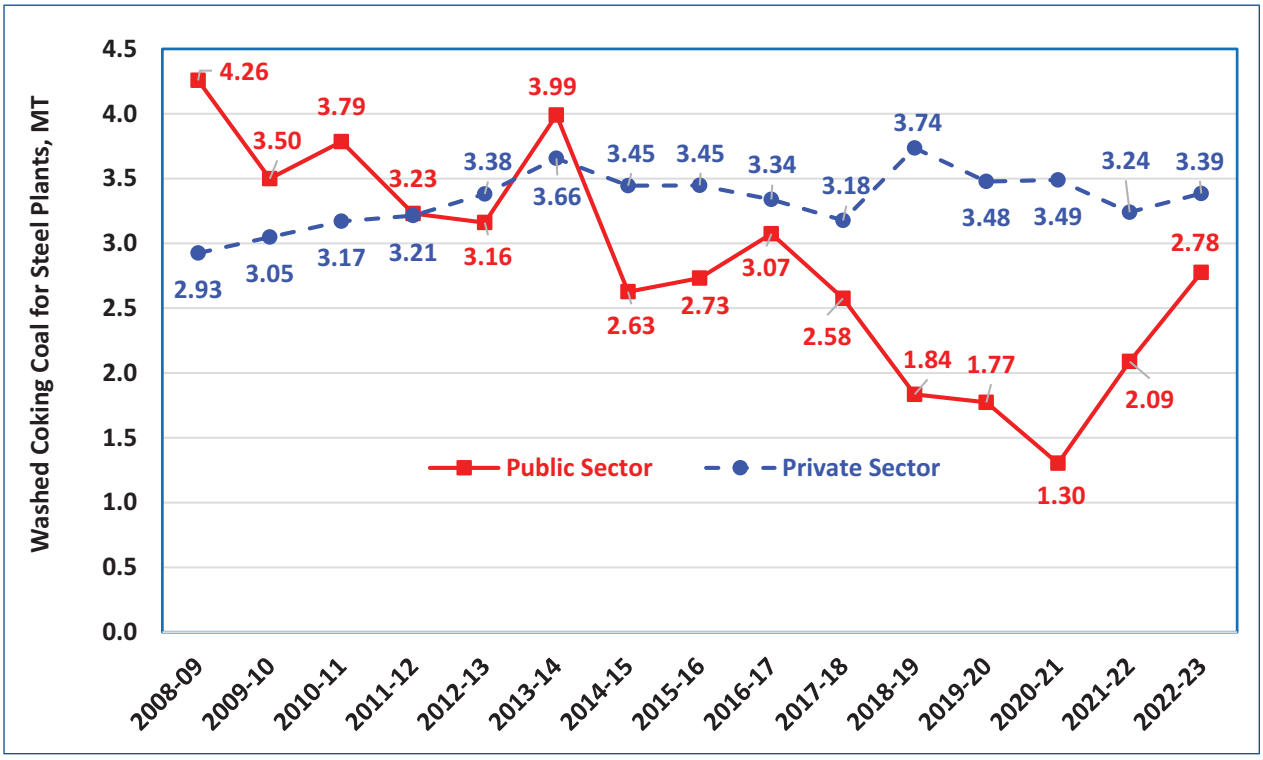
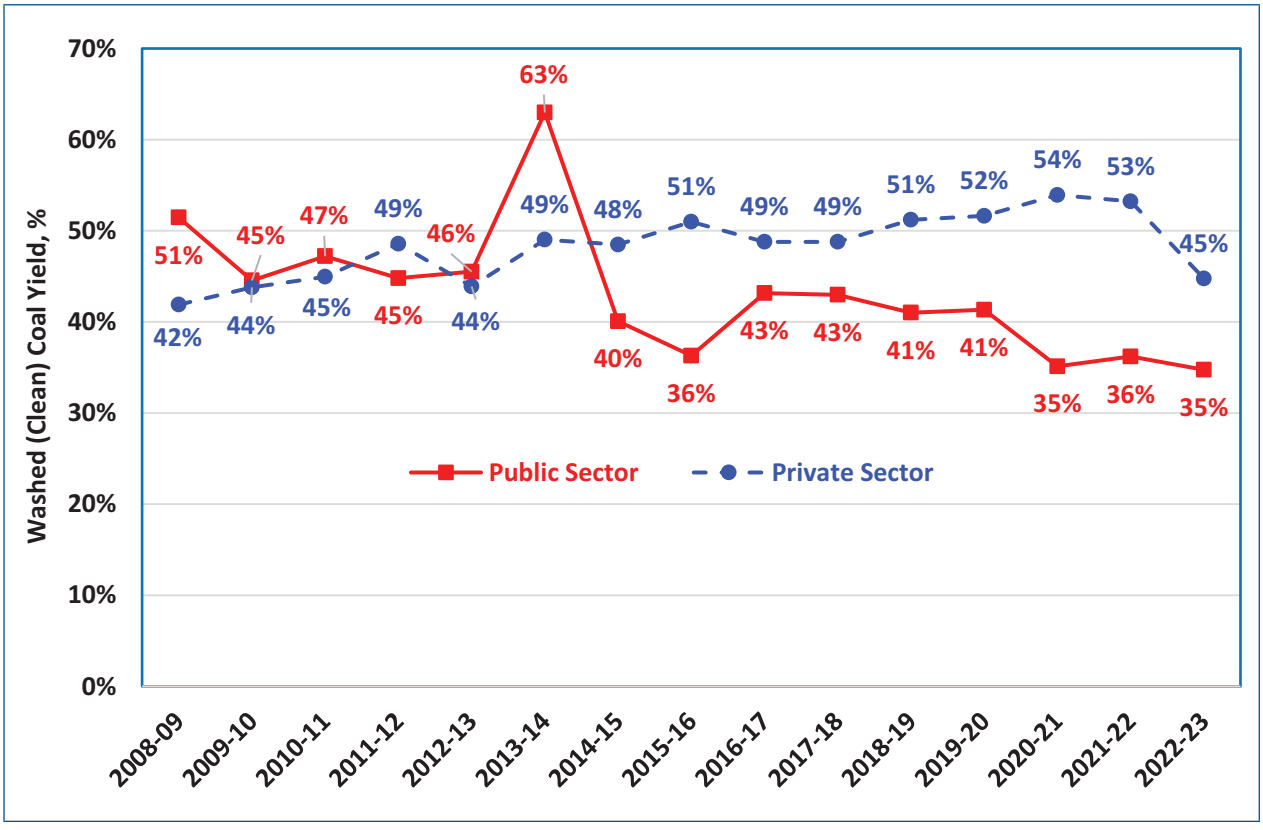


Figure 5.4. Yield of Washed (clean) coking coal in PSU & Private washeries.



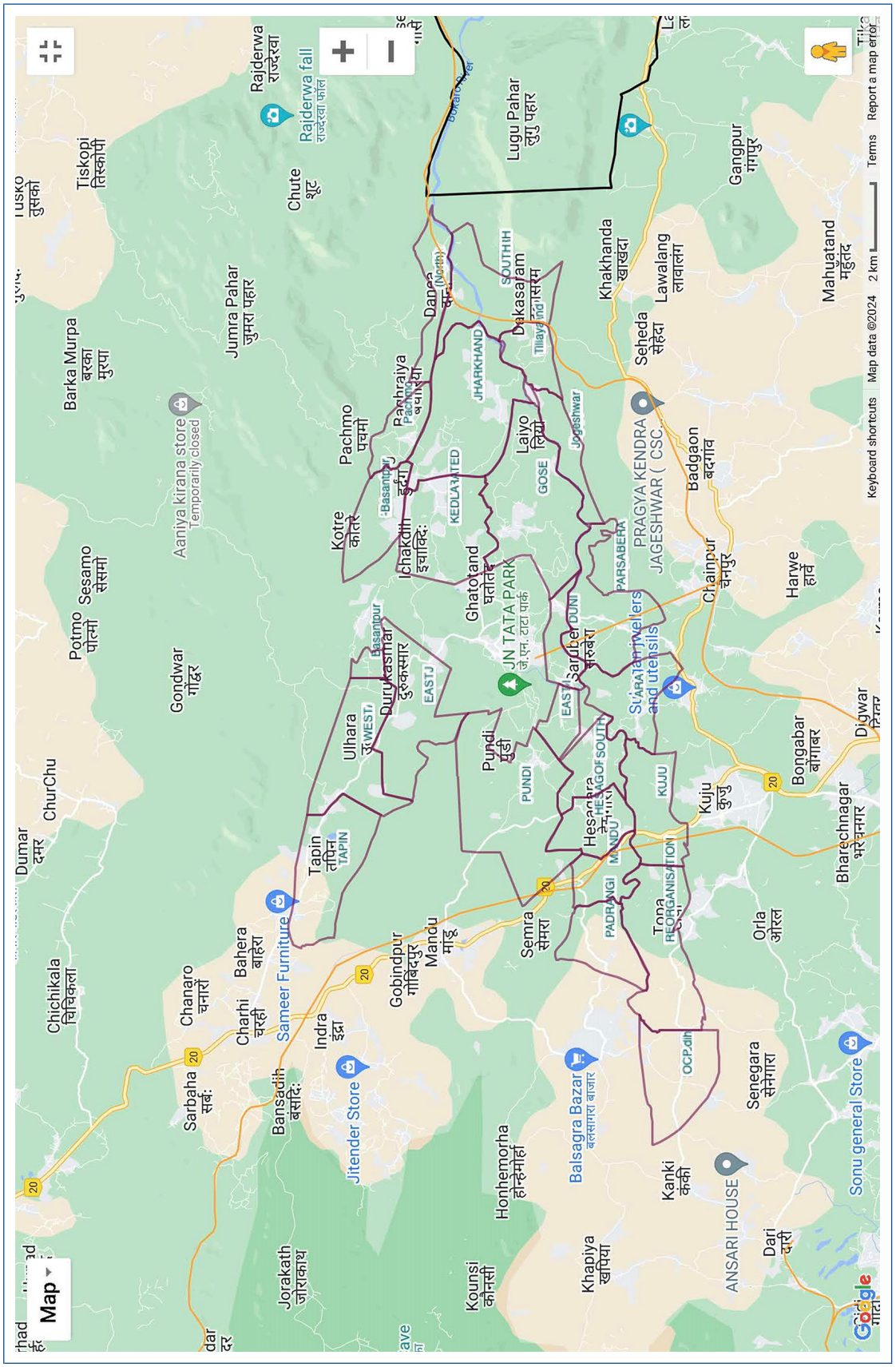


Figure 5.5. Schematic of West Bokaro coalfield showing coal block boundaries (CMPDI, 2022)

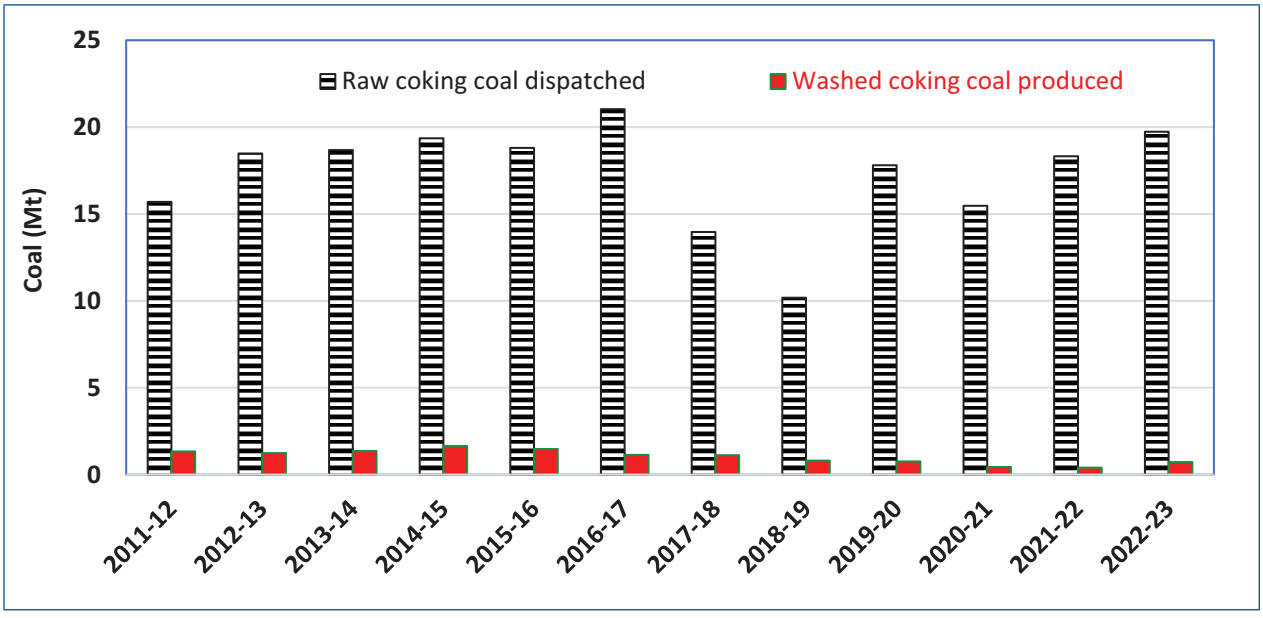
16. CCL has four operating coking coal washeries (Kathara, Sawang, Rajrappa, and Kedla) with a total Raw Coal (RC) throughput capacity of 9.35 MT but has produced only 0.722 of washed clean coal in FY 2022-23 by beneficiating 1.658 MT of raw coal (out of CCL's total coking coal dispatches of 19.737 MT) due to the obsolete equipment & facilities in its washeries (CCL, 2023; Coal Controller, 2024).

17. As per the data extracted from the Coal Directory of India published by the Coal Controller, the annual raw coking coal dispatched from all coking coal mines owned by CCL has varied between 10 MT and 21 MT in the last 12 years. However, the washed coking coal production from CCL's washeries during the same period has declined from a peak of 1.648 MT in FY 2014-15 to only 0.722 MT in FY 2022-23 (Figure 5.6).

18. On the other hand, TSL beneficiated 5.49 MT of raw coking coal and produced 1.99 MT of washed medium coking coal in FY 2022-23 from its two washeries in the WBCF. These two washeries have a combined RC throughput of 7 MT and beneficiate the medium coking coal mined from TSL's captive mines in the West Bokaro coalfield. These washeries are currently underutilised mainly due to the delay in forest clearance for a new coal mine in the same leasehold and the depletion of reserves in the operating mines.

19. The benefits to CIL and the overall Indian economy from the proposed strategy of spinning off the West Bokaro coalfield into two SPVs with ISPs in the PPP mode were explained in the Stakeholder Consultation meeting organised by NITI Aayog on 1 March 2024 (Annexures 1 & 2). Therefore, the formation of such SPVs between CIL and ISPs in the PPP mode deserves policy changes from GOI and the Government of Jharkhand

Figure 5.6. Raw coking coal dispatched and washed coking coal produced by CCL (Data source: Coal Directory of India published by the Coal Controller)



20. As explained in Chapter 3, teamwork between mine planners, geologists, mining engineers, and washery operators, backed by effective management systems are critical to optimizing the production of metallurgical coal from the extremely, difficult-to-wash coal seams in the West Bokaro coalfield (WBCF).

21. As described in Chapter 4, a washery capable of producing metallurgical grade coking coal suitable for stamp-charged batteries by washing the coking coal (@17% ash) mined from various coal seams in the WBCF has multiple, interconnected circuits. Therefore, proper equipment selection (best-in-class), washery design & construction, and highly skilled personnel for operation & maintenance are required. Besides, the washery engineers and other washery personnel must update their knowledge to keep abreast of the latest technologies & practices in coking coal washing since the raw coal characteristics will vary continuously over the project life.

22. The decades-long experience in TSL's Jharia and West Bokaro division indicates that the washery yield can be optimised only by better coordination (including, prompt sharing of coal washability data) between the geological services, mine planning, mining operations, and the washery operators.

23. Best practices in coking coal mines in Australia also demonstrate that this integration can be achieved only if the entire value chain (production geology, mine planning, coal washing, logistics, and quality assurance) are carried out by a single entity. This is in stark contrast to CIL's practice of awarding contracts for mining operations to one private company and washery operations to another company without supplying adequate data on the washability and coking characteristics of the mineable reserves in the 'extremely difficult-to-wash' medium coking deposits prevalent in the West Bokaro coalfield.

24. Therefore, stand-alone washeries proposed by CIL on a BOO basis will not succeed in optimising the clean coal recovery from the 'extremely difficult-to-wash' medium coking coal seams in the CCL command area since the critical success factors for developing & operating a washery to produce metallurgical coal (@17% ash) from coal seams with such characteristics include an integrated approach to infill drilling & sampling, mine planning, and mining operations as well as washery design & operations.

25. Besides deep pockets and managerial expertise, a culture of teamwork, continuous improvement, environmental consciousness, innovations in technology and operating practices, and quick response to customer demands and the external environment are the critical success factors for such a venture. These key success factors are explained in Chapters 3 and 4 of this report.

26. The East Bokaro coalfield contains the 2nd highest reserves of medium coking coal (2.9 BT up to 300 m depth) in the CCL command area, but a large part of these coal reserves is sterilised due to surface features like the river Damodar, railways, and densely populated areas. Therefore, it is difficult to increase the coal production from this coalfield in the short run though the SPV model between CIL and ISPs can also be extended to this coalfield in the next

phase once the SPVs in the West Bokaro coalfield are operationalised.

27. These are the key reasons for recommending the handover of the CCL coal blocks and operating mines in the WBCF to JVs with integrated steel plants in the PPP mode. Once two such SPVs are successfully created by CIL in the WBCF with ISPs, the same model can be replicated in the East Bokaro coalfield which holds the next biggest reserve (2.9 BT up to 300 m depth) of medium coking coal in India.

Chapter 6

New business models and coal pricing policies for involving the private sector in the mining & beneficiation of coking coal from CIL's existing coalfields

1. In February 1996, the Tasra coking coal block was allotted to SAIL by the Ministry of Coal (MoC) under the Coal Mines (Nationalisation) Act. After the mass cancellation of 204 coal blocks allocated under the Coal Mines Nationalisation Act by the Hon Supreme Court in 2014, the MoC allocated approximately 72 coal blocks under the provisions of the CMSP Act and the MMDR Act. These Acts and the Coal Block (Auction) Rules were amended in 2023 to commence the auction of coal blocks to private companies for the sale of coal rather than limiting their use for captive purposes only. After the commencement of coal block auctions for commercial use in June 2020, 104 coal blocks with a total peak rated capacity (PRC) of 226 MT per annum have been successfully auctioned till March 2024. Undoubtedly, the auction of coal blocks for commercial coal mining has introduced a transparent regime for allocating coal blocks with large monetary benefits accruing to the States (and the coal-rich districts) once the mining operations commence. However, the auction process has not considered (till date), the need for amalgamating adjacent coking coal blocks to ensure that the PRC of the merged coal blocks is at least 2 MT per annum to ensure a minimum scale of operations for the complex washeries required to maximise the recovery of metallurgical coal (@ 16-18% ash) from these coking coal reserves.

2. In 2021, 'Mission Coking Coal' launched by the MoC recommended various strategies to increase coking coal production in India. These strategies include the identification of additional coking coal blocks, the auction of inoperative coking coal blocks overlapping with coal bed methane coal blocks, and the allocation of coking coal linkages by CIL to private washeries. As shown in Table 6.1 (and the footnote), the MoC has allocated 16 coking coal blocks till December 2023 and five more coking coal blocks in March 2024 (MOC, 2023b; PIB, 2024). Out of these 21 coking coal blocks, nine coking coal blocks (Kotre Basantpur, Pachmo, Jogeshwar & Jogeshwar Khas, Choritand Tilaiya, Basantpur, Rabodih, Lalgarh-North, Lalgarh South and Duni Central) are in the WBCF (MOC, 2023b; PIB, 2024).

3. The six coking coal blocks allocated to the public sector, have a combined PRC of

17.15 MT per annum, while the 10 coking coal blocks (where the PRC has been declared) allocated to the private sector have a cumulative PRC of 10.17 MT only. There is no visibility as to when modern washeries to beneficiate the 'difficult to wash' coking coal reserves in these 16 coking coal blocks will be set up to produce metallurgical coal suitable for ISPs. For example, SAIL has awarded the construction of a washery in the Tasra coal block in 2023, though this coal block was allotted to them in February 1996.

4. Even though five more coking coal blocks (Babupara (East), Duni (Central), Lalgarh (South), Lamatola, and South Damuda) have been auctioned to private mining companies in March 2024, these coal blocks are impacted by surface constraints and/or geological complexities due to which their PRCs could not be determined even at the time of their auction (PIB, 2024). Therefore, these blocks are not included in Table 6.1 (or Table E1). Specifically, two coking coal blocks in the WBCF (Lalgarh South and Duni Central) were auctioned to private players though these two coal blocks have prominent surface constraints (river/railway/conveyor/forest/habitation), and the geological disturbances in these coal blocks require more detailed exploration to develop a mining plan.

5. The capital investments to put up a 10 MT modern coking coal washery designed to optimise the clean coal yields from the 'extremely difficult-to-wash' coal reserves in the West Bokaro coalfield are estimated to be about Rs. 1900 crores (Tata Steel, 2022). According to CMPDI's comments on the draft report, these costs appear to be higher. However, as shown in Figure 4.1, the proposed Tata Steel washery is a complex washery, with a coarse coal circuit, intermediate gravity separation circuit, fines circuit, belt filters, and concrete silos for coal products since it is designed to maximise the recovery of washed metallurgical coal (@ 17% ash) from the 'extremely difficult-to-wash' medium coking coal reserves in the West Bokaro coalfield. Further, the cost estimates for the Tata Steel washery include the costs related to forest clearance, and the augmentation of an existing railway siding and other infrastructure.

6. The enormous delays in commissioning the Madhuband washery by BCCL and the Tasra washery by SAIL are indicative of the lack of focus by CIL and SAIL on the need to increase coking coal supplies from domestic mines to India's steel plants. This demonstrates the need to allocate large coking coal mines to the private sector steel plants for commercial coal mining so that they can use a part of the washed coal produced in these mines in their own coke ovens and sell the surplus coking coal to other steel plants as per prices linked to the National Coal Index, and the washery by-products (middlings, tailings, and washery rejects) to core sector consumers for power generation by utilities and/or captive power plants. This is possible only when the PRC of each of the coal blocks allocated to a single entity is more than 2 MT per annum which is the minimum scale of operations for a greenfield, integrated, coking coal mining & beneficiation complex in India.

7. While GOI has announced a rebate of 50 percent on the final offer for the coal used for gasification and liquefaction, there is no incentive for producing metallurgical coal suitable for coke oven batteries by

Table 6.1. Key details of Coking coal Blocks allocated between 2015 and 2023.

Name of Coal Mine	Coalfield/State	Allotted to	Allotment / Vesting order date	Peak Capacity Mtpa	Geological Resources, Mt
1. Moitra	North Karanpura	JSW Steel	22-04-2015	**1.0**	215
2-3. Kotre Basantpur & Pachmo	*West Bokaro*	*CIL (PSU)*	*19-04-2018*	*5.0*	*250*
4. Brahmdiha	*Giridih*	*APMDCL (PSU)*	*02-03-2021*	*0.15*	*5*
5. Urtan North	Sohagpur	JMS Mining	03-03-2021	**0.6**	70
6. Urtan				**0.65**	55
7. Jogeshwar, Khas Jogeshwar	West Bokaro	SW Pinnacle Exploration	18-11-2021	**0.6**	84
8. Rohne	*North Karanpura*	*NMDC (PSU)*	*18-06-2021*	*8.0*	*242*
9. Lalgarh North	West Bokaro	Adhunik Power & Resources	24-12-2021	**1.0**	27
10. Basantpur		Gangaramchak Mining	12-12-2022	1.0	200
11. Beheraband (N) Extn.	Sohagpur	Auro Coal Pvt. Ltd.	10-10-2022	1.0	120
12. Sitanala	Jharia	JSW Steel Ltd.	08-06-2023	**0.3**	109
13. Parbatpur Central				**0.74**	147.0
14. Choritand Tiliaya	West Bokaro	Rungta Metals	08-06-2023	**0.78**	97
15. Rabodih		21st Century Mining Pvt. Ltd.	31-03-2022	**2.5**	133
16. Tasra	*Jharia*	*SAIL (PSU)*	*26.02.1996*	*4.0*	*251*
			Public Sector	**17.15**	**748**
			Private Sector	**10.17**	**1257**
			Total	**27.32**	**2005**

Note: Barring the Rabodih coal block, none of other 11 coal blocks allotted to the private sector has an annual production capacity exceeding 2 Mt. Hence, none of these coal blocks have the required scale to set up the coking coal washeries required to produce metallurgical coal (@17% - 18% ash) suitable for stamp-charged coke oven batteries in ISPs. While five more coking coal blocks have been auctioned to private companies in March 2024, they are not included in this table since their PRCs have not been declared till they were auctioned in March 2024. Their production capacities are also not likely to exceed 1 MT per annum due to surface constraints and/or complex geology.

washing the raw coking coal mined from the captive/commercial coal blocks. Absent such incentives to ensure the appropriate use of India's coking coal reserves, the newly auctioned coal blocks will also sell the raw coking coal to users other than ISPs, forcing the ISPs to import more coking coal.

8. To sum up, the production of metallurgical coal after beneficiating the medium coking coal mined from the commercial coal mines in the WBCF will be hampered due to the sub-optimal scale of future operations in eight of the nine coking coal blocks auctioned to the private sector. This indicates the need to have a rethink of the coal block auction policy to achieve the objectives of 'Mission Coking Coal' in the National Interest.

9. As demonstrated by TSL's experience during the last seventy years, the country's coking coal reserves can be best utilized only if the mining and washery operations are combined in one entity as is the practice in all major coking coal-producing countries (including, Australia). This is because certain mining practices and technologies that impose higher costs at the mining stage will have to be deployed to ensure the consistency of raw coal feed to the washeries and optimize the overall recovery of washed metallurgical coal from such complex coking coal deposits. Therefore, handing over the mining and washery operations to separate companies will only lead to the sub-optimal utilization of India's precious medium coking coal reserves by diverting high-quality coking coal to non-metallurgical uses.

10. Considering India's commitments to Net Zero by 2070, the country's interests would be better served by fully utilising the proved reserves of medium coking coal (16.5 BT) in India for metallurgical purposes and ramping up the production of washed medium coking coal in India by allocating contiguous coal blocks which are conducive for a PRC of atleast 2 MT per annum of raw coking coal. This scale of operations is necessary to ensure the long-term viability of an integrated coal mining complex consisting of coal mining operations in complex geological deposits, a modern washery designed to beneficiate extremely difficult-to-wash coals, a pithead power plant to utilise the coarse (+0.50 mm), high ash (ash content > 62%) washery rejects, and an environment-friendly, high-capacity logistics system. This is the key rationale for the recommendation of a PPP model to maximise the production potential of the coking coal blocks owned by CCL/CIL in the WBCF.

11. It is possible to set up two such integrated mining complexes with a PRC of 10 MT each in the West Bokaro coalfield (having a proved geological reserve exceeding 3.5 BT) with a life of 30 - 50 years, even after excluding the coal blocks for which vesting orders have been issued to five (5) private companies in this coalfield. These two integrated complexes in CCL's current coal mining leases in the WBCF comprising all CCL coal blocks/mines on the eastern & northern sides of the Bokaro River, and the other consisting of all CCL coal blocks/mines on the western & southern sides of the Bokaro River, can together produce 7-8 MT of washed metallurgical coal suitable for stamp-charged coke oven batteries if the policy changes in this report are implemented on time. This will quadruple the current production of washed medium coking coal (approximately, 2.5 MT) suitable

for metallurgical use in stamp charged batteries from the WBCF.

12. Further, the experience of the past fifty years (post-nationalization of coking coal mines in 1971-72) in India indicates that a major part of the country's coking coal reserves must be managed by reputed private sector companies (preferably, those operating integrated steel plants in India like, Arcelor Mittal/Nippon Steel, JSW, JSPL, and Tata Steel) who have demonstrated the capacity to invest the necessary financial, technical, and human resources to expedite the development (including, land acquisition, R & R, and community development) and operation of the inter-linked mining, beneficiation, and logistics projects in an integrated manner.

13. To ensure the sustainable development of the West Bokaro coalfield which has large tracts of forest land and is also inhabited by tribal communities, the qualification criteria for the selection of a private company to take over the SPV must include a proven track record of balancing diverse stakeholder interests including the welfare of the local communities. This will enable CCL to focus on its 'Big' mines in its other six coalfields since 67% of CCL's coal production in FY 2022-23 was only from four 'Big' mines. On the other hand, CCL will benefit from the dividends in its minority stake in the JV company formed to own, mine, beneficiate, and sell the washed coking coal and byproducts by optimal exploitation of CCL's current coal reserves in the WBCF without incurring any further investment or operating costs. Divesting its virgin coal blocks, operating coal mines, and associated infrastructure in the WBCF will therefore increase CCL's managerial time & energies on 11 other operating areas after handing over the Kuju and Hazaribagh areas to the proposed JV. This will benefit CIL and the country by enhancing our energy security.

14. Therefore, spinning off two areas from CCL (out of a total of 13 production areas) to form an SPV in which CCL and the Government of Jharkhand will have a significant but minority stake will enable the Ministry of Coal to enable our ISPs to be more *Atmanirbhar* in metallurgical coal which is essential to realize the National Steel Policy (MOS, 2017). The strategy recommended in this report will involve amendments in the Coal Bearing Areas Act of 1957 to enable the surface rights and the deemed mining leases in this area to be transferred to a private company. This will also require changes in the current coal block auction rules as a special case to reduce the upfront payments since the very large investments by the private sector in mine development and setting up washery and logistics infrastructure will create thousands of jobs in the construction & operation of the integrated coal mining & beneficiation complex besides indirect jobs in the local communities.

15. Further, since most of the virgin coal reserves in the West Bokaro coalfield of CCL underlie forest land, expediting the forest clearance for this integrated project before the selected private company takes over the SPV is critical to attracting qualified bidders to take over the SPV. This private sector JV company has the potential to produce double the current washed coking coal production (6 MT) of the country within 7 years of acquiring the mining lease and forest clearance if the Central Government can select the right private company to take over the SPV. The

savings in foreign exchange and the Nation's competitive advantage in steelmaking will rise manifold if these strategies are implemented with an integrated approach rather than the piecemeal approach pursued with a notable lack of success to date.

16. This strategy is proposed as a Value Maximisation strategy to ensure the competitiveness of India's Steel sector by providing it with raw material security on commercial lines and conserving the foreign exchange reserves of the Nation, while CIL and its subsidiaries focus on maintaining India's energy security by increasing the production of non-coking coal to feed the growing demand for reliable and affordable electricity from existing and future thermal power plants. This is in tune with the Central Government's strategy to unlock the value of the underutilized assets of non-strategic PSUs in the Public Interest.

17. Since the enhanced use of domestic metallurgical coal in the coal-blend fed to coke ovens in India will also reduce the cost of steel produced in India, the findings of this study will also contribute to the sustainable development of India to attain developed country standards by 2047.

Chapter 7

Impact of alternative routes of steel making on the demand for coking coal in India

1. The steel industry is a hard-to-abate sector, as 70% of global production is through the Blast Furnace (BF) route which relies on coal. This traditional technology has the benefit of cost competitiveness and the ability to produce differentiated grades of steel with value added products besides being energy efficient since coal is both a reductant and a source of energy (Tata Steel, 2023a). Thirty percent of global steel production uses the Electric Arc Furnace (EAF) and uses scrap as the basic raw material besides large amounts of electricity. The EAF route is less carbon-intensive compared to the Blast Furnace route but consumes more electricity. The EAF technology is not capable of producing the entire range of value-added grades of steel (Tata Steel, 2023a). Moreover, most of the global scrap is generated in developed regions like the U.S. and the E.U. due to their large investments in infrastructure. During the meeting in NITI Aayog in June 2022, the Vice Chairman advised that indications may be given in the study regarding carbon capture & utilization in the coal sector.

2. The Blast Furnace (BF) process dominates steel production in all continents except in North America which prefers the Electric Arc Furnace (EAF) route due to the abundance of high-quality scrap in North America (primarily, the USA and Canada). Ninety percent of the steel produced in China and 57 percent of the steel in the EU-28 countries (including, the UK) is still produced through the BF route (WSA, 2022). India exported only 12 MT of steel (less than 10 percent of its total production) in 2022 (WSA, 2023). Like India, China also uses most of the steel produced in the country within its boundaries and exports less than 7 percent of its total production (WSA, 2023).

3. While 46 percent of the 125 MT of steel produced in India during 2022 was produced through the BF route which requires coke for ironmaking, India is also the largest producer of direct reduced iron (DRI) that uses gas or non-coking coal instead of coking coal. However, the coal-based DRI route has environmental issues and requires high-quality iron ore lumps instead of the more abundant fines from our iron ore mines. The output of the DRI process is used as an input in the EAF route to produce crude steel. While the BF-BOF route has a carbon intensity of 2.32 tons of CO_2 per ton of crude steel (tcs), the carbon intensities of the Scrap-EAF process and the DRI-EAF process are 0.67 tCO_2/tcs, and 1.65 tCO_2/tcs, respectively (WSA, 2022).

4. Coke (formed by heating coking coal in the absence of air) can be replaced by pulverized coal injection (PCI) up to a certain level. This requires the remaining hard-coking

coal to be of higher quality; otherwise, the performance of the blast furnace can be affected. Hydrogen and natural gas potentially used in the blast furnace are not substitutes for coking coal since they do not provide mechanical support to the charge of the blast furnace nor the necessary carbon monoxide (CO) for reducing the iron ore but perform only the function of delivering heat (CRM Alliance, 2023). By-products of coke production play also an important role in the production of battery electrodes, carbon fibres, hydrogen, and many other chemicals. Hence, technologically feasible & economically viable alternatives are not available to replace coking coal at scale in the production of steel from iron ore today (EU, 2022). Therefore, approximately 14 MT of Blast Furnace capacity is estimated to have returned to operations in 2023, with another 11 MT of blast furnace capacity still to return. Therefore, the demand for coking coal will continue to increase going forward (CRM Alliance, 2023).

5. The global steel industry is experimenting with several decarbonization techniques, all of which are at an early stage of development. One of the most promising involves replacing coal with green hydrogen, which is made using renewable power. However, producing enough green hydrogen to make a significant dent in CO_2 emissions from India's steel plants undergoing rapid expansion is still a long way away. This change to electric steelmaking also requires millions of tons of high-quality scrap and/or millions of tons of high-quality lump ore which are in short supply in India. According to Tata Steel which operates two integrated steel plants (ISPs) in Europe besides three ISPs in India (Business Standard, 2023):

> *"If the world largely moves to hydrogen-based direct reduced iron and electric arc furnaces, then high-quality ore will be at a premium — it's already a premium, it will be more so. So, there is a huge economic risk that we see if you go entirely in that route, even if the electricity and hydrogen are green."*

6. In the short term (FY 2030), energy & resource efficiency and the use of renewable energy are the main drivers to reduce carbon emissions in India's steel (MoS, 2023). However, in the medium term (2030-2047), utilization of Green Hydrogen and Carbon Capture, Utilisation, and Storage will be the focus areas to reduce the carbon intensity of India's steel industry (MoS, 2023). This strategy is justified given the above status of technological readiness and financial viability of carbon reduction technologies worldwide.

7. While climate change is a real global threat, this can only be tackled based on equity and according to the principle of 'Common but Differentiated Responsibilities and Respective Capabilities (CBDR&RC)' enshrined in Article 3.1 of the United Nations Framework Convention on Climate Change (UNFCCC, 1992). As Article 4.5 of the Convention (UNFCCC, 1992) states:

> "*the extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties.*"

8. The CBDR&RC principle was also reiterated in Article 2 of the Paris Agreement signed during COP21 which states that (UNFCCC 2016):

   '…. *this Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.*

9. As a signatory to the Glasgow Pact, India has also agreed to (UNFCCC, 2022).:

   '…. *phase-down unabated coal power and phase-out of inefficient fossil fuel subsidies, while providing targeted support to the poorest and most vulnerable in line with national circumstances and recognizing the need for support towards a just transition*' (UNFCCC, 2022).

10. Carbon capture and sequestration need specific geographical formations to store the CO_2 emissions either under the sea or in caverns. This is not a scalable option for most of India's steel plants since no such geological formations have been discovered close to the locations of the integrated steel plants in India. Moreover, the deployment of even the proven 'green' steel technologies like electric-arc-furnace at scale will need huge amounts of subsidies from the Government of India at a time when India's resources are needed for the economic development of its large population. For example, Tata Steel and the U.K. Government have entered into an agreement on a proposal to invest in a 3 MT EAF-based steel plant at Tata Steel's Port Talbot site to replace the obsolete, inefficient, and loss-making blast furnaces with a capital cost of £1.25 billion (Rs.13,225 Crores) inclusive of a grant up to £500 million (Rs.5,300 Crores) from the U.K. Government (Tata Steel, 2023b). This is feasible because the U.K. also exports 10 MT of steel scrap which is the key raw material in the EAF route of steel making. The economics of replacing the BF with EAF technology also depends on the availability of high-quality steel scrap and green electricity at affordable costs as well as high carbon prices (Tata Steel, 2023b).

11. On the other hand, Tata Steel has recently invested Rs.1100 crores for the relining of one of the blast furnaces in its steel plant in the Netherlands, which will give this blast furnace (one of the largest in Europe) a life of another 20-25 years (Tata Steel, 2023a). Since sufficient steel scrap is not available for its 7 MT steel plant in the Netherlands, Tata Steel is exploring the feasibility of using the gas-based DRI process to replace one of its blast furnaces at the end of its campaign life and then switch over to green hydrogen whenever it is available at economically viable prices in the next 20-22 years (Tata Steel, 2023a).

12. This is indicative of the timeline and subsidies required to transform India's steel plants from the BF-BAF to the less carbon-intensive EAF route, even if enough steel scrap and round-the-clock, carbon-free, sources of electricity were to be available in the future. Given these National Circumstances, India has no reasonable alternative but to rely on the BF-BOF route of steel making till suitable viable alternatives (including, with the help of technology transfer and climate finance from the developed countries) are found as part of the country's long-term goal to reach Net Zero emissions by 2070.

Chapter 8

Conclusions and Recommendations

1. Integrated Steel Plants (ISPs) imported 58 MT of coking coal at a cost of approximately Rs. 1.5 Lakh Crores in FY 2023-24 despite holding proved geological resources of 5.13 billion tons (BT) of prime coking coal & 16.5 BT of medium coking coal. Therefore, this report goes beyond the recommendations made in the IMC report on 'Mission Coking Coal'. Similarly, the Ministry of Steel (MoS) can review the sub-optimal utilisation of SAIL's existing coking coal mines and washeries and take suitable actions to upgrade the existing washeries by implementing the flowsheets required to wash the coal seams mined in the coal mines of BCCL/SAIL or establish new washeries with advanced technology to enhance the import substitution of coking coal in SAIL's steel plants and reduce hot metal costs.

2. Government of India (GOI) must include 'Coking Coal' in the list of 'Critical Minerals' since coking coal constitutes approximately 42% of the cost of steel which is an essential commodity for infrastructure development and downstream industries (automobile, white goods, etc.), which are large job creators in India. The European Union has declared coking coal to be a critical raw material along with 29 other raw materials which include 'green energy' minerals like lithium, cobalt, and rare earths. India's import dependence on coking coal is about 85% which is much higher than that of the EU (approximately 62%). Since the declaration of coking coal as a critical mineral is amply justified in India, GOI can provide a special dispensation to enhance its domestic production to provide coking coal security for India's steel sector.

3. The raw coal throughput to the washeries owned by Public Sector Undertakings (PSUs) which have a total throughput capacity of 25 MT per annum was less than 8 MT in FY 2022-23 out of a total raw coking coal production of 55 MT from PSU coal mines. Therefore, the capacity utilisation of PSU washeries was less than 32% in FY 2022-23 while the washed (clean) coal yields were only 35-36% (@ 18-20% ash). This is in stark contrast to the performance of the four private coking coal washeries which have a capacity utilization of 75% and higher washed coal yields (@ 16% - 18.5% ash) which enables Tata Steel to optimize the use of domestic coal in their coke plants.

4. While GOI has announced a rebate of 50 percent on the final offer for the coal used for gasification and liquefaction, there is no incentive for producing metallurgical coal suitable for coke oven batteries by washing (to 16-18% ash) the raw coking coal (34-38% ash) mined from the commercial coal blocks. Absent such incentives to ensure the appropriate use of India's coking coal reserves, the newly auctioned commercial coal blocks will sell the raw coking coal without making the investments in modern coking coal washeries required to wash the

raw coking coal to 16-18% ash for supplying metallurgical coal to steel plants or coke ovens.

5. The West Bokaro Coalfield (WBCF) in Jharkhand contains approximately 22% (3.58 billion tons) of India's 16.5 BT of measured (Category 331) resources of medium coking coal (CMPDI, 2023). Eighty-four percent of these measured coal reserves (3 billion tons) are at a depth of less than 300 metres, which makes it possible to ramp up the coal production in this coalfield quickly once the necessary clearances for environment, forest, land acquisition, and mining are granted by GOI and the Government of Jharkhand (GoJ).

6. The quality of coke produced from stamp-charged batteries in Tata Steel's Jamshedpur steel plant demonstrates the importance of enhancing the production of washed medium coking coal (@16-18% ash) from the WBCF to reduce the cost of coke without compromising on coke quality or blast furnace productivity.

7. This was also confirmed by Tata Steel during the stakeholder consultation meeting when their representative stated that the Jamshedpur Steel Plant has used low-cost, domestic medium coking coal (washed down to 15- 17% ash) to the extent of 50%-67% in the coal blend. This share has declined in recent years due to the shortage of captive coal reserves.

8. Tata Steel's experience indicates that the optimal use of medium coking coal (16 - 18% ash) from the WBCF in stamp charged batteries will reduce the cost of coke (and hot metal) by increasing the proportion of low-ash, imported semi-soft coals that are cheaper than imported hard coking coal from Australia.

9. Considering India's commitments to Net Zero by 2070, the country's interests would be better served by fully utilising the proved reserves of medium coking coal (16.5 BT) in India for metallurgical purposes and ramp up the production of washed medium coking coal by ensuring the allocation of contiguous coal blocks which are conducive for a Peak Rated Capacity (PRC) of at least 2 MT of raw coking coal per annum.

10. This scale of operations is necessary to ensure the viability of an integrated coal mining complex consisting of coal mines extracting complex geological deposits, a modern washery designed to wash extremely difficult-to-wash coals, a pithead power plant to utilise the coarser size (+0.50 mm), high ash (ash content > 62%) washery rejects, and an environment-friendly, high-capacity logistics system.

11. However, the production of metallurgical coal after beneficiating the medium coking coal mined from the commercial coal blocks allocated to the private sector in the WBCF will be hampered due to the sub-optimal scale of future operations in eight of the nine coking coal blocks (barring Rabodih coal block) auctioned to the private sector in the coal block auction process.

12. This implies that the country must depend on the residual coking coal reserves currently owned by CCL in the WBCF to produce metallurgical coal suitable for stamp charged batteries in the National Interest. This is the key rationale for recommending that

Ministry of Coal (MoC) may form two Special Purpose Vehicles (SPVs) in the PPP model for expediting the development of large, integrated coal mining, beneficiation, and logistics projects to maximize the use of domestic medium coking coal. These two SPVs must be vested with the rights to the mining leases (deemed leases or lease grants) held by Central Coalfields Ltd. (CCL) in the West Bokaro coalfield.

13. One of these two SPVs in CCL's current coal mining leases in the WBCF can mine all CCL coal blocks/mines on the eastern & northern sides of the Bokaro river, and the other SPV can mine all CCL coal blocks/mines on the western & southern sides of the Bokaro river.

14. The CBA Act to be amended suitably so that the SPV under the Public-Private-Partnership (PPP) mode continues to be a deemed lessee of the Government of Jharkhand (GoJ) with all the attendant rights, privileges, and responsibilities under the Coal Bearing Areas (CBA) Act, 1957 even after the majority share in the SPV is transferred to the private sector.

15. These SPVs must be spun off from CCL/CIL to form Joint Ventures (JVs) with ISPs which will bring in private sector capital as well as project management skills and operating efficiencies. The GoJ must be granted a minority stake in these JVs so that they can get the full support of GoJ to expedite statutory approvals for land, forest, environment, and mining clearances. This PPP model can be extended to the coal blocks/mines owned by CCL in the East Bokaro coalfield once the SPVs in the WBCF are set up in the PPP mode.

16. MOC can then invite bids from the owners of private sector ISPs to take a majority stake (maximum of 74%) in this JV with CCL and the GoJ sharing the balance 26% as per mutual agreement. The key purpose of limiting this bidding to the private sector ISPs is to ensure that these well-capitalized companies can deploy their enormous project management capabilities to develop integrated, world-class, coal mining & beneficiation complexes expeditiously. Before commencing this bidding process, MOC must consider amending the Coal Block Auction Rules so that the auction of the majority stake in these SPVs is based on a revenue-sharing mechanism with a guaranteed production plan (for metallurgical coal @16-18% ash) with minimal upfront payments.

17. The annual raw coal production in the WBCF can be increased by more than 20 MT per annum from the current level by spinning off the ownership of CCL coal blocks/mines in the WBCF into two JVs in which the majority stakes are held by private sector ISPs.

18. When the medium coking coal produced from these mines (under the PPP mode) is washed to 16-18% ash in washeries designed and operated as a tightly integrated coking coal mining complex to maximize the metallurgical coal produced from the difficult-to-wash coal seams in the West Bokaro coalfield, 7-8 MT of metallurgical coal (@ 16-18% ash) can be supplied to stamp-charged coke batteries from these two JVs. This will double the domestic supply of metallurgical coal to the steel plants in India from the current level and enhance their competitiveness while reducing steel costs which has a knock-on impact on the downstream sector.

19. The annual saving in the coking coal bill of ISPs by facilitating private sector investments on a large scale to develop such integrated mining, beneficiation, and logistics coking coal projects in the West Bokaro coalfield alone is estimated to be 8000 - 10,000 crore rupees even after assuring a reasonable return to the private sector for its risk capital. This will also benefit the minority stakeholders (CCL and GoJ) who have a proportionate stake in the profits of the PPP besides a significant increase in the revenues accruing to the State in the form of royalty, district mineral fund, and GST. The Nation will benefit since the coking coal import bill will be reduced by two billion dollars per annum based on a landing price of $300 per ton for imported prime coking coal, even after normalizing the replacement of coking coal imports with domestic coal based on their ash contents.

20. The production of washed clean coal from medium coking coal seams in India will also yield about 60% of the total raw coal in the form of by-products (middlings, tailings, and rejects) that can be used in power plants. MOC must enable necessary policy changes to allow the JV company to sell the byproducts (middling and tailing) of coking coal washeries when it is not possible to utilize these by products in the steel plant which consumes the washed clean coking coal. This is critical to reduce the costs of washed clean coal since the profit on the sale of these byproducts must be passed onto the steel plant in the form of lower coking coal costs.

21. The Ministry of Environment, Forest and Climate Change (MoEFCC) and GoJ can work together to amend the Forest (Conservation) Rules for increasing the domestic supplies of this 'critical mineral' since it is well-proven that mine closure activities can be organised in a progressive manner to vegetate overburden dumps with dense vegetation within 10 years of completion of post-mine closure activities.

22. Therefore, to expedite the development of these large coking coal mines in the WBCF, the Forest Conservation rules for compensatory afforestation must be amended to permit large, integrated coal mines & washeries to increase the supply of a 'critical mineral' like coking coal. The States as well as local communities will also benefit with sustainable mining practices followed by proper mine closure as per MoC's guidelines.

23. However, the majority partner in the SPV is responsible for paying all charges required to secure forest clearance (compensatory afforestation charges, NPV, etc.) as well as completing the R & R of project-affected persons and ensuring environment compliance.

24. Further, the special dispensation(s) enjoyed by Central Government companies under the 'Consolidated Guidelines' issued by GOI under the FC Act and FC Rules should be extended to a project for the mining and beneficiation of a 'critical mineral' like coking coal.

25. The findings and recommendations of this study were also discussed in a stakeholder consultation meeting organised by NITI Aayog in New Delhi on March 1, 2024. The minutes of this meeting were circulated to all stakeholders including, MoC, MoS, GoJ, industry association, ISPs and others (Annexure 1). The NIAS presentation during this meeting is enclosed as Annexure 2 for ready reference.

References

Argus (2024). Seaborne coking coal market performance in 2023. <https://www.argusmedia.com/en/news-and-insights/market-insight-papers/seaborne-coking-coal-market-performance-in-2023>

BCCL (Bharat Coking Coal Ltd.) (2023). Annual Report 2022-23. <https://www.bcclweb.in/files/2023/07/AnnualReportAccounts2022-23.pdf>

Blengini, G., El Latunussa, C., Eynard, U., et al., 2020. Study on the EU's list of critical raw materials: final report, Publications Office. European Commission. <https://data.europa.eu/doi/10.2873/11619>

Business Line (2024). India's coking coal imports at 10-year high, Russia among top three suppliers with 12% market share. April 17, 2024.

Business Standard (2023). Will not reach emissions goal with current technologies, says Tata Steel. <https://www.business-standard.com/companies/news/will-not-reach-emissions-goal-with-current-technologies-says-tata-steel-123062300183_1.html>

CCL (Central Coalfields Ltd.) (2023). Annual Report and Accounts 2022-23. <https://www.centralcoalfields.in/prfnc/pdf/CCL_Annual%20Report_Final_English_compressed_08.09.23.pdf>

Coal Junction (2024). Request for Proposal for the selection of Washery Developer & Operator for the Dugda Coal Washery by Bharat Coking Coal Ltd. (BCCL). <https://www.coaljunction.in/appuploads/RFP_Dugda%20coal%20wahsery.pdf>

CMPDI (2022). Coal Block Information System. <https://oldsite.cmpdi.co.in/OCBIS/dashboard.php>

CMPDI (Central Mine Planning & Design Institute) (2023). National Coal Inventory 2023. <https://www.cmpdi.co.in/sites/default/files/2023-11/National_Coal_Inventory_2023.pdf>

Coal Controller (2024). Coal Directory of India 2022-23. <https://coal.gov.in/sites/default/files/2024-03/07-03-2024cd-wn.pdf>

CRM Alliance (2023). Critical Raw Materials. <https://www.crmalliance.eu/critical-raw-materials#:~:text=Critical%20Raw%20Materials%20(CRMs)%20are,risk%20associated%20with%20their%20supply.>

Duda, A. and Fidalgo Valverde, G. (2021). The economics of coking coal mining: A fossil fuel still needed for steel production. Energies, 14(22), 7682. <https://doi.org/10.3390/en14227682>

EC (European Commission) (2021). Answer given by Mr. Breton in the European Parliament on behalf of the European Commission. <https://www.europarl.europa.eu/doceo/document/E-9-2021-002691-ASW_EN.pdf>

EC (2023). Raw Material profile: Coking Coal. <https://rmis.jrc.ec.europa.eu/rmp/Coking%20coal>

EU (European Union), 2022. Coking coal: Impact assessment for supply security. Science for Policy Brief. Joint Research Centre. European Union. 8 pp.

India Code (1957a). The Coal Bearing Areas (Acquisition & Development) Act, 1957. <https://www.indiacode.nic.in/bitstream/123456789/13051/1/a1957-20.pdf>

India Code (1957b). The Mines & Minerals (Development & Regulation) Act, 1957. <https://www.indiacode.nic.in/bitstream/123456789/1421/3/a1957-67.pdf>

India Code (2015). Coal Mines (Special Provisions) Act, 2015. <https://www.indiacode.nic.in/bitstream/123456789/2146/1/a2015-11.pdf#search=coal%20mines%20(special%20provisions)>

India Code (2017). Coal Blocks Allocation Rules, 2017. <https://upload.indiacode.nic.in/showfile?actid=AC_CEN_15_16_00002_195767_1517807322197&type=rule&filename=Coal%20Blocks%20Allocation%20Rules,%202017.pdf>

Lok Sabha (2023a). Fortieth report of the Standing Committee on Coal, Steel, and Mines. Demands for Grants from the Ministry of Steel. <https://eparlib.nic.in/bitstream/123456789/1470719/1/17_Coal_Mines_and_Steel_40.pdf>

Lok Sabha (2023b). Forty-second report of the Standing Committee on Coal, Steel, and Mines. <https://eparlib.nic.in/bitstream/123456789/2504794/1/17_Coal_Mines_and_Steel_42.pdf>

MoC (2021). IMC Report on Augmentation and Consumption of Domestic Coking Coal by Steel Sector. <https://coal.gov.in/sites/default/files/2021-01/IMC-Report.pdf>

MoC (2022a). Coal washeries. Reply given by the Minister of Coal in the Lok Sabha on April 6, 2022. <https://eparlib.nic.in/bitstream/123456789/980166/1/AU5589.pdf>

MoC (2022b). Technology Roadmap for the Coal Sector. <https://coal.gov.in/sites/default/files/2022-05/09-05-2022vp1.pdf>

MoC (2022c). Summary of Workshop 1 on Technology Roadmap for the Coal Sector. Vol. 2 Part A. <https://coal.gov.in/sites/default/files/2022-05/09-05-2022SummaryVIIPA.pdf>

MoC (2022d). Summary of Workshop 2 on Technology Roadmap for the Coal Sector. Vol. 2 Part B. <https://coal.gov.in/sites/default/files/2022-05/09-05-2022SummaryVII%20PB.pdf>

MOC (2023a). Monthly Statistical Report-March. <https://coal.nic.in/sites/default/files/2023-05/srn-march-2023_0.pdf>

MoC (2023b). Allocated coal blocks by the Ministry of Coal till 31 July 2023. <https://coal.nic.in/sites/default/files/2023-07/PIB1942809.pdf>

MoC (2024a). Monthly Statistical Report-March 2024. <https://www.coal.nic.in/sites/default/files/2024-05/srn-march-2024.pdf>

MoC (2024b). National Coal Index. <https://www.coal.nic.in/sites/default/files/2024-05/09-05-2024a-nci.pdf>

MoEFCC (Ministry of Environment, Forest and Climate Change) (2019). Handbook of Guidelines for the effective and transparent implementation of the Forest (Conservation) Act, 1980. <https://parivesh.nic.in/writereaddata/FC/HANDBOOK_GUIDELINES/HANDBOOK_GUIDELINES18_03_2019.pdf>

MoEFCC (2022). Forest Conservation Rules, 2022. <https://parivesh.nic.in/writereaddata/FCRule2022Notificationdated28062022.pdf>

MoS (Ministry of Steel) (2017). National Steel Policy (NSP) 2017. <https://steel.gov.in/en/national-steel-policy-nsp-2017>

MoS (2023). Promotion of Green Steel. Reply by Minister of Steel in the Lok Sabha on 8 March 2023. <https://steel.gov.in/sites/default/files/lu%201075.pdf>

MSTCE (2023). Mine Summary of Coal Mines. <https://www.mstcecommerce.com/auctionhome/container.jsp?title_id=Mine%20Summary%20of%20Coal%20Mines&linkid=0&main_link=y&sublink=n&main_link_name=383&portal=coalblock&homepage=index&arcDate=03-11-2022>

PIB (Press Information Bureau) (2023a). Strategic Initiatives by Coal Ministry increase availability of domestic coking coal. <https://coal.gov.in/sites/default/files/2023-09/PIB1953162.pdf>

PIB (2023b). Bharat Coking Coal Ltd. starts commercial operations of 5 MTPA Madhuband Washery. <https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1981073>

PIB (2023c). Vision plan in the works for India to become 30 trillion-dollar economy by 2047: NITI Aayog CEO. <https://www.moneycontrol.com/news/business/vision-plan-being-prepared-for-india-to-become-developed-economy-of-30trn-by-2047niti-aayog-ceo-11620571.html#>

PIB (2024). Thirteen Coal Mines Including Five Coking Coal Mines Auctioned in Forward Auction. <https://pib.gov.in/PressReleasePage.aspx?PRID=2015041>

Prasad, H. N., Singh, B. K., & Dhillon, A. S. (2001). Potential of semi-soft coals as replacement for hard coals in stamp charging blend. *Ironmaking & steelmaking*, *28*(4), 312-320. <https://doi.org/10.1179/030192301678172>

Prasad, K., Sachinraj, D., Awasthi, A., Mukherjee, A.K. (2019). Beneficiation of coal fines using the Reflux™ Classifier. *Minerals Engineering*. Volume 136. 110-119. <https://doi.org/10.1016/j.mineng.2019.03.018>

Prasad, K., Sachinraj, D., Awasthi, A., Mukherjee, A.K., Ranjan, A. (2020). Intermediate size fine coal beneficiation by Reflux™ Classifier using statistical approach. *Powder Technology*. Volume 361. 548-561. <https://doi.org/10.1016/j.powtec.2019.11.078>

SAIL (Steel Authority of India Ltd.) (2023a). Annual Report. <https://sail.co.in/sites/default/files/2023-09/SAIL_Annual-Report-2022-2023.pdf>

SAIL (2023b). Transcript of Conference Call with Analysts & Investors on August 11, 2023. <https://www.sail.co.in/sites/default/files/2023-08/SAIL-Concall-June-2023-Results-Transcript.pdf>

Sivek, M. and Jirásek, J. (2023). Coking coal-Really a critical raw material of the European Union? Resources Policy, 83, 103586. <https://doi.org/10.1016/j.resourpol.2023.103586>

Tata Steel (2021). Tata Steel commissions state-of-the-art 2 MTPA Coal Preparation Plant at Jamadoba. <https://www.tatasteel.com/media/newsroom/press-releases/india/2021/tata-steel-s-jharia-division-commissions-state-of-the-art-2-mntpa-coal-preparation-plant-at-jamadoba/>

Tata Steel (2022). Pre-feasibility report for West Bokaro Coking Coal Washery in West Bokaro Division of Tata Steel Ltd. <https://environmentclearance.nic.in/writereaddata/Online/TOR/16_Feb_2022_133941517201875 40PFR.pdf>

Tata Steel (2023a). Integrated Annual Report. <https://www.tatasteel.com/media/18374/ir2023.pdf>

Tata Steel (2023b). Tata Steel and the UK Government jointly agree on a proposal to replace the Blast Furnaces in Port Talbot with a 3 MT electric arc furnace. <https://www.tatasteel.com/media/19112/tata-steel-uk-call-transcript-v7.pdf>

Tiwari, H. P., Haldar, S. K., Mishra, P., Kumar, A., Dutta, S., & Kumar, A. (2017). Prospect of stamp charge coke making at Tata Steel: an experience. *Metallurgical Research & Technology*, *114*(5), 501.

UNFCCC (United Nations Framework Convention on Climate Change) (1992). United Nations Framework Convention on Climate Change. <https://unfccc.int/resource/docs/convkp/conveng.pdf>

UNFCCC (2016). Decisions adopted by the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015. <https://unfccc.int/sites/default/files/resource/docs/2015/cop21/eng/10a01.pdf>

UNFCCC (2022). Report of the Conference of the Parties held in Glasgow Oct – Nov 2021. <https://unfccc.int/sites/default/files/resource/cma2021_10_add1_adv.pdf>

World Steel Association (WSA), 2022. Sustainability Indicators. <https://worldsteel.org/publications/bookshop/sustainability-indicators-2022-report/>

WSA (2023). World Steel in figures. <https://worldsteel.org/wp-content/uploads/World-Steel-in-Figures-2023-3.pdf>

Annexure 1

File No: M-12026/14/2021-Coal(P&E)
Government of India
NITI Aayog
(Energy Vertical)

NITI Bhawan, Sansad Marg
New Delhi-110001
Dated: 15th March, 2024

Subject: Record of discussions with the Stakeholder Consultation held on Research Study for "Enhancing Domestic Coking coal availability" held on 1st March'2024 under the Chairmanship of Dr. V.K. Saraswat, Member, NITI Aayog, in Room No.122 at NITI Aayog, New Delhi.

List of Participants is included at the end of this record of discussions.

The Stakeholder Consultation Meeting to discuss the Research Study for "Enhancing Domestic Coking coal availability" was organised from 10:30 AM onwards by NITI Aayog in Room No.122 on 1st March'2024 under the Chairmanship of Dr. V.K. Saraswat, Member, NITI Aayog.

At the outset, Dr.V.K. Saraswat, Member, NITI Aayog briefed the house about the importance of enhancing domestic coking coal production to reduce the import of coking coal. He also emphasized on the need to identify best-in-class technologies and optimal flowsheets for the beneficiation of coking coal to enhance coking coal yields @ 16-18% ash for setting up of modern coking coal beneficiation plants. He highlighted the need for the Ministry of Coal (MoC)/CIL to intensify the detailed exploration and test work required to identify coal reserves with the desired coking properties as indicated by the steel plants. He appreciated the work done by National Institute of Advanced Studies (NIAS) in the draft report which covered the key policies and enablers for implementation to enhance the production of domestic coking coal in the country. The Chair also highlighted the need for demarcating clusters of coking coal blocks before auctioning them since a minimum scale of operations is required for setting up viable coking coal washeries in close proximity to the blocks. He stressed on the importance of PPP models to attract large investments from the integrated steel plants in the mining and beneficiation of medium coking coal in India.

2. Prof. R Srikanth, NIAS, Bengaluru presented the status of washed coking coal production in India vis a vis the demand for metallurgical coal, and the key policy recommendation and enablers to bridge the gap. The following observations were made on the report:

i. It was informed that prime coking coal reserves in the country is about 5.13 billion tonnes while the medium coking coal reserve stands at 16 billion tonnes, therefore reserves are not a constraint for India.

ii. Most of the raw coking coal produced by CIL is supplied for non-metallurgical use (about 85%) due to the lack of modern washeries with CIL/SAIL. Tata Steel, has a washery with supply metallurgical coal to SAIL @18.5% ash.

iii. It was observed that coking coal classification and definition are missing. There is no definition for coking coal whether prime or medium. It was also highlighted data for coal seam wise is also missing. It was highlighted whether Ministry of Steel can define the quality of coal for the steel sector as coking coal import is substantial in the steel sector. It was indicated that quality changes from mine to mine.

iv. One of the concern raised was whether greater flexibility to be given to the stamp charging so as to reduce the import dependence. Therefore, the integrated role of mining geology, coal quality assessment, mine planning, mining operations, beneficiation, and logistics backed by a strong QA system and a continuous-improvement culture to maximise the production of washed medium coking coal suitable for metallurgical use in integrated steel plants in India was highlighted. The role of the Government of Jharkhand was also identified as to expedite various statutory clearances and facilitating land acquisition to mobilize the coking coal blocks in Jharkhand.

v. It was also observed that as many as 22 agencies in the country are available to provide services in terms of mine planning and design.

vi. The performance of coal washeries were questioned at large and it was felt that there is need to modernize the coal washing. Further the aspect of co-locating coal beneficiation within the different coal mine areas can optimise the performance of washery. BCCL can play major role and can build long term linkage for coal washeries with the steel and other sectors.

vii. The economic use of middling can also be considered for sale to thermal power plants.

viii. India's largely coking coal reserves are under the control of CIL/SAIL. TATA steel is the only coking coal producer in the private capacity. The extraction is largely done through MDO and BOO contractor, lead to sub-optimal utilisation of extraction and washing of coal. The East and West Bokaro of Jharkhand was considered to be potential areas where coal coking coal production can be enhanced in a mission mode through formation of SPV.

After detailed deliberations with the stakeholders, ministries and departments, the following decisions were taken during the meeting: -

1) CMPDIL/CIL is requested to make available the coal seam wise as well as block wise coking coal characteristics data for all coking coal blocks before auction, so that the bidders can utilize this information effectively while participating in the auction of coking coal blocks.

(Action: CIL/MoC)

2) Ministry of Coal may examine (with CMPDIL/CIL) ways & means to provide data related to the extractable coal reserves and peak rated capacity (PRC) with currently available technology along with the Geological Report since this will enable the bidders (at least for coking coal blocks) to assess the mining and washery capacities required to wash the coking coal to make it suitable for

metallurgical use. The reserve price should be fixed on the extractable reserves rather than the entire geological resources of the coal block put up for auction.

(Action: MoC/CMPDIL)

3) Tata Steel confirmed that they produce superior-quality coke in their stamp charged batteries at Jamshedpur by optimizing the use of low-cost, domestic medium coking coal (washed down to 15- 17% ash) to the extent of 50%-67% in the coal blend and are constrained to reduce the share of domestic coking coal, mainly due to the shortage of captive coal reserves. Therefore, SAIL and CMPDIL can collaborate on a research study to assess the coking properties of various coal blends of domestic coking coal (after washing) to optimize the coking properties while maximizing the use of domestic coking coal. To reduce the import of coking coal to the extent possible, SAIL/ CMPDIL may also take the assistance of Tata Steel to for submitting a research report on this important matter.

(Action: SAIL & CMPDIL)

4) There is a need for detailed study of coking coal blocks to determine the minimum production capacity of a coal block or a group of coal block for setting up a viable washery at pithead. The data bank developed based on this study can be utilized for making clusters of coal blocks to set up modern coking coal washeries (for each cluster) so that the whole coal block auction process results in enhancing the production of washed coking coal for metallurgical use as per 'Mission Coking Coal'.

(Action: MoC/CMPDIL)

5) Bharat Coking Coal Limited (BCCL) stated that they are implementing an action plan to increase the production of coking coal suitable for producing metallurgical coal after beneficiation in modern coking coal washeries. Therefore, the Ministry of Steel can examine the sub-optimal utilisation of its existing washeries. Based on this performance review, the necessary steps to be taken to upgrade the existing washeries by implementing the flowsheets required to wash these coals or establish new washeries with advanced technology to enhance the import substitution of coking coal in SAIL's steel plants and reduce hot metal costs.

(Action: Ministry of Steel)

6) Ministry of Coal needs to enable necessary policy changes to allow the owner of coking coal blocks to sell the by products (middling and tailing) of coking coal washeries when it is not possible to utilize these by products in the steel plant which consumes the washed coking coal. This is critical to reduce the waste generation during coking coal beneficiation and reduce the costs of clean coal since the profit on the sale of these by products must be passed onto the steel plant in the form of lower coking coal costs.

(Action: Ministry of Coal)

7) A meeting may be organized with NITI Aayog, Ministry of Steel (MoS), Ministry of Coal (MoC), Integrated Steel Plants (ISPs), Prof R. Srikanth, CIL, and other key stakeholders to discuss NIAS's

proposal for CIL to form separate Joint Venture (JV) companies between CIL and integrated steel plant(s) in the PPP mode in the West Bokaro coalfield (to start with) and other medium coking coalfields of India to maximise the production of washed medium coking coal for use in stamp charged batteries that are widely prevalent in India. NIAS will incorporate this recommendation in their final report.

(Action: NITI Aayog /MoS /MoC / CIL /ISPs /NIAS)

8) NIAS will incorporate the stakeholder comments in the final report of the Research Study for "Enhancing Domestic Coking coal availability" under RSNA study

(Action: NIAS)

The meeting ended with a vote of thanks to the chair.

(Jawahar Lal)
General Manager, Energy
Tel.: 011-23096813
jawahar.lal68@gov.in

To:

1. All the participants of the Stakeholder meeting

Copy for kind information:

1) Secretary, Ministry of Coal
2) Secretary, Ministry of Steel
3) Chairman, CIL, Kolkata
4) CMD, SAIL, New Delhi
5) PS to VC, NITI Aayog
6) PS to Member (VKS), NITI Aayog
7) Sr.PPS to CEO, NITI Aayog
8) PS to Adviser (Energy), NITI Aayog

List of Participants of the Stakeholder Consultation Meeting on Research Study for "Enhancing Domestic Coking coal availability" held on 1st March'2024 at 10:30 AM under the Chairmanship of Dr. V.K. Saraswat, Member, NITI Aayog, in Room No.122 at NITI Aayog, New Delhi

1. NITI Aayog: Energy Vertical, Industry vertical
   - Dr. V K Saraswat, Member
   - Shri Rajnath Ram, Advisor, Energy Vertical
   - Shri Anshu Bharadwaj, Sr. Consultant, Energy Vertical
   - Shri Jawahar Lal, General Manager, Energy, Energy Vertical
   - Dr. Ritu Mathur, Energy Vertical

2. Ministry of Steel
   - Sh. Abhijit Narendra, Joint Secretary

3. Ministry of Coal
   - Mr. Deepak Goel, Director

4. Government of Jharkhand
   - Shri Gopal Kumar Das, Deputy Director, Mines

5. Steel of Authority of India Ltd.
   - Sh.Sandip Kumar Kar, Ex. Director (RDCIS)
   - Sh.Basudev Chakraborty, GM

6. Rashtriya Ispat Nigam Limited, Vishakhapatnam
   - Shri Ranjan Mohanty, Chief General Manager (Iron, Energy & Utilities)

7. Bharat Coking Coal Ltd
   - Sh Samiran Dutta, CMD
   - Sh Sanjay Singh, Director

8. Central Mine Planning & Design Institute Ltd. (CMPDIL)
   - Shri Satish Jha, Director (Technical / Engineering services)
   - Smt. Abha Prasad, General Manager (CMP)

9. Tata Steel Ltd.
   - Mr. D. B. Sundara Raman – Vice President Raw Materials
   - Mr. Amit Prakash Singh, Head Regulatory Affairs Mining & Steel
   - Mr. Dilip Kumar Singh – Associate

10. JSW Steel Ltd.
    - Mr. Anil Kumar Singh-President & WTD
    - Mr. Puneet Jagatramka-EVP - Commercial & Purchase
    - Sh. Gautam Senapati

11. Jindal Steel & Power Ltd.
    - Sh. Kapil Dhagat, EVP,

12. Confederation of Indian Industry
    - Mr Manish Mishra, Chief Corporate Affairs, Tata Steel
    - Mr Rajesh Gopinathan, Director, CII
    - Ms Debayani Majumder, Executive, CII

13. FICCI
    - Mr. Arpan Gupta, Additional Director, FICCI
    - Mr. Sanjay Singh, Senior Assistant Director, FICCI
    - Ms. Namrata Sagar, Assistant Director, FICCI

14. ASSOCHAM/JSW Steel
    - Mr. Sachindra Kumar Singh, Member, ASSOCHAM National Council on Coal & Head
    - Mr. Gautam Senapati, Member, ASSOCHAM National Council on Coal & AVP (Mines).
    - Mr. Rajeev Raman, Member, ASSOCHAM National Council on Coal & GM, JSW Steel Ltd
    - Mr. Amit Sharma, Assistant Director (Metals & Mining), ASSOCHAM

15. Mr. Surya Prakash Kansal, Director -Surmine Consulting Pvt. Ltd.

16. Mr. D N Prasad, former Advisor-Projects, Ministry of Coal

17. INDIAN STEEL ASSOCIATION
    - Mr. Alok Sahay, Secretary General
    - Sh. Anup Kashyap

18. ARCELOR MITTAL – NIPPON STEEL INDIA LTD.
    - Sh. Sudhir Sharma
    - Sh. Rajesh Gupta

Participants who attended the meeting through VC

19. Shri Pankaj Satija, Tata Steel.

20. Ms. Namrata

Annexure 2

National Institute of Advanced Studies

Annexure 2

Enhancing Production of Coking Coal to reduce Coking Coal Imports

Prof R. Srikanth, Energy, Environment, Climate Change Program, NIAS

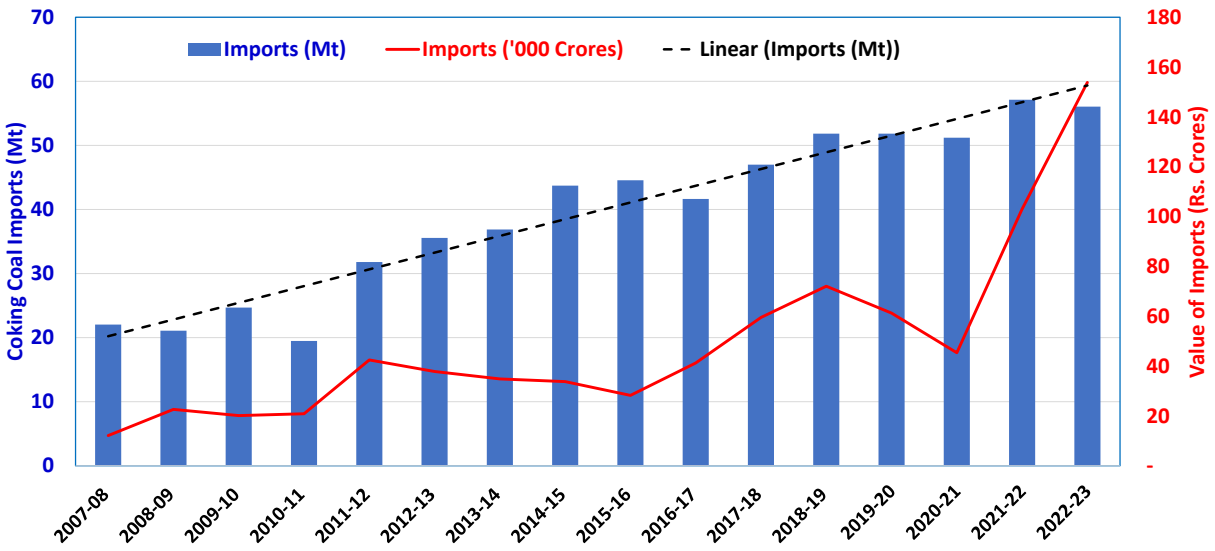
Presentation at the NITI Aayog Stakeholder Meeting on 1 March 2024

Why are policy interventions required beyond Mission Coking Coal

- India's total coking coal import bill exceeds 1.5 lakh crores (will increase further)
- Since the cost of coking coal accounts for approximately 42 percent of the total cost of steel produced in India, steep increases in the landed price of imported coking coal have a major impact on the cost of steel.
- This impacts the financial performance and competitiveness of India's steel sector and affects the input costs of the automotive & infrastructure sectors.
- Increasing costs of steel also impact the infrastructure development required to make India a developed country with a 30 trillion-dollar economy by 2047
- The sharp rise in steel imports from China in FY 24 demonstrates the need for increasing the competitiveness of India's steel industry.
- Any sustained reduction in the cost structure of India's steel sector can be achieved only with higher coking supplies from domestic coal mines & washeries in India.

2

Volume and Value of Coking Coal Imports



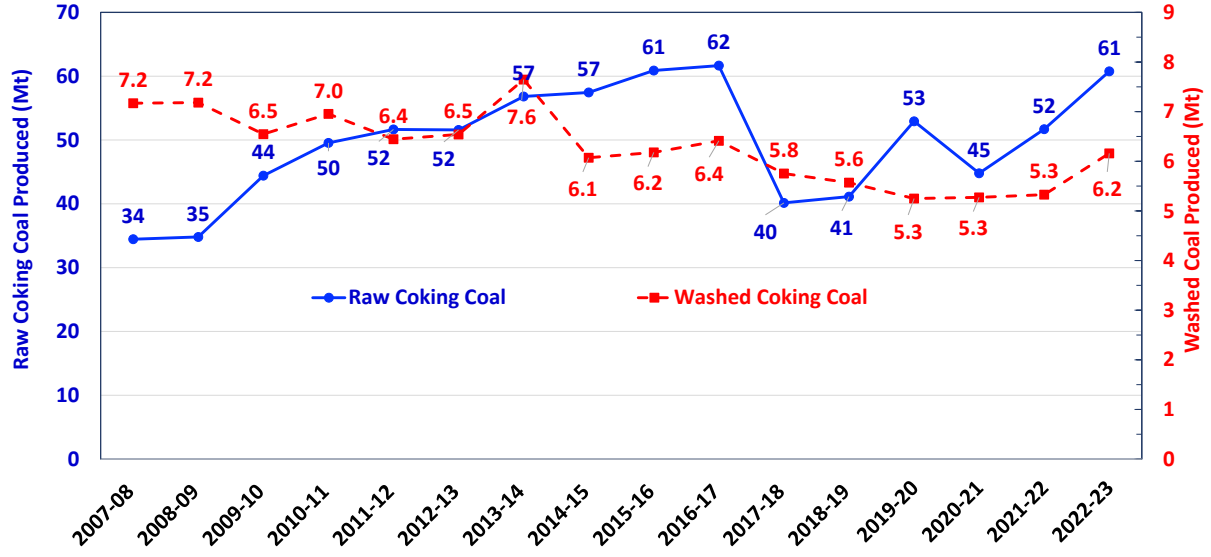
While volume of coking coal imports is in the range of 51 – 57 Mt in the last 5 years, the total import value is now ~ Rs. 1.54 Lakh Crores due to the steep increase in coking coal prices leading to steel price hikes. 3

National Steel Policy, 2017

- Raise India's crude steel capacity to 300 Mt (144 Mt today) by FY 2030-31.
- Hike finished steel production to 230 MT by FY 31 to increase per capita steel consumption to 158 kg from 75 kg in FY 20.
- To achieve this target:
  - 161 MT coking coal is required for coke-making;
  - 31 MT of low-ash non-coking coal for pulverized coal injection (PCI) into the blast furnace.
- The Indian steel industry is looking beyond 2030 and has ambitious expansion plans even beyond 2031.
- While some steel makers use the DRI-EAF route, most of the integrated steel plants in India will continue to use the Blast Furnace route that requires coking coal. 56% of India's steel projected to be produced through the Blast Furnace route by 2030.
- India has 5.13 billion tons of proved geological resources of prime coking coal & 16.5 Bt of proved medium coking coal resources.
- **Coking Coal Reserves are not a constraint for India.**

4

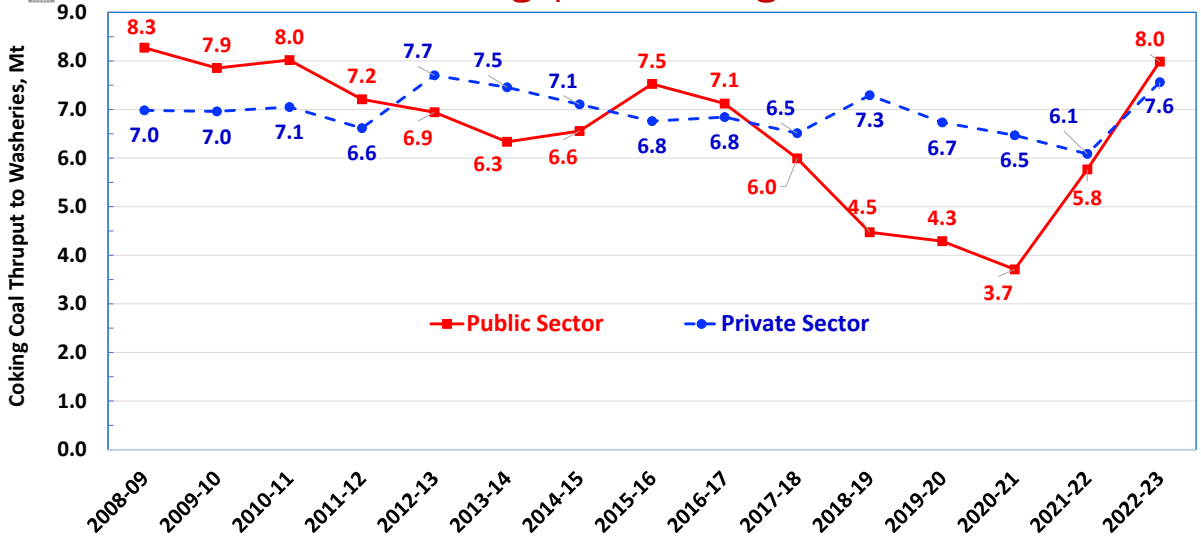
Production of raw coking coal & washed metallurgical coal



Eighty-five percent of the coking coal dispatched by CIL (53.28 Mt in FY 2022-23) is supplied to power sector

5

Raw Coal throughput to coking coal washeries

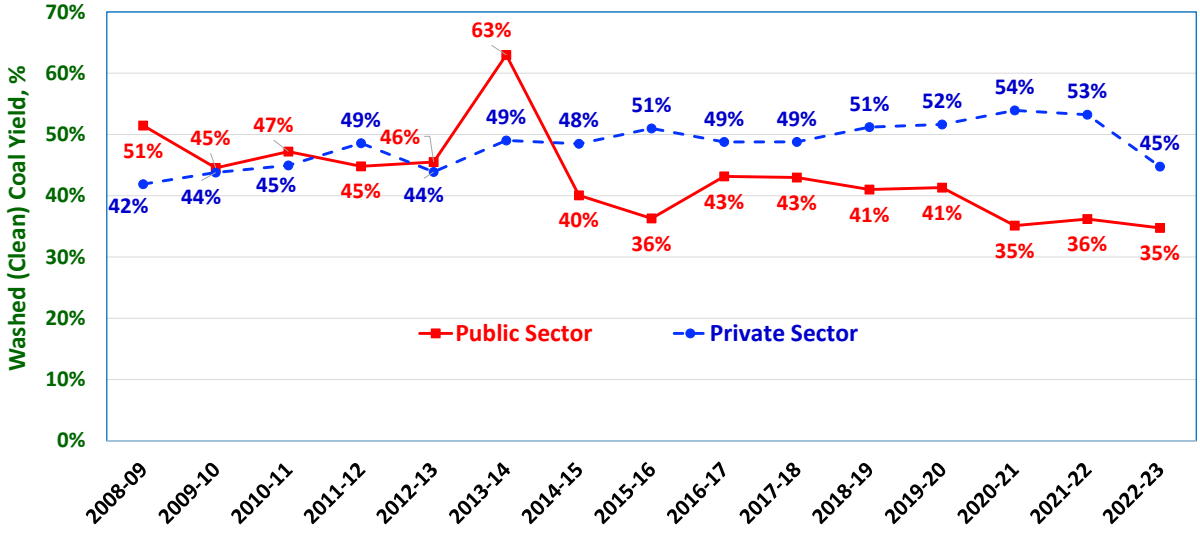


PSU coking coal washeries with a nameplate capacity of 25 Mt processed only 8 Mt of raw coking coal

Tata Steel (only private sector coking coal producer) with a total raw coal throughput capacity of 10 Mt, also washed raw coking coal from BCCL (1.59 Mt in FY 23) to supply 0.85 Mt of metallurgical coal to SAIL @18.5% ash.

6

Clean coal yields in PSU washeries are low due to obsolescence & lack of synergy between mine planning, mining operations & washeries



The success of Tata Steel in maximizing production of metallurgical coal (@ 16% ash - 18.5% ash) from the same coalfields operated by CIL/SAIL is due to the synergy between geology, mine planning, mining operations, & washeries

Current Status of Metallurgical Coal Production in India

- All pre-2018 washeries installed in BCCL/CCL are obsolete since they were designed to wash coals from the upper horizon of coal seams which had superior washing characteristics. Most of these superior quality seams are exhausted.
- Since these obsolete washeries are unable to produce metallurgical grade coking coal (<18.5% ash) from the raw coking coal mined today, BCCL supplied 1.59 Mt of raw coal to TSL's washery to supply 0.85 MT of metallurgical coal to SAIL.
- In Nov 2023, BCCL commissioned the Madhuband washery and is setting up three coking coal washeries in Jharia coal field with a total throughput capacity of 7 MT.
- SAIL has awarded a contract to construct a 3.5 MT washery in Tasra coal block.
- TSL's modern washeries in the Jharia coalfield have a throughput capacity of 3.5 MT
- Capacity of these 7 (BCCL-4, TSL-2, SAIL-1) washeries >18 MT, which is enough to process the coking coal (fit for metallurgical use after washing) mined in Jharia.
- Since Stamp Charged Batteries are replacing Top Charged Batteries, production of washed medium coking coal suitable for stamp charged batteries must be increased

8

Key Enablers to realise the goals of National Steel Policy

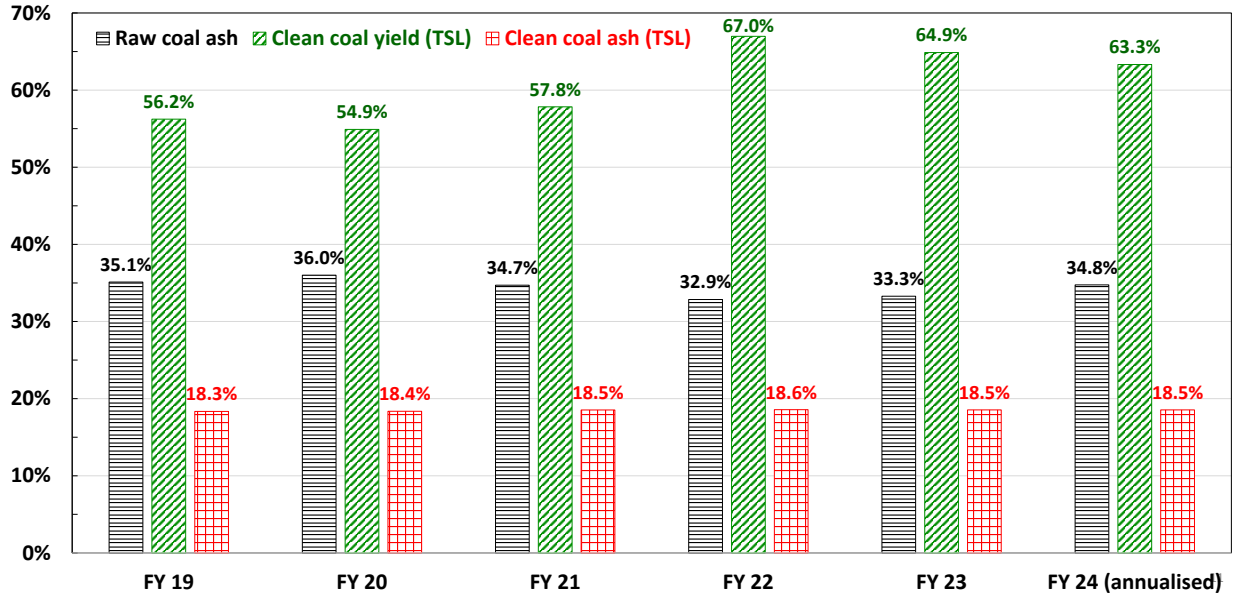
- India has tremendous potential to leverage our high-quality iron ore and coking coal to continue our growth in the iron & steel sector.
- While India is exporting value-added steel products, we are the second-largest importer of metallurgical coal, next only to Japan despite having:
  - 5.13 billion tons (Bt) of proved geological resources of prime coking coal & 16.5 Bt of proved medium coking coal reserves (largely in Jharkhand).
  - Established exploration, mining, and beneficiation expertise in producing washed coking coal fir for metallurgical use despite having ample reserves of 'extremely difficult to wash' coking coal.
- Current policies must be changed by declaring coking coal to be a 'critical mineral'
- While the proved coking coal resources are sufficient for > 50 years, the supply of metallurgical coal to steel plants from domestic sources lags far behind India's potential.
- Govt. of India must create an enabling environment to provide coking coal security to the expanding steel sector with suitable policies & amendments in Coal Bearing Area Act, MMDR Act, Forest Conservation Rules, Auction Rules.
- These policy interventions will increase India's coking coal security and cushion the impact of volatility in coking coal prices that affects infrastructure development & the competitiveness of the steel sector.

9

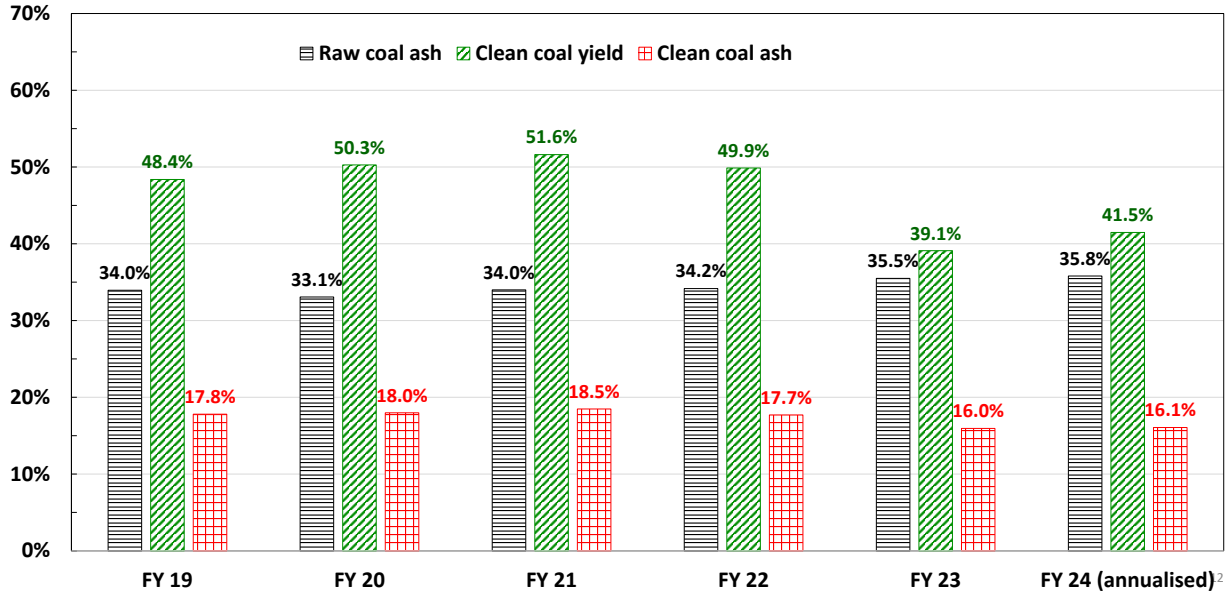
Case Study of the Integrated Coking Coal Mines and Washeries operated by Tata Steel in the Jharia and West Bokaro coalfields in Jharkhand

10

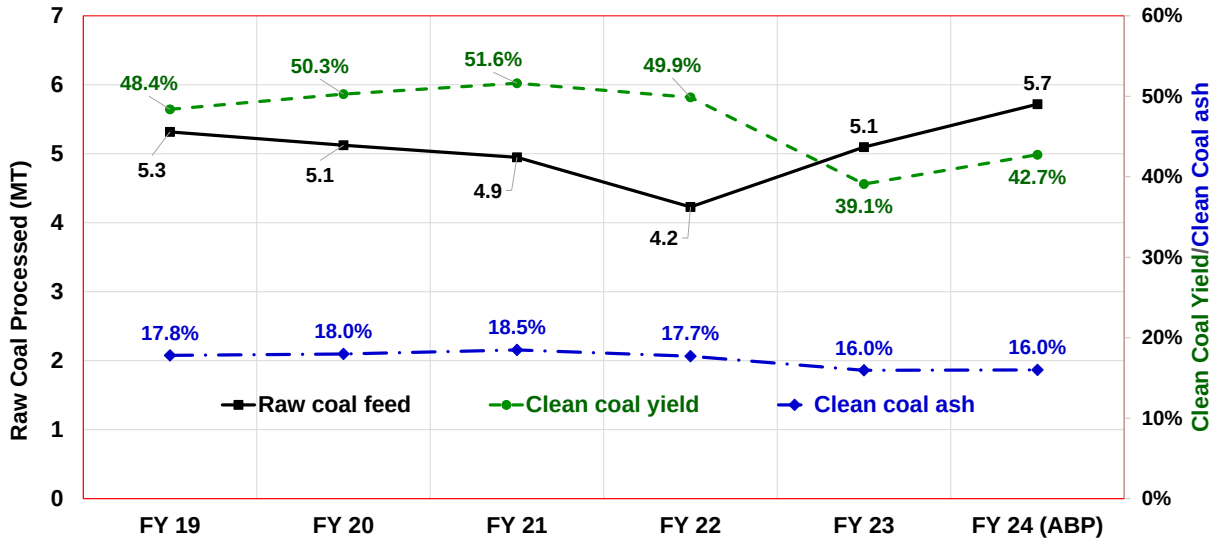
Raw coal ash, Clean Coal Ash and Clean Coal Yield in Tata Steel's Jharia division (Prime Coking Coal)



Raw coal ash, Clean Coal Ash and Clean Coal Yield in Tata Steel's West Bokaro division (Medium Coking Coal)



Raw coal feed, clean coal ash & yield in TSL West Bokaro Division



Raw coal production in TSL West Bokaro division dipped in FY 22 due to undue delay in grant of forest clearance. Drop in Clean Coal Yield in FY 23 (39.1%) from FY 22 (49.9%) is due to an increase in Raw Coal (RC) feed ash from 34.2% to 35.5% (besides other changes in washability characteristics) and a reduction in CC ash from 17.7% to 16%. [13]

Government initiatives to increase production of coking coal under Mission Coking Coal will only increase raw coking coal production without increasing production of washed coking coal fit for metallurgical purpose

14

Salient details of coking coal blocks allotted till August 2023

Name of Coal Mine	Coalfield/State	Allotted to	Vesting / Allotment order date	Peak Capacity Mtpa	Geological Resources Mt
1. Moitra	North Karanpura	JSW Steel	22-04-2015	1	215
2-3. Kotre Basantpur & Pachmo	*West Bokaro*	*CIL (PSU)*	*19-04-2018*	*5*	*250*
4. Brahmdiha	*Giridih*	*APMDCL (PSU)*	*02-03-2021*	*0.15*	*5*
5. Urtan North	Sohagpur	JMS Mining	03-03-2021	0.6	70
6. Urtan			03-03-2021	0.65	55
7. Jogeshwar, Khas Jogeswar	West Bokaro	SW Pinnacle Exploration	18-11-2021	0.6	84
8. Rohne	*North Karanpura*	*NMDC (PSU)*	*18-06-2021*	*8*	*242*
9. Lalgarh North	West Bokaro	Adhunik Power & Resources	24-12-2021	1	27
10. Basantpur		Gangaramchak Mining	12-12-2022	NA	200
11. Beheraband (N) Extn.	Sohagpur	Auro Coal Pvt. Ltd.	10-10-2022	NA	120
12. Sitanala	Jharia	JSW Steel Ltd.	08-06-2023	0.3	109
13. Parbatpur Central				0.74	147.0
14. Choritand Tiliaya	West Bokaro	Rungta Metals	08-06-2023	0.78	97
15. Rabodih		21st Century Mining Pvt. Ltd.	31-03-2022	2.5	133
16. Tasra	*Jharia*	*SAIL (PSU)*	*26.02.1996*	*4*	*251*
			Public Sector	**17.15**	**748**
			Private Sector	**8.17**	**1257**
			Total	**25.32**	**2005**

- Barring the Rabodih coal block, none of other 11 coal blocks allotted to the private sector has an annual production capacity of + 1 Mt.
- Hence, none of these coal blocks have the required scale to set up the coking coal washeries required to produce metallurgical coal (@17% - 18% ash) required for blending with imported coal for consumption in integrated steel plants.

5

Made for Each Other: Medium Coking Coal & Stamp Charged Batteries

- While BCCL is modernising its coking coal washeries in the Jharia coalfield besides putting up new washeries, sustaining the raw coal throughput of all these washeries at their peak rated capacities will continue to be a bottleneck.
- Out of SAIL's total coking coal requirement of 26 MT during FY 2030-31, it is projecting a total domestic coking coal requirement of only 7 MT (27%) in the blend proportion even with stamp charged batteries with the balance 19 MT imported.
- Key advantage of stamp-charging technology is that it enables cheaper semi-soft coking coals to be blended with domestic medium coking coal (@ 16%-18% ash) (and some hard coking coal) to produce coke of an international standards.
- Tata Steel's experience in the last 20-30 years indicates that washing of medium coking coal from the West Bokaro coalfield to 17% ash before blending it to the extent of 55% with 35% imported semi-soft coal and 10% hard coking coal produces good quality coke (CSR >= 65%; coke ash <16.5%) in the stamp charged batteries.

16

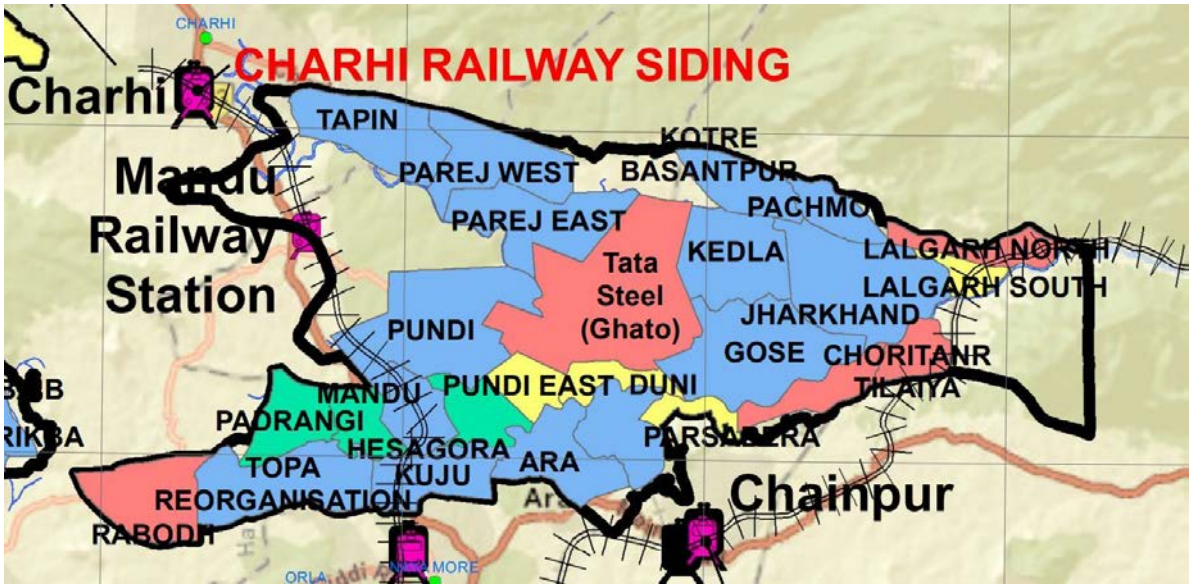
Key Findings and and Recommendations

- More than 99% of India's coking coal reserves are under the control of CIL/SAIL, with Tata Steel being the only coking coal producer in the private sector till date.
- Most coking coal blocks allocated after 2014 (SC Judgement) have been allotted to PSUs, with a few small coal blocks allotted to the private sector through auctions.
- We must re-examine India's strategies, policies & practices in relation to coking coal blocks to raise coking coal security for increasing steel production in National Interest.
- The piecemeal approach of appointing an MDO for mining and another BOO contract for washing will result in sub-optimal utilisation of our coking coal reserves since optimising the clean coal yields from difficult-to-wash medium-coking coals requires:
  - Integration of exploration, mine planning, mining operations, logistics, and beneficiation.
  - Large capital investments in this integrated value chain cannot be brought in by contractors in India
  - Culture of continuous improvement & periodic technology upgradation to beneficiate the wide variety of washing characteristics in years to come.
- This requires a reorganisation of Central Coal Fields by spinning off their operations & coal blocks in the West Bokaro coalfield into an SPV to be operated in the PPP model.[17]

Why should West Bokaro coalfield be prioritised for expansion

- Since SAIL is also putting up stamp charged batteries based on TSL's proven experience, demand for domestic washed medium coking coal will increase sharply.
- The West Bokaro Coalfield (WBCF) in Jharkhand contains approximately 22% (3.58 billion tons) of India's 16.5 BT of measured resources of medium coking coal.
- 84% of these measured coal reserves (3 BT) are at a depth of less than 300 metres.
- Therefore, it is possible to ramp up the coal production in this coalfield quickly once all necessary clearances (including, environmental & forest clearances and mining lease & surface rights) are granted by GOI and the Government of Jharkhand.
- The annual raw coal production in the WBCF can be increased by more than 20 MT per annum from the current level by opening additional coal mines in this coalfield.
- When the medium coking coal produced from these mines is washed to 16-18% ash in washeries to be put up and operated in an integrated manner with the coal mines, 7-8 MT of metallurgical coal can be supplied to stamp-charged coke batteries.
- Savings in import bill with this incremental metallurgical coal: 1.2 Bi $ = Rs. 10,000 Cr.[18]

West Bokaro coalfield



19

Key Recommendations to achieve National Steel Policy

- While Coal India Ltd. has succeeded in achieving energy security for India, the focus of CIL (and CCL) will continue to be on the production of thermal coal.
- While BCCL is at an advanced stage of setting up 3 more washeries for enhancing supply of prime coking coal suitable for metallurgical purposes, the obsolete coking coal washeries in CCL are not fit to optimise the washed coal yields from the extremely 'difficult-to-wash' medium coking coal reserves in CCL.
- A public-private partnership with GOI and GOJ and Pvt. Steel Companies is essential to increase production of coking coal fit for stamp charged coke ovens. For this, contiguous coking coal blocks with high production capacity must be allotted to a PPP.
- Amendments in Coal Bearing Areas Act, Forest Rules, and Auction Rules are reqd.
- Of all the coking coal areas in Jharkhand, the West Bokaro coalfield has the largest unexploited medium coking coal reserves (3 billion tons up to 300 m depth).
- Spinning off the West Bokaro coalfield as a SPV with minority stakes owned by CCL & Govt. of Jharkhand and majority stakes with a Steel Co. can unlock this potential.
- This model can be applied to the East Bokaro Coalfield also in due course.

20

Key Recommendations to achieve National Steel Policy –(cont'd)

- Two SPVs can be formed in the PPP mode in the West Bokaro coalfield itself.
- The private partner (with majority share) in each SPV can be selected by a transparent process from the private sector integrated steel producers of India.
- Coal Bearing Areas Act must be amended to ensure that the SPV continues to be a deemed lessee of the Government of Jharkhand and enjoys all other rights granted under this Act.
- The coal block auction rules must be amended (e.g., to minimise the upfront payment) so that the majority private partner is able to invest on land acquisition, forest clearance, and the development of mines, washery, and logistics.
- The Forest Conservation Rules must be amended to facilitate this SPV to have a level playing field with Govt. companies as far as compensatory afforestation is concerned. This is critical to expedite mine development, coal production & dispatches.
- The SPV must be allowed to sell only washed coking coal (clean coal and by-products) with no permit for raw coal sales.

21

Document Control Sheet

1	**Document No and Year**	:	NIAS/NSE/EECP/U/RR/01/2024
2	**Title**	:	Enhancing Domestic Coking Coal Availability to Reduce the Import of Coking Coal
3	**Type of Document**	:	Research Report
4	**No. of Pages and Figures**	:	81 pages and 12 figures
5	**No. of References**	:	58
6	**Authors**	:	R.Srikanth
7	**Originating School**	:	Natural Sciences and Engineering
8	**Programme**	:	Energy, Environment, and Climate Change
9	**Collaboration**	:	NA
10	**Sponsoring Agency**	:	NITI Aayog, Government of India

11 **Abstract:**

India is the 2nd largest steel producer in the World and steel companies in India are expanding to meet our growing demand. Since Government-owned Coal India Ltd. is unable to supply the required quantities of good quality coking coal to produce high-quality steel in the Integrated Steel Plants (ISPs), they depend on imports for more than 80 percent of their coking coal requirements. The total value of coking coal imports into India currently exceeds Rs. 1.5 Lakh Crores.

India's National Steel Policy aims to raise crude steel production to 255 MT by FY 2030-31 for which 161 MT of coking coal are required. India has adequate reserves of coking coal that can be washed down to 17-18% ash for supplying metallurgical coal to ISPs. However, even after the implementation of Mission Coking Coal from 2021, there is no substantial reduction in the import of metallurgical coal by our ISPs who compete globally.

In this context, NITI Aayog commissioned a study by the NIAS to suggest the way forward to enhance the domestic supply of medium coking coal to stamp-charged coke oven batteries after washing the raw coal to 17-18% ash.

The NIAS report was discussed in a Stakeholder Consultation meeting with the Steel and Coal ministries involving all major ISPs and Industry associations. Since coking coal is a 'critical' mineral for India, policy changes suggested in this report can be considered by the Government of India to achieve Viksit Bharat 2047..

12 **Keywords:**

Coal washeries, Critical Mineral, National Steel Policy, Raw Material Security, Integrated Steel Plants.

13	**Security Classification**	:	Unrestricted
14	**ISBN**	:	None

National Institute of Advanced Studies

The National Institute of Advanced Studies (NIAS) was conceived and established in 1988 by the vision and initiative of the late Mr. J.R.D. Tata primarily to nurture a broad base of scholars, managers and leaders to address complex and important challenges faced by society through interdisciplinary approaches. The Institute also engages in advanced multidisciplinary research in the areas of humanities, social sciences, natural sciences and engineering, as well as conflict and security studies.

Energy, Environment, and Climate Change Program
National Institute of Advanced Studies
Bengaluru, India