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Energy Security Insights

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Preface

There is considerable interest worldwide in the place of coal as a source of energy both currently and as projected in the future. The major reason that this subject is being considered is because coal is a major source of carbon dioxide emissions and also a source of local environmental pollution. At the same time, in a country like India coal is the mainstay as far as fuels for power generation are concerned. Historically, coal was also seen in official policy circles as an important part of the country's energy security, even though India's dependence on coal imports is growing rapidly. In the context of India, it is important to look at the prospects for increase in coal production in conjunction with issues related to emissions of greenhouse gases, the problem of the large burden of fly ash in Indian coal and implications for local pollution in the vicinity of establishments where coal is used.

TERI brought out an important policy brief on India's coal reserves and concluded that India does not have adequate extractable coal reserves required either to meet current incremental demand or to make long term supply commitments. It also concluded that if this fact is denied then clearly India will not take the necessary and urgent steps required to augment its reserves, which are clearly inadequate. This policy brief also observed that in recent years several countries, such as Germany, the UK and Poland have downgraded their reserve base, and till 2007 the overall world reserves of coals were reduced from 10,000 billion tonnes to 4,200 billion tonnes. Consequently, the ability to import large quantities of coal would also be getting increasingly restricted and, therefore, impacting unfavourably on India's energy security. To some extent, this situation was being mitigated by the acquisition of coal mines in other countries, but despite such developments it was observed that coal security needs to be given the same, if not higher importance, as oil security, particularly since potential sources of coal imports are limited to barely three or four countries, unlike sources of oil which are far more diverse.

In the light of this a very comprehensive reappraisal of coal's place in India's energy sector becomes imperative. At any rate, global compulsions to reduce emissions of greenhouse gases worldwide also require India to develop strategies by which it moves to a much lower carbon pattern of growth and development. Hence, if coal is to be used on a growing scale in India, then perhaps technological innovation such as in situ gasification of coal might present one option. If such a technology were to be developed perhaps some of the deepest seams, which would not be of any great value with existing mining technology and practices, could be opened up as a source of cleaner energy supply.

The articles in this issue of Energy Security Insights would undoubtedly add to our knowledge and understanding of coal in the larger scheme of things as far as India's energy and economic challenges are concerned. There is indeed a need for an in-depth reappraisal of coal policy in this country in all its dimensions.

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Status Note: Coal Sector

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Introduction

India's total raw coal production in 2013–14 increased from 556.4 million ton (MT) in 2012–13 to 565.7 MT, a rise of 1.7% (Table 1) (CCO 2014). Despite this increase, Coal India (CIL), which remains the key supplier for coal in the country, was unable to meet the demand of 769.9 MT (CIL 2014) leading to total imports of about 168.43 MT (CCO 2014) (Table 2). This dependence on imports, despite having huge amount of coal reserves underlines the need for reforms in the sector. And a number of changes were seen in the sector in the past year (2014), especially in the captive mining space.

Changing Domestic Scenario

The issue of captive coal blocks which has been under the scanner for the last couple of years was finally resolved when the Supreme Court in its order (Manohar Lal Sharma vs The Principal Secretary & Ors 2014), held that 204 coal blocks which have been allocated since 1993 will be scrapped and fresh auctions will be held. This order paved the way for reforms in the sector. The government acting on these orders released the Coal Mines (Special Provisions) Ordinance in October 2014. Further to this ordinance, the Ministry of Coal (MoC) released a set of rules under the ordinance which aims at managing and re-allocating all the cancelled privately- and publically-owned coal blocks through a transparent process. Therefore, this ordinance has paved the way for the public auction of mines by way of competitive e-bidding of the cancelled coal blocks (PIB 2014). This approach of auctioning is expected to bring in healthy competition, efficiency in operation as well as optimize the power tariff levels in the power sector, the biggest consumer of coal in the country. At the same time, coal pricing that continues to remain a contentious issue among purchasers would also receive a chance at fair and transparent estimation.

Table 1: Coal production in 2013–14 (Company-wise) (MT)

Company	Coking Coal	Non-Coking Coal	Total Coal
CIL	48.91	413.49	462.41
SCCL		50.46	50.46
Other Public	0.58	14.61	15.19
Total Public	49.50	478.57	528.08
Total Private	7.31	30.37	37.68
All India	56.81	508.94	565.76

Source: CCO, 2013–14

Table 2: Coal imports by India in 2013–14

Type of Coal	Quantity (MT)	Value (₹/Million)
Coking	37.19	3,51,926
Non-Coking	131.24	5,81,003
Total	168.43	9,32,929

Source: CCO, 2013-14

The de-allocation or cancellation of all captive coal block allotments in September 2014 raised alarms on its immediate effect on the struggling coal production, coal supplies to core/operating end-use industries and the increasing dependency on coal imports. However, the move was an urgent need, especially with the CAG report stating if not for favourable allocations, the government would have made an additional gain of ₹1.86 lakh cr in revenues. Commencing reforms in the coal sector with the efficient, credible, and timely allocation process must be followed by complimentary processes (clearances, mining technology, pricing, transportation, and delivery) to ensure the larger goal of self-sufficiency.

The following sections provide a detailed understanding of the auctioning process and the likely impacts on the sector dynamics.

Understanding the Auction Process

As per the latest guidelines, the coal block auctioning process would be conducted electronically with the launch of a portal, in accordance with the Ordinance Rules. In the first lot, the government has offered 101 coal blocks for auction/allotment. Of this, 65 will go under the hammer while the rest will be allocated to public sector entities. Of the total 65 blocks put up for bidding, 28 goes to the power sector, while 37 will go to the non-regulated sectors (steel, cement, and captive power plants) (Table 3).

Table 3: Coal block auctions

	Sector	Number of Mines
Blocks up for allotment	Power	35
	Steel	1
Blocks under e-auction (private and public bid)	Power	28
	Steel, Cement, and Captive Power	34
	Steel (Coking coal)	3

Source: Ministry of Coal, 2014

The government has stated that the auctions for the first tranche of 42 blocks will be concluded by March 23rd, post which the auction process for the second tranche of 32 coal blocks will begin by the first week of April.

Based on the end-use, there are two methods of bidding, namely (Ministry of Coal 2014):

- Forward Bidding, where specified end use is production of iron and steel, generation of power for captive use and cement,
- Reverse Bidding, where specified end-use is generation of power.

As per the general terms of bidding, no bidder (including affiliates) shall be permitted to submit more than one bid for any coal block/mine–individually or as a part of a joint venture, for the same end-use plant (s). The companies eligible for participation in the bidding process, as per the Ordinance rules, include:

- A government company or a Joint Venture (JV) formed by such a company or between state government or the central government
- A company or a JV formed by two or more companies having common specified end-use
- A company engaged in specified end-use having a coal linkage or one that has made an application for a coal linkage
- A government company or a JV formed by such a company with any other company with a common specified end-use

As part of the bidding process, the bidder — post registration — is required to provide a bid security in the form of a bank guarantee issued by a nationalized bank or a scheduled bank (with net worth at least ₹1,000 cr). The security shall be equal to 2% of the intrinsic value of the coal mine.

The selection process for the successful bidder for the allocation of the coal mine comprises of a two-stage bidding process (Ministry of Coal 2014):

- Technical Bid: For purpose of qualification would include the technical and financial qualifications (technical capacity) and the indicative price offer[1]
- Financial Bid: For determination of successful bidder would comprise of the top 50% of the pre-qualified bidders ranked on the basis of the diminishing or increasing Price Offer.

The bidder that quotes the highest or lowest bid price would be declared as the Preferred Bidder[2]. The selected Preferred Bidder is recommended to the Central Government by the Nominated Authority as the Successful Bidder. Payments made by the Successful Bidder include a fixed amount for value of land and mine infrastructure, cost of preparation of Geological Report and obtaining all statutory permits, licenses approvals etc.; the floor price and the variable amount of the bid. The Successful Bidder is also required to provide a performance security in the form of an irrevocable and unconditional bank guarantee that is 14% of the peak capacity of the mine (as per approved Mine Plan) multiplied by the applicable Bid Price in the relevant year. This guarantee is linked to the milestones set for the development of the mine, delays/defaults in achievement of which shall result in deduction of the bank guarantee amount for the year. However, in case of excess production of its annual requirement, the same would be sold to Coal India Limited (CIL) at the Bid Price or the prevailing CIL notified price for the grade.

What to Expect

The major takeaways from the new auctioning mechanism include the transparency in the allotment process, increased accountability from the allotees, a constant monitoring system, targeted coal production, and time-bound deliverables so as to avoid any more of collateral national losses. This new process set to right the major issue of non-production from captive blocks which was the main grouse in the earlier auction process. Moreover, it has been hailed as

1 Indicative Price or Bid Price per tonne of coal would be above the Floor Price in case of Forward Bidding or below the Ceiling Price in case of Reverse Bidding (Ministry of Coal 2014)

2 In case the Preferred Bidder:
- Backs out of accepting coal mine: second-ranked bidder is asked to match preferred bid
- Withdraws bid: Bid security forfeited and bidder not permitted to participate in any tender or RFP issued by the authority for a year from tender release.

paving the way for commercialization of coal mining in India. Private mining would bring in improved and efficient mining techniques leading to lower costs of production. Furthermore, the proceeds of the auction would entirely go towards the coal bearing—state government revenue accounts —Jharkhand, West Bengal, Orissa, Chattisgarh and some parts of Andhra Pradesh, Uttar Pradesh and Bihar — financially empowering these states. The level of labour and managerial employment across the blocks is also bound to increase as they become operational.

The cancelling and re-allocation decision highlighted some aspects that may limit the extent of success of the reform process which are as follows:

- **Lack of bidding or participation:** The possibility exists that with the stringent rules and regulations under the renewed auctioning system, the route may not receive the expected number of participants or bids satisfactory enough to finalize allocations.
- **Rising debt:** Moreover at least some of the bidders will be part of those who were allotted the captive mines earlier. These companies will once again need fresh capital to finance these bids which will increase their debt.
- **Complexity of the bid process:** Bidders have opposed the so-called double price bid process stating that it would be easier to have just a single bid from the final short-listed bidders. Also, the eligibility criterion states that only companies having common end-use are allowed to bid together. This makes it impossible for those JVs not having common end-use, but which had bid for blocks earlier and which have set up their end use plants to bid under the new rules. For example, Hindalco and Essar Power had made a joint bid for the Mahan block for their aluminium and power plant respectively. While the end-use plants have been constructed, these companies cannot now form a JV to bid for the block (Singh 2014).
- **Idle blocks and stalled production:** The route of competitive bidding will take up to a year or more for complete allotment. In the interim, the Supreme Court had directed that CIL must take up additional production to compensate for the blocks (Manohar Lal Sharma vs The Principal Secretary & Ors 2014). But CIL is unable to satisfy the country's coal demand due to inefficient production process. Further, the cancelled blocks that made progress since last allocation — and could have begun production in coming years — will now remain disrupted until re-allocated, all adding up to rising imports at least in financial year 2016.
- **Impact on coal production:** With a transparent and efficient allocation process in place, unless succeeding process of land and forest clearances are expedited and coal linkages and coal pricing are rationalized, an actual positive impact on the levels of production would be constrained.
- **Illusion of commercialization:** The Ordinance gave rise to the hope that it would pave the way for commercial mining, specifically due to the eligibility criteria. But the government has not yet set a timeline to open the coal industry. Not only that, none of the 204 blocks to be auctioned this year or the next will be allowed to commercially mine coal and sell it in open market (Economic Times 2015).
- **Power tariff increase:** The fixed reserve price of ₹100 per tonne as payable by the Power Sector Mine Allocatee, over and above the 14% Royalties currently applicable, raises concerns on its subsequent impact on the power tariffs that are aimed at being optimized in favour of the consumers.
- **Delays due to labour unrest:** The new Ordinance has come under attack from Coal India unions, who are opposing what they consider a move that will open the sector for private mining. Moreover, while the auction process would increase labour opportunities at the mine sites, private mining companies would be under no obligation for minimum wage or providing social security.

Table 4: Pros and cons of the new auctioning process

Benefits	Limitations
Transparency in allotment	Lack of participation
Increased accountability	Delayed coal production
Constant monitoring by the Nominated Authority	Complexity of the bidding process (double price bid)
Time-bound deliverables	Increase in power tariffs
Increased revenue for coal-bearing states	No commercial sale of coal for now
More employment opportunities	Constrained positive impact due to delay in clearances

Conclusion

The speedy start to the auction process from December 25, 2014, provided an encouraging push to sector's growth expectations. Moreover, the new auction process for the first time generated confidence among the industry that the new government means business. The auction process on paper ensures that there will be greater clarity, transparency and monitoring this time around. However, only time will tell how these promises will be implemented and whether their implementation will be up to the mark.

Bibliography

Manohar Lal Sharma vs The Principal Secretary & Ors, 120, 463, 515, 283 of 2012 (Supreme Court September 2014).

CCO. 2014. *Provisional Coal Statistics, 2013-14.* Ministry of Coal.

CIL. 2014. *Annual Report & Accounts, 2013-14.* Coal India.

Economic Times. 2015. *No commercial sale from auctioned coal blocks: Coal secretary Anil Swarup.* Retrieved January 19, 2015, from The Economic Times: http://articles.economictimes.indiatimes.com/2015-01-17/news/58175223_1_204-coal-blocks-coal-secretary-anil-swarup-coal-india

Ministry of Coal. 2014. *Approach Paper for Auctioning of Coal Mines.* New Delhi: Ministry of Coal.

PIB. 2014. *Ministry of Coal: Press Release.* Retrieved January 5, 2015, from http://pib.nic.in/newsite/pmreleases.aspx?mincode=42

Singh R. 2014. *Who will bid for Mahan coal block? Essar or Hindalco?* Retrieved January 19, 2015, from LiveMint: http://www.livemint.com/Industry/72z7NkwLvPoOmmubk9E2oM/Who-will-bid-for-Mahan-block-Essar-or-Hindalco.html

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Trends in Production and Import of Coal and their Implications

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Introduction

The rising trend in import of coal in India has been a source of concern. Apart from its impact on current account deficit, dependence on imported coal is viewed as a source of vulnerability from an energy security perspective. In light of the trends in production and import, this paper analyses the factors leading to a widening of the demand-supply gap and a rise in imports and delineates their implications for the Indian economy[1].

Table 1: Global production, export & imports of coal

	Country	MT	%	Export	MT	%	Imports	MT	%
1	China	3,549	45.3	Indonesia	383	32.8	China	278	23.4
2	USA	935	11.9	Australia	302	25.9	Japan	184	15.5
3	India	595	7.6	USA	106	9.1	India	158	13.3
4	Indonesia	443	5.7	Russia	103	8.8	Korea	126	10.6
5	Australia	421	5.4	Colombia	82	7.0	Taipei	65	5.5
6	Russia	354	4.5	S Africa	72	6.2	Germany	45	3.8
7	S Africa	259	3.3	Kazakhstan	32	2.7	UK	44	3.7
8	Others	1,275	16.3	Others	88	7.5	Others	288	24.2
	Total	7,831	100		1,168	100		1,188	100

Source: IEA, Key World Energy Statistics, 2012

Table 2: Production and imports of coal (MT)

Year	Import	Gr.%	Production	Gr.%	Imp/Supply %*
2002–03	23.3		341.3		6.4
2003–04	21.7	-6.8	361.2	5.9	5.7
2004–05	29	33.5	382.6	5.9	7.1
2005–06	38.6	33.3	407	6.4	8.9
2006–07	43.1	11.6	430.8	5.8	9.3
2007–08	49.8	15.6	457.1	6.1	9.9
2008–09	59	18.5	492.8	7.8	10.7
2009–10	73.3	24.2	532	8.0	12.5
2010–11	68.9	-5.9	532.7	0.1	11.6
2011–12	102.9	49.2	540	1.4	16.1
2012–13	145.8	41.8	557.5	3.3	20.4
2013–14	168.5	15.8	565.4	1.5	22.8

Source: CCO. Supply measured as domestic supply + imports

1 Scope of the paper is limited to aggregate trends. The paper also draws on an earlier working paper on the same subject listed in the references.

India figures prominently at third position accounting for 7.6% of world production. At the same time, India is the third largest importer of coal (Table 1). India also accounts for 7% of global reserves[2]. Total reserves are estimated at 301.5 BT[3], of which, 42% are proved, and balance 47% and 11% are in the inferred and indicated categories respectively. Though reserves of coking coal are meagre, India has significant reserves of non-coking coal (88%). Production of coal in India grew from a little over 341 MT in 2002-03 to over 567 MT in 2013–14. Growth in production in the 10th plan was 5.6% and reached a high of 8% in 2008–09 after which, there was a sharp slowdown and widening of the demand-supply gap. The recent trend points to increasing dependence on imports. Imports increased from 23.3 MT in 2002–03 to 168 MT in 2013–14. Imports in relation to total consumption[4] also increased from 6.4% in 2002–03 to close to 23% in 2013–14 with a fall in 2010–11 (Table 2). Coking coal currently accounts for about 22% of imports in quantity and about 38% in value. Non-coking coal, on the other hand, accounts for over 78% in quantity and about 63% in value terms (Table 3).

Table 3: Share of coking & non coking coal quantity and value

Item	Qty (MT)	Value ₹bill.	Qty %	Value %
2002-03				
Coking coal	12.9	339	55.6	67.5
Non-coking	10.3	163	44.4	32.5
Total	23.3	502	100	100
2013-14				
Coking coal	37.2	351	22.1	37.7
Non-coking	131.2	581	77.9	62.3
Total	168.4	932	100	100

Source: Recent trends in production and import of coal in India, MoC, 2013

2 World Energy Council (2013)
3 As on 1/4/14.
4 Consumption = domestic supply+ import unadjusted for calorific value difference.

India has traditionally imported coking coal due to inadequate reserves. But the striking feature of recent trends is the increase in share of non-coking coal from 44% in 2002–03 to 78% in 2013–14 (Figure 1) which also corresponds to the spurt in imports and is reflected in source imports.

Australia used to be the source of imports for coking coal. While it still accounts for over 80% of coking coal, Indonesia has come to account for 78% of non-coking coal. Therefore, price movements and availability of coal from these sources is of interest from an Indian perspective.

International coal prices have been trending down since 2011 (Figure 2). From a high of USD 180 per MT for Australian 6300 Kcal coal in the run up to the financial crisis in July 2008, spot price crashed to USD 58 by May '09. After an upswing that lasted till January 2011, coal prices declined. Recent data, on price of coal from Australia, South Africa and Indonesia show a decline. The causal factors leading to decline in international prices include - slower global growth (in particular, China) and discovery of shale oil/gas (in US). It can be expected that these factors will keep international prices subdued (Figure 3).

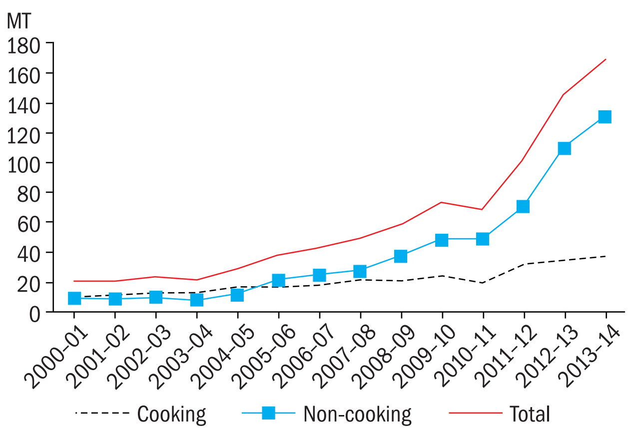

Figure 1: Import of coking and non-coking coal (MT)
Source: CCO, Provisional Coal Statistics, 2013-14

Table 4: Country of import 2013-14 (%)

Country	Coking		Non-coking		Total	
	Qty	Val.	Qty.	Val.	Qty.	Val.
Indonesia	0.2	0.2	78.5	71.9	61.2	44.9
Australia	80.9	81.4	3.6	5.7	20.6	34.3
S. Africa	1.9	1.3	15.2	18.4	12.2	12.0
U S A	7.1	7.3	0.8	1.1	2.2	3.4
New Zealand	3.1	3.1	0.0	0.0	0.7	1.2
Others	6.8	6.7	2.0	2.9	3.1	4.3
Total	100	100	100	100	100	100

Source: Recent trends in production and import of coal in India, MoC, 2013

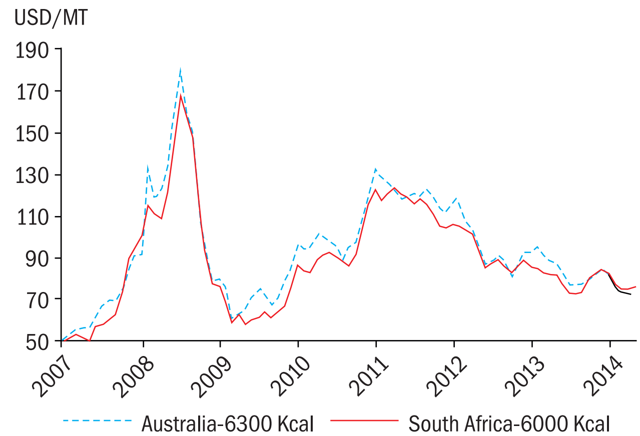

Figure 2: FOB price of thermal coal (2007–14)

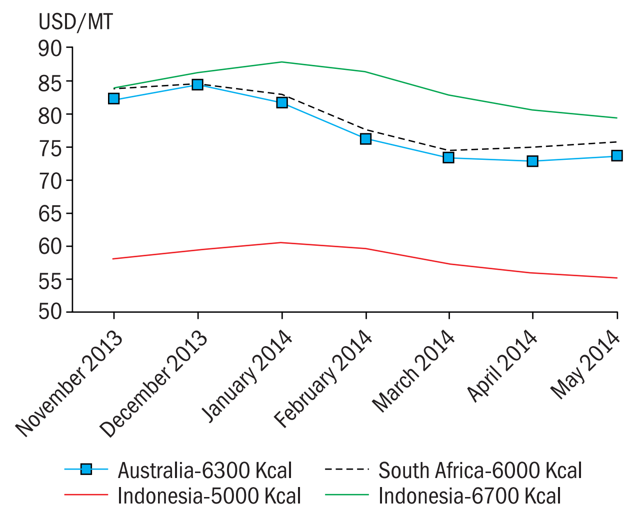

Figure 3: FOB price of thermal coal (USD/MT)
Source: Recent trends in production & import of coal in India, MoC, 2013

Factors Leading to Demand-supply Gap

Import of coal was allowed from 1993-94 when it was put under open general license whereby, users could import coal directly. However, coal imports have figured significantly in total imports only in recent years.
On the demand side, there is a positive correlation between GDP growth and energy demand. Changes in composition of consuming sectors also impacts energy demand. On the supply side, while resource endowment is not a constraint for India, structural and institutional constraints are relevant. This section examines these aspects.

At the macro level, a self-evident factor has been high GDP growth that India witnessed from 2003–04 to 2010–11. Despite a noticeable slowdown from 2011–12, the fact remains that, India witnessed high growth for over a decade, or so, from 2003–04. Virtually all economies (including China) that have witnessed high growth have witnessed a spurt in energy demand (including demand for primary energy). Therefore, there is nothing unique about the Indian experience.

The question really is, what were the changes on demand side from consuming sectors and whether, strategies for energy supply were appropriately coordinated to meet increasing energy needs?

Actual demand, (which includes unsatisfied demand), is difficult to estimate. Hence we make use of coal consumption by sectors and its break-up in terms of indigenous supply and imports for 2002-03 and 2012–13. While recognizing that there is greater certitude about consumption (i.e. indigenous supply + imports), it cannot be equated to demand if there are unsatisfied buyers willing to pay notified or e-auction price for indigenous coal, but, unable to get indigenous or imported coal.

Regardless of the forgoing limitation, it is seen that the decline in share of indigenous coal in total consumption has been across board for most sectors. In the case of coking coal (i.e. steel sector), the ratio of domestic to imported coal which was 58:42 in 2002–03 changed to 33:67 by 2012–13[5]. For non-coking coal for power sector, this ratio changed from 98:2 to 88:12 during the period. For cement, the ratio changed from 78:22 to 59:41. For the omnibus category 'Others' too, the ratio changed from 97.6:2.4 to 69.5:30.5 in 2012–13. The only sector where indigenous coal continued to account for 100% is sponge iron. This trend accentuated further in 2013–14.

Not surprisingly, the power sector which accounted for only 25% of imported coal in 2002–03, came to account for over 45% of the imports in 2012–13. Therefore, the build-up of capacity at the sector level deserves greater scrutiny, especially, for the power sector. Additions to power generation capacity showed a steady upward trend during 1990s till 2004–05. There was a noticeable upturn in coal-based capacity, in 2004–05 that became pronounced in 2006–07 (Figure 4).

5 Figures are not adjusted for difference in calorific values for imported and domestic coal. We recognize that the gap may be higher if such adjustment is made.

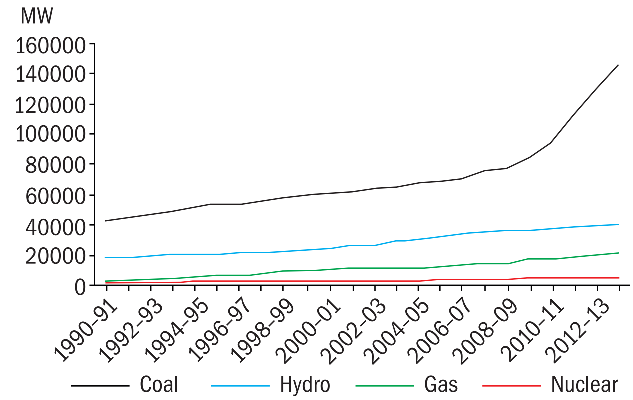

Figure 4: Installed capacity: mode-wise
Source: Based on data from CEA

From 2007–08 to 2011–12, 40,901 MW of coal-based capacity in utilities was added. During 2012–2014, another 33,651 MW was added. This strategy followed the 10th Plan of increasing power generation capacity through private sector and by setting up ultra mega power projects. Projects, especially in coastal districts, were based on imported coal[6]. In that sense, a certain amount of demand for imported coal was built in the energy/power sector strategy adopted. In view of the shortage in domestic coal, power capacities (boilers) also came to be designed for blending of imported and domestic coal.

While coal-based power generation increased, addition to domestic capacity and production of coal stagnated after 2009–10 after touching a high growth of 8% in 2008–09. Growth in coal production collapsed to nil in 2010–11 and recovered, marginally, from 2011–12.

In this context, it is worth enumerating the factors that led to a slowdown in production of coal and non-materialization of capacities in the coal sector in 11th Plan. First, the moratorium due to enforcement of CEPI norms and introduction of 'Go' and 'No-go' areas for projects in this sector resulted in uncertainty for projects in pipeline and slowed down production. Second, the coal sector has faced increasing difficulty in acquiring statutory clearances; acquisition of land and difficulties in R&R. A third problem has been the non-implementation of critical rail links to major coal fields. Coal is a bulk commodity and requires rail links without which production cannot increase.

While coal sector faced constraints, new power capacity addition went on unabated. There were twin pressures to import: first, on account of new plants,

6 12th Five-Year Plan, Chapter 14, 14.27, pp 138

designed on imported coal and second, due to a slowdown in domestic production (and investment) in coal sector. It is therefore not surprising that import of coal rose sharply.

Implications of Production and Import Trends

The rising trend in imports has implications at macro- and micro-economic levels which have been examined further.

Macro level impact: The share of import of coal in total imports appears to be modest at 3.1% in 2012–13, though it is higher than the 2% witnessed in 2002–03. If current account deficit (CAD) is low and easily financed, a rise imports is not of concern. But, if the CAD is persistent and widening, (as in 2012–13), a rise in import of critical fuels (like coal) can be a source of macroeconomic vulnerability.

Micro level impact: A high degree of dependence on imports has implications for end users also. Apart from variation in international prices, landed costs are impacted by exchange rates, charter and bunker prices (PwC 2012). Changes in regulatory regimes in exporting countries can impact availability and cost of coal especially as world exports account for only 13% of global production. Moreover, coal is a bulk commodity and there are costs of switching to new sources. The recent decision by Indonesia to impose limits on export of certain grades of coal is a case in point.

Quality-price-equation and projects: Imported coal, in general, has lower ash (below 15%) and higher GCV (6500 to 3400 Kcal/Kg) compared to indigenous coal. At the same time, domestic coal is cheaper than imported coal of corresponding varieties. However, with global growth remaining subdued and international prices on a downward trend, the possibility of the gap between domestic and international prices narrowing cannot be ruled out. With rising land issues, R&R and operational costs, Indian companies will find their costs rising. Coal companies in India will therefore need to factor in a possible narrowing of the price gap, (if not a reversal) in planning projects.

Supply logistics: Change in relative importance of imported coal across sectors is reflected in the change in the share of ports of unloading of coal which has a bearing on related logistics in terms of coal movement as well as location of end-use plants. This is because much of the rail routes for movement of coal was geared to the coal belt which is on the eastern part of the country.

Policy implications: The mismatch between the pace of expansion in power capacity and with setting up import-based plants, and the pace of clearances for coal production capacity raises questions of policy. First, there are considerations relating to energy security which are rooted in non-economic factors. Even as there is an economic argument for keeping open access to imported coal, on the margin, in order to bridge the demand-supply gap, maintaining a substantial degree of self-reliance in energy is also strategic in its own right. This is more so, given large size of the Indian economy and the fickle nature energy markets.

Second, at the macroeconomic level also, it is clear that domestic production needs to be enhanced to the maximum possible in order to reduce or minimize the CAD, especially as it continues to be financed through borrowed resources.

Third, at sector level, energy and mining sectors (like coal), involve large sunk costs on infrastructure.

Table 5: Import of coal by ports (%)

Port	2002–03	2012–13
Paradip	1.1	12.0
Mundra	3.0	9.9
Krishnapatnam	0.0	9.8
Visakhapatnam	27.8	8.2
Gangavaram	0.0	7.1
Dehej	0.0	5.7
Kolkata	20.7	4.8
Marmagoa	7.5	4.7
Navlakhi	2.3	4.6
New Mangalore	0.0	4.6
Tuticorin	1.3	3.7
Magdalla	0.0	3.4
Chennai	13.7	3.4
Mumbai	2.4	3.2
Kandla	0.9	3.1
Others	19.2	24.0
Total	100.0	100.0

Production resulting from investment takes place with considerable lag and consequences of investment decisions manifest much later. The fact that coal-based power generation capacities outstripped coal production goes to show that some assumptions about use of imported coal and its macroeconomic consequences were not well founded[7], but the impact, came after a lag.

This also raises an important issue of policy coordination across sectors and coherence of action which are the essence of the function of the 'State'. In a regime where capacities were determined through inter-sector consistency models, dovetailing expansion in one sector to another may have been easy, though it is known that from the Indian experience (till 1980s) that there were mismatches and shortages even then. But the developments outlined suggest that even in an economy in the process of being liberalized, overseeing inter-sector consistency remains a critical function of the State.

Possible Way Forward

As far as coal sector is concerned, narrowing of domestic demand-supply gap will require a mix of strategies that address short-to-medium-term imperatives and also technological, institutional and human resource related issues. An immediate step could be of allowing increase in production from existing mines to peak capacity without compromising environmental and safety aspects. The advantage in expanding production from existing mines may be less demanding in terms of investment, design, and procedures. As mines are in operation, environmental, and land acquisition issues may be less daunting. This has already been allowed to happen in a limited way[8]. Obviously, such a measure can only be for the short run.

Another medium-term measure could be that all cost plus mines, including underground mines that are operational or can expand capacity or made operational should be allowed, through special dispensation of a sale through e-auction. Given that the country imports coal at higher cost, the bench mark of 12% IRR used for public sector projects needs revisiting. A fourth and a critical measure that needs to be taken up is speeding up implementation of rail links for coal projects that can step up production but are unable to do so in the absence of infrastructure for evacuation.

Beyond the foregoing measures, for a sharp step up in investment, it needs to be borne in mind that coal mining has had a long legacy of poor and unscientific mining by private sector which brought in the public sector in the first place. The lessons from the past need to borne in mind while devising an appropriate regulatory framework for this sector. At the same time, in order to bring a scalar jump in production, the time may be ripe for permit direct entry of high quality firms from the private sector into commercial mining through upfront legislative changes rather than through captive mining. In economic terms, captive production is an inefficient use of resources. However in bringing in greater participation into commercial mining, it is critical that market incentives of players are well aligned such that market outcomes are the ones that meet requirements of the economy. And this could be done while retaining the preeminent position for the public sector which can continue to play a counterbalancing role and of ensuring energy security. Keeping in view the overriding national economic priority of maintaining macroeconomic balances and energy security, such a measure should be logical sequel to the policy announcements made by the Government from mid-2014[9].

Finally, keeping in view the large sunk costs that characterize the energy sector, investments in this area need to be envisaged within an integrated framework that take into account both renewable and non-renewable forms of energy as also managing the demand side of energy, especially as resource extraction industries will increasingly face environment related challenges globally.

Views expressed are personal.

Bibliography

CEA. 2012. *Report of the Group for Studying range of blending of imported coal with domestic coal.* Government of India.

CSO. 2013. *Energy Statistics.* Government of India.

IEA. 2013. *World Energy Statistics.*

7 On setting up of UMPP in private sector, the 12th Plan document observes that "Unfortunately, some of these projects are plagued with uncertainties regarding fuel supply because they were based on imported coal and changes in government policies in countries where the coal mines were located have raised the cost of coal whereas the power tariff is based on a competitive bid which does not contain a provision for passing on such increases."

8 Ministry of Environment and Forests (2014)

9 Issues arising from Ordinance issued on October 21, 2014 and matters relating to allocation of coal blocks are outside the purview of the paper in view of the scope.

MoC. 2013. Recent Trends in Production and import of coal in India, Working Paper series No. 1/13.

Ministry of Coal, Annual Plans, Various Issues

MoEF. 2014. Guidelines for Environment Clearance for expansion of coal mining projects involving one-time production capacity expansion in existing operation. Government of India.

Planning Commission. 2013. *12th Five-year Plan*. Government of India.

PwC. 2012. *The Indian Coal Sector: Challenges and Future Outlook*. Indian Chamber of Commerce.

Coal Sector Needs Revolutionary Reforms

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The Supreme Court Order Underscores Deep Challenges

The Supreme Court in its order dated September 24, 2014 cancelled 204 coal blocks that were allocated from 1993 till 2010, leaving four, of which two were allocated through tariff-based competitive bidding to Sasan Ultra Mega Power Project (UMPP) and two others to central government-owned companies, NTPC and SAIL (Supreme Court of India 2014). This ended the business uncertainty that had been prevalent for the last couple of years which had led to lower-than-expected investments in coal block explorations and development activities. Some market participants had anticipated the judgement, which is reflected in the relatively lower impact the order had on the stock markets when compared to a similar order on cancelation of 2G spectrum allocation had.

The Context

When coal mines were nationalized in 1971–73 in two phases, the provision for captive coal mining was retained to allow for continuation of coking coal mines then called TISCO, IISCO, and DVC. This one provision led to a series of measures that shaped the coal sector landscape. In 1993, the government allowed captive coal mining for steel, power generation, and coal washing to public and private sector companies. This was extended for cement sector in 1996 and then for coal gasification and liquefaction in 2007. The definition of captive was enhanced further to allow companies that had long-term coal supply contracts for the approved end-users also to be considered eligible for allocation. The ownership of government-owned companies was considered compliant with the Coal Mines Nationalization Act for government dispensation route for commercial mining, which allowed these government-owned agencies to mine coal and sell in the market, which no private company was allowed to do.

The number of coal blocks allocated between 1993 and 2004 reveals that there was not much of demand for coal blocks. The international prices of coal had been rangebound from 1977 till 2003 around US Dollar 25-30 in nominal terms (USEIA 2012). Prices in India could not have been higher than global prices, and hence, the Coal India prices were low too. As a result, coal input costs were not significant portions of the cost structures for steel or cements manufacturing or power generation. The spur in demand from 2003 onwards led to the international prices to peak, analysts however, failed in their assessment of coal prices cooling off and stabilizing at much lower prices than they were trading. Coal miners globally became price makers. This boom was also reflected in the demand for coal in domestic market as the economic growth engine needed more electricity and power generation capacities were added at a brisk pace. Domestic prices rose up too leading to coal accounting for 40–60% of the final cost of manufacturing or power generation. Therefore it made strategic sense to acquire coal assets for price advantages and supply securities.

Evidence of the rush to acquire coal assets became evident in the 2007 round of coal block allocation when the Ministry of Coal received 748 applications for the 16 coal blocks identified for power sector. The 'beauty parade' methodology for allocation was not geared to handle this situation. The applications focused on the development stages of end-use plants, degree of preparedness, size of plant, a few financial parameters of the project developer, and on the extraction plans for the mine. These were to be evaluated by a Screening Committee with memberships from a large number of stakeholders. The degree of competition was so high that it became fairly evident that process would fail and there were questions raised in the aftermath of allocations from all quarters.

The methodology of evaluation was sought to be improved. The economics of captive power generation for the manufacturing of metals like aluminium, copper, lead, and zinc which are totally market-driven were less favoured, just as those merchant power plants which purported to keep a larger portion of their generation capacities free and not tied up with long-term PPAs. The called in applications for allocation of coal blocks for merchant power plants were not considered with the realization that such could open up a potential for profiteering. In the subsequent rounds of allocation, the marking scales were devised for quantifying merits. However, as the Supreme Court order of September 1, 2014 (Supreme Court of India 2014) observes, the breaches were many for consideration as higher in merit for allocation.

The letters of allocation evolved as well. The earlier ones did not mention the risk of de-allocation and did not require bank guarantees which were the norm for allocations from 2008 onwards. The earlier ones did not specify the usage of coal middling and washery rejects and the ownership question of these were left unanswered. While the transfer of ownership of coal block or its leasehold was not permitted, the transfer of equity in the holding company with the power generation asset was not covered. Given these, there were chances that coal blocks could be packaged in some form along with the respective end-use plant and sold in the market.

The challenges of operationalizing these coal blocks soon began to surface. Most companies had no experience and expertise in coal mining. They required consultants even for filling application forms for prospecting licenses and prior approvals for mining leases. Procuring environmental and forest clearances became tougher. Land acquisition turned out to be the most critical milestone, which could not be done phase-wise and all the land had to be acquired at the beginning. Several stakeholders considered mining projects a bonanza and took undue advantages of it. A whole new industry for mine developer and operators (MDO) evolved. The contractors that were engaged in overburden removal earlier saw this as the natural extension in their evolution. Since these were newer concepts, risks were not well understood by the owners and the MDOs, which lead to unbalanced risk sharing. Due to limited market depth, the MDO agreements appeared to be a good business even with such formulations of project responsibilities and risk sharing

The government meanwhile formulated a series of rules to assuage the doubts created by the coal block allocations as well as fears of unrestricted potential for profits. Coal produced from the coal blocks needed regulatory oversight and the power so generated needed to regulate fuel charges. Long-term PPAs with state distribution companies were necessitated. These were in view of the electricity market moving largely to tariff-based competitive bidding models of Case 1 and Case 2 defined by the Electricity Act, 2003, which obviated the role of electricity regulators in the electricity so procured. To augment coal supply, several steps, such as allowing CIL to buy surplus coal from captive coal blocks at notified price, forming a coal bank were spoken about. But the CAG report published in 2012 threw a major spanner in the works.

There were flip flops on the captive coal blocks front, which had the potential to produce surplus coal, which was expressly restricted. However, in the view of widening gap in the demand and supply of coal, largely due to state-owned CIL not being able to augment capacities quickly, some measures to tap the reserves in the allocated coal blocks were required. The proposals ranged from allowing CIL to buy the surplus coal so produced at notified price minus a certain commission, to forming a kind of coal bank where surplus coal supplied to another project could create a credit in coal and could be redeemed later when coal for the project was available from its own sources.

This was when the CAG report was published. Summing up, it can be said that the government tried to fix the problems in the coal sector using labyrinthine policy measures. However, these rules and regulations just added layers of complexity to an already complicated sector. The Coal Mines Nationalization (Amendment) Bill 2000 that sought to impact the fundamental of coal mining business in India languished.

Now the Supreme Court has ruled that all the coal blocks allocated, except those under tariff- based competitive bidding for Ultra Mega Power Projects (UMPPs) are illegal. The findings of the Supreme Court have been anticipated and hence, in the last year there was little progress in investments in the coal blocks. The lack of objectivity and transparency in process of allocation has been accepted and the Government of India formulated a policy and mechanism for auction in 2012 through amendment of the MMRD Act and notification of auction by Competitive Bidding of Coal Mines Rules, 2012. The three coal blocks that were placed for auction in the 2013–14, one each for steel, sponge iron, and cement sector, received lukewarm response.

The Impact

The impact of the Supreme Court Order depends upon the response and the response time of the Government of India. If the producing coal blocks are not re-allocated quickly, the cancellations will have a telling impact on Indian coal imports and power generation in the near term as this additional shortfall in coal availability will have to be made good by imports. Imports are expensive even though coal prices are lower now than in 2012, but these may rise in view of the additional demand from India. The imports will also add to the misery of already congested infrastructure facilities of ports and railways. For reducing the impact of high cost imports on those power plants affected by coal block de-allocation, demand for price pooling is being raised, which may bring its own set of challenges. The idea was mooted earlier in view of difficulties in apportioning physical high-grade imported coal and financial costs of power plants that get their entire supply from domestic sources.

The other significant impact is likely from the fine of ₹295 per tonne of coal mined from the operating mines till March 2015. It may be noted that some of these mines are for power sector, and the coal produced has been utilized for power generation at tariffs approved through electricity regulatory authorities. These electricity utilities will not have any mechanism to recover the penal charges from the consumers and in the case where the coal blocks were not acquired by them through any illegal means, this penal provision can hurt them dearly. Such may be the case for other companies as well even though they may not be in regulated businesses, but where they had not resorted to illegal means to acquire coal blocks that Government of India offered.

The Ordinance 2014

The Coal Mines (Special Provisions) Ordinance, 2014 legally, permits participation from commercial and independent miners in the auction. This certainly is a progressive reform and meets the industry expectation. The Ordinance does this by inserting a clause in the Coal Mines Nationalization Act, 1973 that defines the eligibility for coal mining. It replaces the eligibility restricted thus far for only central government-owned entities to any government-owned and private entities and thus, even the foreign miners with their India-registered arms will be eligible to participate. This will serve the objective of wider participation, and facilitate introduction of better and efficient technology into coal mining sector.

The Need for Reform

The need to restructure coal industry is critical since it will help the power sector meet the expectation of electricity generation and supplies. The immediate priority for the Government of India should be to ensure that coal supplies are enhanced from domestic production and that the investment environment in the power sector improves. The roadmap for opening of coal sector for greater private and foreign participation needs to be drawn, which may include de-nationalization and also creating independent subsidiaries out of Coal India Limited.

The best way forward will be to remove the entry barriers to coal mining and auction the coal blocks through transparent and objective process to independent miners or end users if they desire. Increasing the number of suppliers in the market will not only improve supplies but also make pricing transparent and market driven. It is time that the Coal Mines Nationalization Act is repealed.

The other mechanism for enhancing competition in coal sector that has been mooted is to split Coal India Limited into independent companies. However, looking at the fact that the subsidiaries are still monopolies in their geographies and these subsidiaries were created based on coalfields; the mechanism of competition may not help. It is also noteworthy that the marketing function of Coal India Limited and its subsidiaries are restricted and coal linkages are provided by long-term Standing Linkage Committee (SLC), which is a multi-ministerial and multi-stakeholder body constituted by the Ministry of Coal. Under these circumstances, competitive forces in the proposed liberated subsidiaries will still remain negligible. To make splitting of CIL effective, it needs to be supplemented with large-scale stake sale of each of these subsidiaries; mostly to the public should outright privatization be politically unpalatable. Government may still be in control but large floating public shareholding will enhance accountability of the Boards of Directors and help competition.

Through the transition of coal sector from the current state to one that is more market-oriented with private and foreign participation state, the Coal Regulator may play a crucial role. The framework for the regulator is already in place but needs to be strengthened in scope.

Short-term challenges of the domestic supply of coal will persist since the projects that CIL has planned may need quicker permissions and development of infrastructure for coal evacuation. But a strategic roadmap laid for the turnaround of the sector will pave the way for reducing import dependence and create a vibrant domestic market.

The Pricing Challenge

The pricing of natural resources has been a challenge and Government of India has faced difficulty in oil and natural gas sectors. Coal prices are deregulated but the Government through ownership of CIL and SCCL is still able to control prices. Hence there is no need for regulation as such right now. But when the market opens, and given that there is an acute shortage, prices will need to be regulated till the time market forces stabilize.

Coal sector, when opened, will present a similar challenge of pricing as other natural resources. The facets of the challenge will include the quality of coal, making it a limited market — only to domestic sector, regulations in the electricity sector which is the prime consuming sector, provision for auctioning of coal blocks for allocation, and the challenges of evolving legislations in the areas of environment and social risks mitigations, which will continue to present uncertainties for development and construction of mines.

When these uncertainties exist, the allocation of coal blocks will reflect the risk perception of bidders in the form of bids they place for coal blocks. In view that the prices of the coal they produce may be uncertain, bids can remain low and may not meet the expectations of the Government. Hence, pricing must not be looked at in isolation from the core issue of allocation mechanism for coal blocks.

Coal prices are determined through the mechanism of allocation. The Supreme Court has not prescribed the methodology for auctions and the Government may consider electricity tariff-based competitive bidding for coal blocks that it intends to allocate for power sector as it will serve the objective of affordable power better. Else in the scenario of pass-through of fuel costs, bidding for coal blocks may turn aggressive and may lead to higher electricity tariffs. In case of tariff-based competitive bidding based on coal block allocation, pricing of coal may become an issue of transfer price and cost-plus approach for such transfer price may be appropriate.[1] In other cases, coal should be allowed to be sold at market-determined prices in an equilibrium market condition.

The role of Government should be to restrict the excesses of the market forces that may come into play when there are imbalances in demand and supply. Hence, for the transition period between now and till the time it takes to establish sufficient supplies, there must be a coal regulatory mechanism in place to monitor coal pricing. However, reasonable return must be allowed for the miners keeping in mind mining-specific risks, such as geological, geo-technical, quality, and quantity risks which are unique to mining businesses.

The proposal for Coal Regulator has been mooted since 2008 especially since differences in opinion about the scope of its powers have led to delays in its constitution. There is no denying the fact that coal block allocations and pricing regulations must form the two most critical parts of its functions. For the others, such as monitoring of projects and such others, Coal Controllers' Organization exists and Government may merge it with the Coal Regulator to avoid numerous authorities in the sector.

Long-term Vision

While the Coal Mines (Special Provisions) Ordinance, 2014, legally permits participation from commercial and independent miners in the auction, the Government through the tender/auction terms and conditions may still regulate the participation. The inclination of the Government for captive consumers in the initial round may not yield desired results as has been the experience from the past, and hence, it may be better to allow independent miners with a sound regulatory regime to control prices. This may ensure quicker development and efficient and sustainable operations of coal mines.

It may be one thing to legally permit and invite participation from innovative technology providers and creative entrepreneurs and quite another to see

1 The government has issued guidelines for the bidding process which includes the pricing mechanism for the auction. According to this, there will be two types of bidding process. Coal blocks for the non-regulated sectors comprising iron, steel, generation of power for captive use and cement shall use forward bidding while blocks where specified end-use is power shall use Reverse Bidding. For further clarification, refer to the Paper on auctioning of coal mines under Coal Mines (Special Provisions) Ordinance, 2014.

them invest. The foreign direct investments have been opened in the sector for a while with negligible foreign investments actually being made. It needs to be understood that for investments, Indian coal mining projects will compete with projects in Australia, Indonesia, South Africa, Canada, Mozambique, and several other countries. Ease of doing business needs to be improved. Transparency in clearances and approvals, which limit scope of bribery, through electronic systems for applications and approvals needs to be implemented. Foreign companies have stricter compliance requirements and the permit mechanism in India needs to address these concerns.

For economies of scale, India needs to create coal blocks of sizes that can sustain production capacities upwards of 30–40 million tonne per annum. Blocks prepared by CMPDIL restrict production to 1–2 million tonnes per annum in open-cast mining which may not provide economies of scale for foreign investors. Upon blocking, accurate data needs to be provided for assessment of resources and reserves, quality of coal, geo-technical parameters, and topographical features, including land use details so that the investors can make a prudent judgement call on the risk-profile of projects. The roadmap for these preparatory works must be built into national inventory recognition system for long term sustainability of the sector.

On long-term blue print for coal sector, the Ordinance does not offer much. There is a need to look at streamlining hydrocarbon resource policies. Coal, coal bed methane, coal gasification, coal liquefaction, underground gasification and even shale gas from a tenement must be governed under one uniform framework if all these resources are available and commercially viable from the same tenement. Creation of such a framework will need different arms of the Government and regulatory agencies to work together in the same direction to tap abundant coal for energy security in India.

Sustainability is another key approach that requires a long-term plan and coordinated efforts between several key stakeholders within the Government. The policy makers on mining and environment, labour, land, social responsibility, and such others need to create a homogeneous system for project development in sustainable manner, with none of the important concerns compromised for want of an appropriate policy or procedural framework. As of now, depending upon the political expediency, the sustainability concerns swing from one extreme to another.

Conclusion

The coal sector will continue to play a crucial role in the energy security of India and therefore it needs a major thrust to reform existing policy measures. The recently promulgated Ordinance does address the needs for now but the Government must come up with a blue print for long-term sustainable development of the sector. The current requirement of continued production and reduced dependence on imported coal are significant but for longer term, India needs to look at enhanced efficiencies, better technologies, optimal utilization of resources, and creating a vibrant market for the co-existence of a large number of participants. For that the government as well as the industry needs to dig deeper.

Bibliography

Manohar Lal Sharma VS The Principal Secretary & Ors, Writ Petition no. 120 of 2012 (Supreme Court September 2014).

Ministry of Coal. 2007. *New Coal Distribution Policy*. Government of India.

Ministry of Coal. 2014. *Approach Paper for Auctioning of Coal Mines* . Government of India.

Ministry of Coal. 2014. *Draft for Public Consultation: The Coal Mines (Special Provisions) Rules, 2014* . Government of India.

Ministry of Coal. 2014. The Coal Mines (Special Provisions) Ordinance. Government of India.

USEIA. 2012. *Annual Energy Review 2011*.

The Dynamics of Transporting Black Diamond

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Introduction

The process of coal formation is called 'Carbonization', which is a slow process of conversion of dead vegetation, under conditions of high pressure and high temperature, into coal. The distribution, extent, and underlying reserves of coalfields are decided by definite geological parameters. Coalfields are naturally located over undulating terrain, mainly in deep forest areas with inclement weather, inhospitable for any dense population.

The determinants of the location of thermal powerhouses—the major consumption point of coal are: the availability of sufficient water, skilled and semi-skilled labour and importantly, proximity to dense population or dense industrial cluster with growing demands for domestic and industrial power consumption. This is the reason why thermal power plants cannot always be based at the pit-head. The potential 'transmission loss' is another important factor that goes in favour of locating thermal power plants amidst dense domestic and industrial clusters. Therefore, this necessitates coal transport from the mines to the points of consumption.

The transportation of coal from its production point and to its consumption point is a major challenge and this is where the railways step into the scene. Railways are heavy bulk carriers and their potential cannot be as yet matched by any other mode of transportation, which is why most economics eventually weigh in favour of railways. This paper seeks to highlight the importance of railways for coal transportation. It looks into the logjam that is being caused due to insufficient rakes and lines and analyses the reasons behind this issue. It also lays the groundwork for resolving existing issues as a stepping stone towards rationalization.

Coal Transportation: A Brief History

Railway lines to transport coal have a long history. Such lines were initially laid by the British Empire in India, the first of which being the Calcutta — Raniganj line, which was primarily laid to evacuate and transport coal from Raniganj coalfields. The discovery of coal near Jharia led to the construction of a short-branched line from Sitarampur to Dhanbad in 1880. In 1888–89, a route was determined from Dhanbad to Mughalsarai to Gomoh to Koderma and finally Gaya. The then Viceroy, Lord Minto inaugurated this 'New Line' called the 'Grand Chord' on December 6, 1906 by inserting a silver fish bolt with a silver spanner in a glittering ceremony at Gujhandi. This 281 miles long line laid at the cost of ₹4.15 cr. was a 'chord' to the mainline via Jhajha and Luckeesarai and it reduced the lead for coal from Jharia coalfields to North India by 110 miles as it would no longer be necessary to take a detour via Sitarampur. It was a freight line and coal was transported from Eastern and Central Indian Coalfields to the 'up country' powerhouses through the 10,052 ft. long Sone bridge, then the second longest railway bridge in the world falling short of the Tay bridge near Dundeee by 455 ft.

The transportation of coal continued unhindered and in 2012–13, with continuous operating innovations and technological inputs the railways notched freight loading level of 1000 MT. Of this, coal transportation amounted to 496 MT, a major jump from 271 MT in 2004–05, thereby aiding India's energy scenario.

A Few Key Issues and Facts about Coal Transport via Railway

- Coal is and will continue to be the mainstay of Indian Railways. If railways are 'lifeline' of the nation, coal is its 'soul'.
- With the present level of technology, railways are the most economical option for the coal sector.
- The movement of coal along the main 'arterial routes' – the 7 HDNs (High Density Network) will be sluggish and meandering with their inceasing saturation levels due to induction of more passenger trains and demand for the movement of more freight traffic.
- 'Capacity augmentation' will be the major challenge for the Indian Railways, which will require a sustained inflow of large amount of funds since

track laying is highly capital intensive (one km of new line costs almost ₹15-20 cr with electrification).

- This funding cannot be managed through internal generation by the railways alone. All over the world the funding has come from outside — Government or Public.
- Coal and power sector will have to put in funds in track and allied infrastructure and also in small projects of yard modifications and faster loading and onloading mechanisms for faster evacuation and transportation of coal. It cannot be neglected as the responsibility of the Indian Railways alone.
- Special care should be taken so that in the entire spectrum of initiative the first and last mile connectivity is not left out.
- A strong and carefully crafted policy framework ought to be put in place for garnering more resources, enabling the implementing authorities, tiding over the crisis of clearances mainly environmental and land acquisition issues. All these could develop mutual trust and a comfort zone required for better transportation.

Table 1: Major projects by the railways

Sr. No.	Name of the project	Executing Agency
1.	Tori–Shivpur New BG line	Construction Department of ECR
2.	Shivpur –Kathautia.	Construction Departmentof ECR
3.	Coal connectivity projects in Mand area in SECR	IRCON
4.	Private siding on private land between Jharsuguda–Barpalli–Sardega including Dhutra to serve MCL in CKP Division.	Construction Department of SER
5.	Piparwar railway siding of CCL	RITES
6.	Ashoka siding of CCL	Construction Departmentof ECR
7.	Shivpur–Chatti Bariatu (14 km) and Hazaribagh–Banadag (9 km) sidings	Construction Department of ECR
8.	Koderma–Hazaribagh–Barkakana–Ranchi new line (189 km)	Construction Department of ECR
9.	Koderma–Tillaiya new line (64 km)	Construction Department of ECR
10.	Diversion of fire affected railway lines in Jharia area of BCCL	Construction Department of ECR and SER
11.	Angul-Talcher bulb line	ECoR
12.	Rail corridor connecting Angul–Talcher line	RITES
13.	Rail connectivity project from Bhadrachalam to Sattupalli new line project (56.25 km)	Construction Department of SCR
14.	Additional link from Vasundhara area with SECR's network	SECR

It has been accepted that 31 'Coal Connectivity Projects' jointly identified by the Ministry of Coal, Ministry of Power, and Ministry of Railway are critical for evacuation and transportation of 615 MT of coal production target by 2016–17. The incremental production of Mahanadi Coalfields Limited is significant for Andhra Pradesh, Tamil Nadu and Karnataka and Raigarh and Mand area of Chhatisgarh for Rajasthan, Maharashtra and Gujarat. The ultimate objective of these 'Coal Connects' are to substantially increase coal availability, improve power scenario and provide energy security, enhance freight loading and increase the revenue of railways as also enhance incremental revenue of states.

Table 2: Minor projects by the railways

Sr. No.	Name of the project	Executing Agency
1.	Renovation of Chainpur–Sarubera siding	Dhanbad Division
2.	Completion of balance work of Dhori siding of CCL	Dhanbad Division
3.	Improvement of DudhiChua siding of NCL	Dhanbad Division
4.	Modification of DudhiChua Yard for 2nd silo of NCL	RITES
5.	New railway siding for Block B project of NCL	RITES
6.	Complete track renewal at Shaktinagar to Jayant silo of NCL including improvement to Jayant and Spur siding	RITES
7.	Balance work of KBJ railway line between Krishnashila and Shaktinagar railway station	RITES
8.	PRL system Amlohri and Nigahi	RITES
9.	Krishanshila railway siding	RITES
10.	Construction of railway siding at Lakhanpur Coalfields of Bishrampur area	RITES
11.	New railway siding at Kusmunda area.	RITES
12.	Construction of new siding parallel to old siding at Bhatgaon area	RITES
13.	Survey work for finalization of alignment for Magadh and Amarpali railway siding.	
14.	Renovation of CP siding of Giridih of B&K area.	ER
15.	Renovation of Swang siding in Adra division and Jarandih railway siding of CCL under Dhanbad division.	SER and ECR
16.	Temporary connectivity of Lingaraj siding with Talcher main line.	RITES
17.	Provision of 2nd siding at Himgir station, Kanika.	RITES

Table 3: Projects undertaken by different divisions

Sr. No.	Railway	No. of Projects
1.	ECR	18
2.	SECR	06
3.	ECOR	03
4.	ER	01
5.	SER	01
6.	SCR	01
7.	SCR+ECR	01

Table 4: Projects undertaken by different subsidiaries of CIL

Sr. No.	Coal Subsidiary	No. of Projects
1.	CCL	12
2.	NCL	07
3.	SECL	05
4.	MCL	05
5.	BCCL	01
6.	SCCL	01

Coal Connectivity Projects

The three projects most critical and significant for coal transportation are as follows:

- Tori–Shivpur–Kathautia Railway Line in North Karanpura in Jharkhand
- Jharsuguda–Barpalli–Sardega Railway Line (53 kms) in Ib Valley, Odisha
- Bhupdevpur–Korichapar–Dharamjaigarh (180 kms) in Mand–Raigarh coalfield, Chhattisgarh

These projects are being monitored at the highest level. The first two are being implemented by railways and the third one by JV with 26% equity of IRCON.

The Railway Ministry maintains that it has all the determination and wherewithal for timely execution of these projects. They have been sensitizing other concerned ministries, such as Coal, Power and Environment and Forests and PSUs and the concerned State governments and the good offices of PMO through the mechanism of status reports and 'DO' letters. The ultimate objective has been time bound completion of the Critical Coal Connectivity Projects. The details of these projects as well as reasons which are hampering their completion are listed as under.

Table 5: Critical projects for coal transportation

Sr. No.	Name of Project	Coal Field	Coal Subsidiary Co.	State	Dist.	Cost (₹/ Cr)
1A.	Tori-Shivpur -Kathautia	North Karanpura	CCL	Jharkhand	44	1,588
1B.	Shivpur -Kathautia	North Karanpura	CCL	Jharkhand	53	NA
2.	Jharsuguda-Sardega	IB Valley	MCL	Odisha	53	1,597
3.	Bhupdeopur-Korichappar-Baroud	Mand-Raigarh	SECL	Chhattisgarh	64	NA

1A. Tori–Shivpur connectivity

This is a 44 km railway line of East Central Railway being executed at a cost of ₹1,588 cr to serve the North Karanpura Coalfields of CCL in Jharkhand. It is expected to evacuate 40 MT of coal annually. The total land required is 1,038 acres. The division received Stage II forest clearance in June 2013 as also a relaxation in night time restrictions (00 hrs to 0500 hrs) on train operation from MoEF recently. But land acquisition has been problematic as the government of Jharkhand has not handed over the required land to the railways. The major issues hampering this project are given below:

- Transfer and physical possession of 55% of land from State Government of Jharkhand is pending.
- The current available land is also in small and non-continuous stretches due to which construction cannot be started. Contractors are threatening legal action if land is not available for execution of work.
- Frequent change in the ownership of land is a major issue.
- This project was expected to be completed by July 2017, subject to all land made available by September 2014. Therefore any delay will impact the timelines accordingly.

1B. Shivpur–Kathautia

This is a 53 km railway line in North Karanpura in Jharkhand being executed as 'Deposit Work' of Central Coalfields Ltd (CCL). It is expected to give a coal output of 20 MT annually from North Karanpura of CCL. The major issues involved are:

- Identification of different land types by state government of Jharkhand for expeditious processing of forestry clearances. The government of Jharkhand needs to give an NOC for Government Jungle Jhari land for filing Stage I forestry clearance.
- Nearly, 1,296 acres of land in Chatra and Hazaribagh districts to be acquired and handed over to railways.

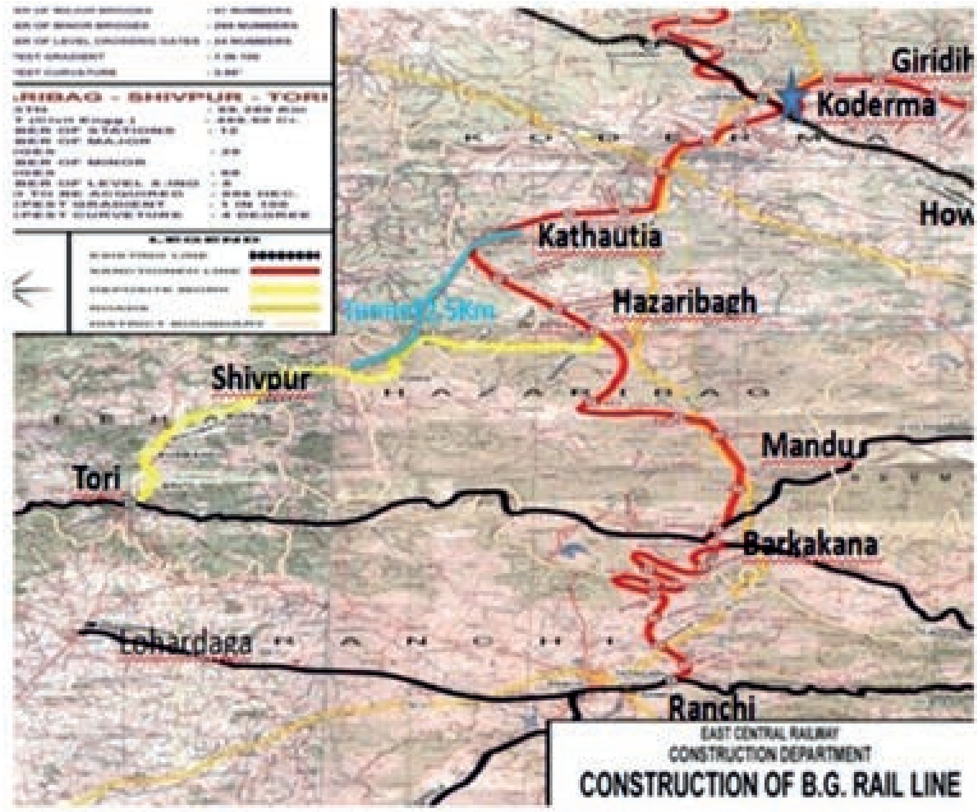

Figure 1: Route of the Tori–Shivpur line
Source: From the official document of the construction of the ECR

Figure 2: Route of the Tori–Shivpur–Kathautia line
Source: From the official document of the construction of the ECR

Table 6: Status of land for the Tori–Shivpur–Kathautia line (as on August 2014)

Type of Land	Requisitioned	Acquired/Handed over (acres)	Yet to be acquired/ handed over	Remarks
Forest	256.945	256.945	Nil	Government of Jharkhand accorded approval for diversion on 26.02.2014. Tree cutting is in progress.
Government Jungle Jhari	156.54	Nil	156.54	Not yet transferred
Government	180.05	Nil	180.05	Not yet transferred
Raiyati	444.31	206.33	237.98	To be obtained
Total	1037.85	463.275	574.57	55% (approx.) area yet to be given

Railways have already filed applications from December 2012 to March 2013.

- Project is expected to be completed three years after getting forest clearance and land for construction.

This has been a classic case of delay and is often cited as a case study in railway training institutes as example of time and cost overruns. It came for the first time to the railways in 2005 and has been facing rough weather on account of clearances. Initially, it was stalled as its alignment was running through a 'Reserve Forest'. The entire stretch was realigned since the MoEF did not approve the original Shivpur–Hazaribag alignment and therefore, the Shivpur–Kathautiya alignment was firmed up as an alternate alignment causing enormous delay.

The Stage I clearance was given with severe restrictions such as no 'splits' or station on the entire 44 km long line and that working during the night was not allowed on the grounds that it might disturb the wildlife. This project further determines the tremendous lack of co-ordination and also reflects poorly on our planning.

2. Jharsuguda–Barpalli–Sardega railway line (53 kms)

This 53 km line is being executed at a cost of ₹1,597 cr on 'deposit terms' of MCL and takes off from Jharsuguda–FCI–Shunting neck & terminates at buffer end at Sardega and includes the Dhutra connection. It passes through twenty-four villages, two tehsils i.e. Jharsuguda and Hemgir and two forest divisions i.e. Sambalpur and Sundergarh of Jharsuguda and Sundergarh districts. The expected coal output is 35 MTPA, to start with, from Gopalpur–Manoharpur Blocks Ib valley fields, finally touching up to 60 MT of coal. This project has been executed in suitable phases from the point of view of functional requirement and from execution angle. The phases are as follows:

- Phase I (Part I)–Jharsuguda–Barpali single line (42 Kms) with connection at Jharsuguda and Barpali loading Bulb will be executed.
- Phase I (Part II) – Barpali – Sardega single line (8 Kms) and Doubling of Jharsuguda - Barpali will be executed.
- Phase II–Flyover connectivity at Jharsuguda and Dhutra plus coaching and relief yard augmentation has been proposed.

The major issues are:

- Felling of 1000 trees by end of 2014.
- Shifting of seven high tension transmission lines by Odisha state government and two by Power Grid Corporation of India Ltd by November 2014. Odisha Government needs to give a fresh tender document cost (TDC) by March 2015.
- Power connection to Traction Sub-Station (TSS) by OPTCL (Odisha Power Transmission Corporation Limited).
- Compensation for trees on private land.
- Fresh private land acquisition — due to incomplete up-dation of revenue land records, some of the plots falling in the alignment could not be identified for acquisition initially. MCL has to acquire 14 acres of land.
- Demand of compensation for trees on non-forest government land.
- Villagers in Panchpara, Kantapali, Deogan village in Jharsuguda district and Laikera Barpalli and Bandhapali district of Sundergargh are protesting the construction of the line.
- MCL still needs to acquire land for Barpalli bulb and hand it over to railways for construction of loading lines.

Table 7: Status of land for the Jharsuguda–Barpalli–Sardega railway line

Type of land	Private	Govt.	Forest	Total
Total length	(22.7 km) 54%	(10.7 km) 25%	(8.7 km) 21%	42.1 km
Total available for construction	(22.7 km) 100%	(10.7 km) 100%	(8.7 km) 100%	42.1 km
Balance	14 acre	-	-	-

- Stage II Forest clearance was received only in June 2014 after 8 years.
- Project completion by June 2016 to be delayed due to the aforementioned problems.

3. Bhupdevpur/Kharsia-Korichapar/Dharam-jaigarh line (64 km/104 km)

For this project the railways entered into an MoU with Chhattisgarh Government on 27.02.2012 since

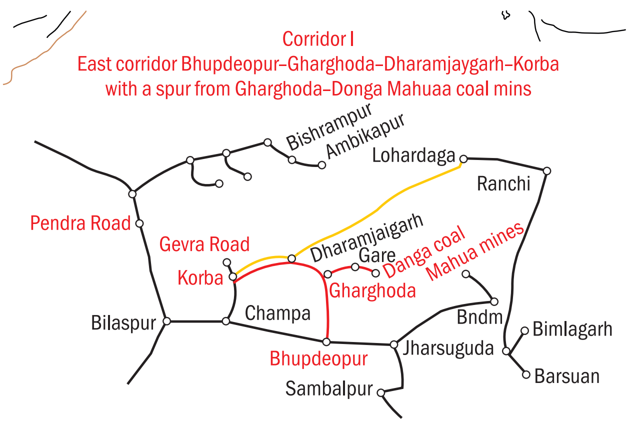

Figure 3: Route of the Corridor I of the Bhupdevpur/Kharsia–Korichapar/Dharamjaigarh line
Source: From the official document of the construction of the ECR

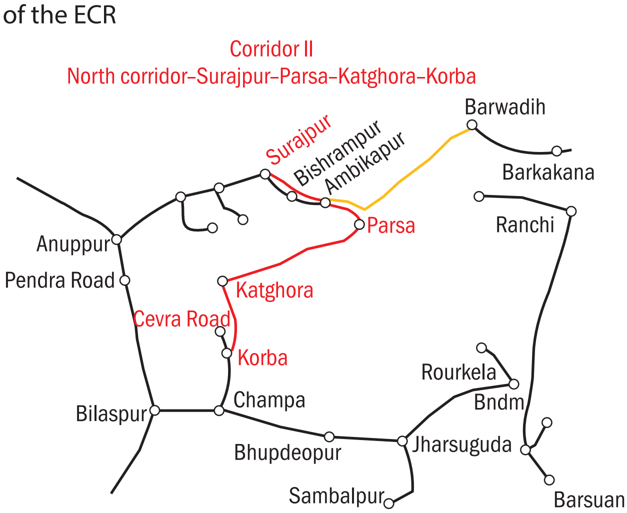

Figure 4: Route of the Corridor II of the Bhupdevpur/Kharsia-Korichapar/Dharamjaigarh line
Source: From the official document of the construction of the ECR

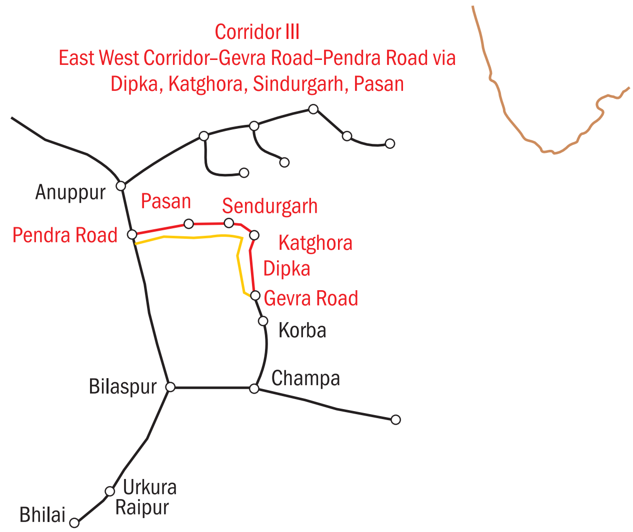

Figure 5: Route of the Corridor III of the Bhupdevpur/Kharsia–Korichapar/Dharamjaigarh line
Source: From the official document of the construction of the ECR

it made sense for the states to be a part of the overall implementation and strategy. Moreover, their role made it easier for the railways to acquire land. As per the MoU, three corridors—East, North and East-West Corridor— were to be laid under SPV route with equity from government of Chattisgarh (10%), SECL (64%) and IRCON (26%). The Raigarh–Mand coal fields of SECL are expected to give an output of 60 MT annually.

The major highlights of the project are as follows:

- Stage I clearance still to be filed by government of Chhattisgarh.
- TDC for handing over government and private land is January 31, 2015.
- The project was expected to be completed in September 2016 subject to forest clearance, land acquisition and handing over of land to railways for execution of work by 2014. However, as of January 2015, since the land has still not been handed over to the railways, the project completion is expected to be delayed.

To accelerate the construction of new lines the Railway Ministry introduced a new PPP policy on December 10, 2012. This policy (Ministry of Railways 2012) postulates the following five models:

- Non-goverment railway model which will be applicable for first and last mile connectivity projects at either end of the rail transportation.

- JV model applicable for new line and gauge conversion projects which are either sanctioned or proposed or to be sanctioned having clearly identifiable stake holders as users or utilities.
- Railway projects on BOT awarded through competitive bidding applicable to sanctioned projects where it is not possible to identify a stakeholder or strategic investor.
- Capacity Augmentation model which deals with expanding the rail lines (doubling/multiple) with funding provided by customers.
- Capacity Augmentation – Annuity model applicable to sanctioned expansion of rail lines (doubling/ multiple) where it may not be possible to find funding from any specific user.

Transportation of Imported Coal

Transporting imported coal has assumed great significance off late primarily because of three reasons:

- Domestic production is not enough to meet the demand.
- Imported coal, having higher calorific value, blends well with the domestic coal and the economics is also favourable.
- Governments abroad are attracting investment to take care of recessionary trends.
- Proposed power plants are located closer to the ports.

The Ministry of Railways has formulated a 'Coal Logistic Plan' mainly from 2010 onwards, wherein power plants have been clubbed with 'recommended' and 'exigency' ports. The idea is to enable evacuation and transportation of coal through less congested routes that can save detention to wagons and ensure timely supply. It becomes economical to ship coal from countries East of India to the Eastern Coast from where they can be taken to the nearby power plants in states closer to the Eastern Coast, (mainly Orissa, Andhra Pradesh, and Chhattisgarh) so that they can take advantage of both domestic and imported coal and reduce their unit cost of production. These power plants are against the recommendation to use the ports of Western Coast as the long distance will make their unit cost of production non-competitive.

As a national carrier, it is not desirable on part of railways to negate or 'guide' the route of traffic other than the shortest route except in emergency cases. Several private studies have been done wherein it has been attempted to establish that either the capacity actually exists for bringing coal on the ports of the Eastern Coast to feed the nearby power plants or with minor investment, capacity augmentation and de-bottlenecking can be achieved. There are several tested methods of capacity augmentation — increasing speeds, removal of permanent speed restrictions, tightening of master charting, splitting of block sections, auto-signaling, yard modifications, time-tabling including altering the time of a few 'bad runners'— to name a few. It is advisable to revisit the coal logistic plan and if need be, additional capacity may be created with funding commitment from stakeholders.

Conclusion

In sum, the major issues concerning coal transportation are environmental clearances, land acquisition, and proper planning. Different countries have solved these problems in their own ways ranging from special courts, such as forest and land courts of China, to involvement of local self-government and 'Prefectures' in Japan. India has to work out a customized model so that the projects are completed in a time-bound manner. It requires a strong political will, administrative commitment, and nationalistic verve — and what Tagore wrote 'Where the clear stream of reason has not lost its way'.

Bibliography

Ministry of Railways. 2012. *Participative model for rail-connectivity and capacity augmentation projects.* Government of India.

Integrating Sustainable Environmental Practices into Coal Mining

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Introduction

A major coal mining company in the Jharia Coalfield (JCF), Bharat Coking Coal Limited (BCCL) is the first amongst many companies formed by Government of India to take over operations of coal mines when the industry was nationalized during 1971 to 1973. All 398 (214 coking and 184 non-coking) mines were nationalized and placed under the management of BCCL. BCCL reorganized the mines into 103 mines placed under 12 administrative areas including 65 Operating Mines at present. The company also operates 6 coking coal washeries, 2 non-coking/NLW coal washeries. With majority of its operations in JCF (273 sq. km in area), it also operates in Raniganj coalfield (32 sq. km). The company is major source of energy and income generation in the region. The coal mining activities in Jharia Coalfield started as early as 1890 and by 1895 the Eastern Indian Railway extended their Howrah–Barakar line upto Katrasgarh. By 1901, Bengal Nagpur Railway extended their line from Midnapur to Gomoh. This expansion of railway lines to Jharia coalfield gave the required impetus to the industry.

Previously, when the surface was not densely populated, mine operators extracted as much coal in the upper coal horizons without stowing or supporting. Overtime, with the growing commercial importance of Asansol/Jharia sub-divisions, several townships have come up in the area that continue to expand, despite some of the areas falling in the zones declared unsafe and/or affected with fire. Erstwhile private companies carried out mining with a primary motive of profit-making without any regard to safety, conservation or environment. Consequently, this 'slaughter mining' in the JCF resulted in severe land degradation, subsidence, mine fires, and other socio-environmental problems.

Environmental Hazards of Coal Mining

Coal mining is associated with a number of environmental hazards. Degradation of land especially in Open Cast (OC) mines is most important. Air pollution, noise pollution, and depletion and pollution of water are the other associated hazards. Poor mining practices often lead to coal fire, releasing fly ash and smoke laden with greenhouse gases and toxic chemicals. Burning for decades, the fires also release coal mine methane. Socio-economic impact due to displacement of habitants is also an important aspect.

Environmental Issues of Jharia Coalfields

Coal mines of BCCL have some unique inherent and perennial characteristics which adversely affects the normal operation of the company.

- Land degradation due to unscientific pre-nationalization mining practices, abandoned quarries, overburdened dumps, degraded soil, mine fires, and subsidence etc., increase potential danger to railway lines, river/jores, roads, houses, and inhabitants.
- Unstable working areas, such as under-sized pillars, unstowed voids, shallow cover workings, widened and heightened workings.
- Large number of surface and underground water bodies in developed/abandoned workings in upper seams are potential sources of danger for working of the lower seams.
- Difficult geo-mining conditions due to closely-spaced 46 coal horizons with 20 workable seams.
- Highly gassy coal seams prone to spontaneous heating.
- Air pollution problems due to emissions from mine fires, private coke plants, mining operations, domestic fuel burning, transportation, and vehicular emissions.
- Dense population (about 2500/sq. km) around coalfields with occupants living for over a century, even on fire and subsidence prone areas.

Liquidation of Century Old Jharia Mine Fires by Strategic Plan

The first incidence of fire in Jharia coalfield was reported in 1916, from the XIV seam of Bhowrah colliery. The mine fire was attributed to the presence of closely-spaced multi-seam, multi-section workings creating a complex scenario causing dynamic and multidirectional fire advances. The selective and haphazard mining without adequate care to safety and conservation procedures by erstwhile private mine operators led to an outbreak of a number of fires that spread across large areas. The fires more often lead to formation of a number of surface and underground water bodies in developed or abandoned workings thus endangering and preventing workings in such mines. Such conditions along with high population density in the coalfield affect suitable exploitation of coal and in turn the profitability of the company. For instance, BCCL was referred to the Board for Industrial and Financial Reconstruction (BIFR) as a sick company with it net worth falling to negative in 1995, recovering in December 1997 and thereafter referred again in 2001.

As per investigations made after nationalization (1973), 70 fires were known to exist in JCF, covering an area of 17.32 sq. km. Subsequently, 7 more fires were identified making the total tally of fires to 77. These fires could not be controlled even after spending more than ₹100 cr through various methods like sand flushing, chemical treatment, blanketing etc.

In 2008, BCCL prepared and adopted an innovative strategic plan that addressed the issue of multiple-seam mining. Areas that were unstable and waterlogged were excavated through open cast mining, within the available land. The coal seam underlying the open-casted area would then be free from any danger of fire or inundation and then further extraction could take place through highly mechanized processes of underground mining. Given the plan, the requisite production growth for performance turnaround, despite the non-availability of land, seemed feasible. This strategy was implemented with remarkable success. The fire-prone area as per latest report of NRSC, ISRO, Department of Space, Hyderabad, has reduced to 2.18 sq. km. The revised plan based on this strategy proved to be successful in turning around the fortune of the company. As per the revised plan, BCCL was expected to come out of BIFR by 2013–14; however, it succeeded to turn net worth positive by 2nd quarter of 2012–13 itself. BCCL has also earned cumulative profit of ₹6,508 cr (Profit after Tax of ₹5,923 cr) over the last five years, contributing to the national treasury. Fire excavation resulted in the recovery of valuable coal which otherwise would have been lost forever. It has recovered coal locked in thick seams previously extracted through inefficient techniques giving way to efficient mining and mass production promoting conservation, at lower seams. In addition, the reduction of fire areas at the JCF has also greatly contributed to the reduction in Greenhouse Gas emissions from the coalfield and thus reducing carbon foot print as a whole.

A 'master plan for dealing with fires and subsidence and rehabilitation in the Leasehold of BCCL', approved by the Government of India in 2009 is under implementation. As per the plan, evacuation from all the 595 fire and subsidence affected sites would be done by construction and rehabilitation of 79,159 houses.

Figure 1: Digging out fire is the ultimate method all over the world to extinguish coal mine fire

Figure 2: Isolation of fire from endangered railway line by trench cutting

Figure 3: Demonstration R&R township-bird's eye view

Figure 4: A vibrant R&R township at Belgaria

Ecological Restoration

Biological reclamation i.e. plantation or afforestation by BCCL has been carried out mostly by large-scale plantation on subsided land, surface areas affected by fires and overburden (OB) dumps, and also in colonies and along the coalfield roads thus reclaiming 3,460 hectares of degraded land. BCCL has planted more than 25 lakh trees since 1997–98 which can be considered as carbon sequestration of 62.5 thousand tonnes per year. Previously under State Forest Department's stipulations, mining companies undertook single-tier, block plantation consisting of a handful of species, which neither catered to the restoration of the degraded land nor to the use of the local community.

BCCL is the pioneer company in the coal industry for starting ecological restoration of degraded areas. It is the first company to prepare a roadmap of eco restoration and implementing the same through a model eco-restoration in association with experts in this field like Forest Research Institute (FRI) Dehradun. Eco-restoration is basically a process which is ecologically, economically, and socially acceptable and provides

Figure 5: Mono culture, single-tier species with no diversity

Figure 6: 3-tier plantation with native species and biodiversity

short circuit to natural recovery of environment of the area. Restoration is the process of assisting with the recovery of an ecosystem that has been degraded, damaged, or destroyed by re-establishing its structural characteristics, species composition, and ecological processes. Biodiversity of flora and fauna is the essence of ecological restoration. The work of ecological restoration consists of three-tier plantation of native species for establishing natural forest i.e. grass, shrubs, and trees. It will attract the forest eco-system including food chains.

Ecological Restoration vs Plantation

- Ecological restoration involves three-tier plantations with native species consisting of lower-level grasses and bushes, middle-level shrubs and top-level trees. The objective being establishing a natural forest eco-system with biodiversity and to bring back original normalcy of function, structure, potential, service, and process of eco-system.

- The earlier practice of plantation adopted by BCCL through the state forest department was of single-tier and mono culture. This method while creating a green cover, does not establish biodiversity of species.
- Eco-restoration differs from plantation that it tries to restore the original biodiversity and ecosystem processes that existed before the degradation or disturbance.
- BCCL developed eco-restoration model at Tetulmari OB Dump (8 ha) through FRI which has been completed in July 2014 and another pilot project undertaken at Damoda over two dumps (7 ha). The results of both the model eco-restoration sites are noteworthy.

In addition to training its own employees, BCCL also arranged training of local villagers and unemployed youth in ecological restoration methods through FRI scientists, with the objective for creating livelihood opportunities to the unemployed youth of Dhanbad district as well as upgrading the surrounding environment through ecological restoration.

Seeing the success of the pilot projects, BCCL has taken up eco-restoration for 44 ha by utilizing the surplus manpower. The results are very encouraging and promising. BCCL plans to ecologically restore about 225 ha of mined out land in the next 5 years. This innovative endeavour in the coal mining industry taken up by BCCL has been widely appreciated by the authorities like that of MoEF; CIL; Singareni Collieries Company; State Pollution Control Board and various other dignitaries, academicians, experts and media like DD, Rajya Sabha TV, National Geographic Channel, Outlook, Indian Express.

Figure 7: Training of BCCL personnel at FRI, Dehradun

Figure 8: Onsite training by FRI Scientists to PAPs

Figure 9: Damoda dump before eco-restoration, 2012

Figure 10: Damoda dump after eco-restoration, 2014

With the success of ecological restoration, the energy sector as a whole will greatly benefit due to the following reasons:

- India has a total land of 3,287,539 sq. km out of which 692,027 sq. km is forest (21.05%).

- The potential coal bearing land is 17,300 sq. km (00.53%) out of which 5,190 sq. km (0.75% of total forest) is forest land.
- About 206 coal blocks over 4,039 sq. km in nine coalfields having production potential of 660 million tonnes are locked in NO-GO Zone. Through ecological restoration, attempts can be made to create no-go areas coupled with offsetting biodiversity.
- With success of eco-restoration, it is expected that industry will be able to open up such zones.

Surplus Mine Water Utilization

A 'Scheme for multi-purpose utilisation of surplus mine water of Barora Area, Block II and Govindpur Area of BCCL' was prepared with a view to harness the excess water discharge to take care of the persistent problem of water scarcity in the nearby villages. In the scheme, two water reservoirs of capacity 31 million gallon (MG) (Khonathi village) and 16 MG (Behrakudar village) have been developed in the non-coal bearing area with storage of 3,250 gallons per minute (GPM) and 2,000 GPM surplus mine water which are fed through pipeline by mine discharge at mines of Barora, Block II, and Govindpur Area. Surplus mine water is used by the villagers from Behra Kudar Pond and Khonathi Pond by means of lift irrigation, overflow from spillways for irrigation, fisheries and daily uses for animals, etc. The excess mine water is also used by the 27,000 residents in the surrounding villages.

BCCL has also installed 28 pressure filter plants with a total capacity of 4.81 million gallons per day (MGD) to meet the drinking water requirements in the area. At present, 63 water treatment plants are operational with a capacity of 17.30 MGD. The process for installation of 28 pressure filter plants of 10,000 and 15000 gallons per hour (GPH) capacities (total 5.84 MGD) is in progress for capacity augmentation of existing water supply. In collaboration with Central Institute of Mining and Fuel Research, Dhanbad, a water treatment plant of capacity 4,000 GPH was installed in Putki Balihari Area for making the mine water potable after treatment. This water treatment plant uses a mix of technologies including membrane technology, using ozone as a disinfecting agent instead of chlorine. This also opens up possibility of preparation of packed drinking water from mine water which could possibly be source of income for the project affected families.

Figure 11: Pressure Filter Mine water for community use

Cluster Concept for Environmental Clearance

BCCL is the first company to formulate the cluster concept for preparation of the Environmental Impact Assessment–Environment Management Plan (EIA-EMP) for obtaining environmental clearance based on environmental rationale for all its mines. Environmental

Table 1: Utilization of surplus mine water in Barora, Block II & Govindpur

	Surplus mine water (GPM)	Loss in supply, storage and distribution	Available water for utilization (GPM)	Drinking water @ 45 gallon/per day per person		Non-drinking purpose agriculture/ plantation/fisheries etc(GPM)
				GPM	beneficiary (persons)	
Reservoir A	2000	50%	1000	500	13500	500
Reservoir B	3250		1625	812.5	22000	812.5

clearance procedures practiced till now was for individual mines. But often it has been observed that the buffer zones of several mines fall under the core zones of the adjacent mines and vice versa, leading to data duplication. The issues of water and air pollution and other environmental parameters have to be taken care of in a combined and comprehensive manner rather than individual mine-wise. Development of cluster concept based on environmental rationale can therefore serve as a benchmark for a comprehensive environmental management resulting in clear environmental benefits.

> ***"A Cluster consists of a group of mines with mine lease boundaries lying in close vicinity and should include operating mines, abandoned/closed mines, proposed projects and washeries with a view to take up reclamation and ecological restoration of the whole cluster and putting them to an environmentally and socially benign post-mining land use".***

Advantages of Cluster Concept

- Ensures clear environmental benefits, addresses the issues of abandoned mines and their reclamation and dovetailing with the Jharia Action Plan.
- Permits common control and mitigation measures.
- Integrated environmental management plan for critical activities may be drawn more effectively for the compliance of environmental standards in a cluster.
- Ease of handling large number of units for environmental clearances for MoEF, SPCB and for the company.
- Cost effective and easy to comply.

Methodology of Cluster Concept

The following environmental parameters were considered while clustering mines:

- Ambient air quality in a cluster of mines
- Conservation of coal
- Rock/OB waste management
- Ecological restoration
- Socio-economic environment
- Fire abatement measures
- Prominent wind direction
- Surface hydrology
- Environmental corridors

Based on these parameters and benefits, all the 103 mines of BCCL have been grouped into 17 clusters. BCCL has obtained environment clearance of 15 clusters and recommended one for another cluster (Cluster-XII, Proposed Kapuria UG}. TOR for balance one cluster (Kalyaneshwari OC) is granted. The cluster concept designed by BCCL can be replicated with suitable environmental rationale in other coalfields and mining areas in India. This would accelerate the process of obtaining environmental clearances, thereby helping the industrial growth as well as leading to better environmental restoration.

Other Measures

- A project for Coal Bed Methane (CBM) is in operation at Moonidih for commercial utilization of CBM .The methane is being trapped for power generation, generating 500 KW at present.
- BCCL has taken up various awareness programmes including social networking to encourage awareness on environmental issues.
- Domestic use of coal is stopped and instead reimbursement of one LPG cylinder per month is being given to employees. It reduces GHG from 0.72 T to 0.04 T per employee per month.
- Installation of Rapid Loading System with SILO arrangement at Maheshpur is in progress. Three more RLS are being planned by BCCL in the coalfield.
- All washeries operate under closed recirculation arrangement.
- Rainwater harvesting structures is being installed in various existing colonies in non-coal bearing areas and made integral part of all new houses (11,836) under construction

Figure 12: Coal Bed Methane (CBM) project at Moonidih

Technological Challenges in Coal Use

Swati D'souza
TERI

Introduction

Coal's dominant position in India's energy mix is likely to continue, projected to contribute 58% of India's electricity generation in 2030 (Planning Commission 2013), compared to 70% in 2012. This dependence on coal will have an adverse impact on India's climate change mitigation goals. Fossil fuel combustion accounts for nearly 90% of the total carbon dioxide emissions of which coal accounts for about 40%. In India, carbon dioxide emissions continued to increase by 6.8% in 2012 making it the fourth largest CO_2 emitting country in the world (TERI 2014). This increase was mainly led by a 10% jump in coal consumption, of which coal-based power consumption which accounts for almost 70% of coal-related CO_2 emissions grew by 13% in 2012, the highest annual growth ever. (European Commission 2013).

Since coal-based power generation will remain India's mainstay, it is imperative to pursue coal technologies that minimize the pollution and environmental impacts. A study by the World Coal Association (n.d.) shows that one percentage point improvement in the efficiency of a conventional pulverized coal (PC) combustion plant results in a 2–3% reduction in CO_2 emissions. Therefore promoting technologies that make efficient use of the fuel will not only meet the near-term needs but also set coal-based power on a trajectory that will help it to meet future challenges. The term 'clean coal technologies' (CCT) refers to every option capable of reducing emissions upstream, downstream, or within the power generation (energy conversion) process (Tavoulareas 2008). The next section will review current technologies in use in the sector and viable alternatives which will decrease coal consumption and thereby help reduce greenhouse gas emissions in power generation.

Current Technology

In India, thermal-based power is mostly generated from sub-critical PC. This process pulverizes coal into fine powder which is then burnt to heat water in boilers. The high pressure steam which is generated is used to drive electrical generators. These plants operate at steam temperature of 538 °C and steam pressure of 170 kg per sq. cm. The net efficiency of the best sub-critical plants in India with sub-critical units of 500 megawatt (MW) is about 38%. The high ash content (40–50%) and high moisture content (4–20%) in Indian coal hinders the efficiency of the power plants as it requires additional coal to generate amount of electricity (Ananth P Chikkatur and Ambuj D Sagar 2009). Presently a variety of technology is being used to remove chemical impurities prior, during and after combustion. Technologies, such as chemical washing of coal to remove impurities and minerals before combustion, scrubber technology to filer exhaust air into smoke stacks and flue-gas separation are already in operation (EIAS 2013). Renovating and modernizing existing PC-based power plants is a necessity, but more importantly it has become imperative to shift to better available technologies.

Supercritical Technology

The Planning Commission in the 12th Five-year plan stated it expects a capacity addition of 88 gigawatts (GW) of which coal-based capacity would be about 69 GW. Further it stated that of this 69 GW, about 50% of the thermal plants would be based on supercritical technology (Planning Commission 2013). Supercritical units operate at a higher temperature than subcritical units which leads to higher efficiency of about 42%. This lowers carbon emissions from these plants. The steam cycle for these units operates at pressure above 226 bars and temperature above 537°C which results in fuel savings of up to 5%. Moreover, the efficiency of supercritical plants can be increased to 45% and beyond with steps like reducing the boiler exit gas pressure. At an exit gas temperature of 130°C, a reduction of every 10°C (18°F) in boiler exit temperature, increases the plant efficiency by about 0.3% (Beér, n.d.). Among other things it lowers operating costs and increases operational flexibility. Table 1 highlights the key differences between subcritical and supercritical thermal power plants (TPPs).

In India, the first supercritical plant was the Mundra power plant which came up in Gujarat. The first unit of the 2x660 MW project turned operational in December 2010 while the second one reached the same milestone in early June 2011. Other supercritical power plants which are in process of being commissioned include a 3x660 MW unit at Sipat by National Thermal Power Corporation (NTPC), the Mundra Ultra Mega Power Plants (UMPP) by Tata Power, the Barh plant (Stage II) among others.

Table 1: Comparison of Subcritical and Supercritical TPPs

Input Parameters	Unit	Subcritical TPP	Supercritical TPP
Steam pressure	Megapascal (MPa)	16.7	24.1
Steam temperature	Degree celsius	538/538	565/593
Plant configuration	Unit x rating	4 x 500	3 x 660
Plant capacity	MW	2000	1980
Engineering, procurement and construction cost per MW	₹million	40	46
Operation and maintenance cost	₹ million per MW	1.46	1.34
Land Required	Acres per MW	0.80	0.65

Source: Power Line, 2013

Box 1 Supercritical technology: Best Practice

Following the procurement of 10 units from Russia, China first began using supercritical technology only in 1990. The first plant was commissioned at Shi Dong Kou in 1992 and consisted of 2X600 MW units with 565 °C steam conditions. The second plant installed was the Waigaoqiao plant in Shanghai (next to the Shi Dong Kou), which consisted of 2 × 900 MW units with steam conditions 565 °C (Tavoulareas 2008). Since then, Chinese manufacturers like Shanghai Boiler Works, Harbin Boiler Group among others have teamed up with international players like Alstom, Siemens, and Hitachi via joint ventures (JVs) or licencing agreements to manufacture majority of the equipment required the supercritical technology in China itself. By 2010 about 27 supercritical units were operational in China representing a total of 37.8 GW. From 2010 to 2020, new supercritical power plants in China will be built with unit capacities of 600 MW and more and about half of the newly built power generating units will be ultra-supercritical. Consequently, supercritical units will account over 30% by 2020 (Horbach, Chen, Rennings, & Vögele, n.d.). This situation offers a valuable lesson for India which now faces a situation similar to what China faced prior to 1990s.

Box 2 Ultra-Supercritical Technology: Best Practice

Japan and Germany are forerunners when it comes to ultra-supercritical technology. In both these countries, it was the government's support that led to improvement in technology to advance state-of-the-art pulverized coal technology. The government-funded research was carried out by both power plant manufacturers as well as power generation companies with customers absorbing the initial high cost through tariff adjustment. Japan continues to design newer power plants with higher steam conditions. Japanese power plant major the J-Power Group constructed Japan's first USC facility in 1997 at Matsuura Thermal power plant. The Isogo thermal power plant constructed in 2002 has the highest efficiency with steam temperature of 6100C (J-Power Group, 2012). Moreover, the company is also heading a consortium to build Asia's largest IPP project (1 GWx2) on the island of Java in Indonesia.

Ultra-supercritical Technology (USC)

Ultra-supercritical boilers operate at a pressure and temperature of over 250 bars and 600 0C respectively. NTPC, Bharat Heavy Electricals Limited (BHEL) and the Indira Gandhi Centre for Atomic Research are jointly undertaking research and development (R&D) for this particular technology. BHEL has already submitted a project design memorandum for an 800 MW pilot project based on this technology to the government. This project will be funded by the government's National Mission for Technology (an initiative to research into CCT) and could well be over ₹600 cr (*Hindu Business Line* 2013). This R&D project will run until 2017 which will be followed by a full-fledged thermal power plant of 800 MW capacity to be set up by NTPC (PIB 2014).

Integrated Gasification Combined Cycle (IGCC)

Under this process coal is gasified under high pressure (30 bars) with temperature maintained above 1000 ^{0}C to produce a high-energy gas (synthetic gas or syngas) which is comprised of carbon monoxide and hydrogen. This syngas is then burned in a gas turbine and the steam produced from heat exchanger (used to cool the syngas) is used to power a secondary steam turbine which produces electricity (Ananth P Chikkatur and Ambuj D Sagar 2007). India has some experience in IGCC since BHEL has conducted preliminary work in this technology. BHEL commenced with a 6.2 MW demonstration plant in Tamil Nadu in 1988. This was

Asia's first and the world's second coal-based IGCC plant. To date, one small IGCC plant operates in India — a 52 MW unit operates as part of the Sanghi cement plant (EIAS 2013). BHEL is also in the process of setting up a 125 MW demonstration IGCC plant in Andhra Pradesh in co-ordination with Andhra Pradesh Power Generation Corporation Limited (APGENCO), the power generating company of the state (TERI 2013). Using this technology will lead to increased efficiency from the combined cycle, lower costs for the clean-up technology, greater ease of capturing carbon and decreasing emissions. But the high degree of complexity while using this technology is one of the primary disadvantages. IGCC is more like a chemical plant than a power plant. This technology also lacks the maturity that is present in other clean coal technologies and hence it has higher capital costs as also the perception of having higher risk. The most recent cost estimates published by the US Energy Information Administration (USEIA) were in April 2007. In its report[1], USEIA has estimated the overnight capital cost of generating plants using newer technologies. The overnight capital-cost estimates for a 650 MW plant are listed in Table 2. A comparison with capital costs in 2010 reveals that the overnight capital costs for a Single Unit IGCC power plant both with and without Carbon Capture and Sequestration (CCS) has risen by 19% instead of falling (Table 3).

Despite these disadvantages, harvesting this particular technology will prove to be beneficial in the future especially since it is one of the cheapest options for carbon capture. Therefore its development can eventually lead to deployment of pre-combustion capture technology in the power sector.

Table 2: Capital cost of different technologies

Technology	Capital Cost Estimates/kW
Single Unit Advanced PC	$3,246/kW
Single Unit IGCC	$4,400/kW
Single Unit IGCC with CCS*	$6,699/kW

*The nominal capacity for the single unit IGCC with CCS plant is reduced to 520 MW
Source: (USEIA, 2013)

Table 3: Capital cost of different technologies between 2010 and 2013

Technology	Capital Cost Est/kW (2013 Report)	Capital Cost Est/kW (2010 Report)
Single Unit Advanced PC	$3,246/kW	$3,292/kW
Single Unit IGCC	$4,400/kW	$3,706/kW
Single Unit IGCC with CCS*	$6,699/kW	$5,559/kW

*The nominal capacity for the single unit IGCC with CCS plant is reduced to 520 MW
Source: (USEIA, 2013)

1 Updated capital cost estimates for utility scale electricity generating plants

Underground Coal Gasification (UCG)

This technology which is in the early stages of development, refers to gasifying coal seam in-situ under controlled combustion and then extract the products usually syngas, containing hydrogen, carbon monoxide and methane. This process of extraction uses less land and can be used to extract energy from deep and isolated beds in India. Moreover, the government is also in the process of addressing the regulatory hurdles in the space. The Ministry of Coal had issued a Gazette Notification in July 2009 which specified that production of syngas obtained through gasification (underground and surface) has been notified as an end-use under the Captive Coal Mining Policy (Singh, Prasad, & Sahay 2012) (Ministry of Coal 2009). The present government has stated that it will come out with a draft policy on underground coal gasification after the coal block auctions. Seven blocks (five in lignite and two in coal) have been identified by the Central Mine Planning and Design Institute (CMPDI) as suitable for commercial development of UCG. This method can be used to increase coal production especially since it can be used for coal deposits found beyond 300m in-depth. However, there are several risks associated with this technology like contamination of ground water, inconsistent supply of syngas as well as lack of control when it comes to underground combustion.

Circulating Fluidized-bed Combustion (CFBC)

Fluidized-bed combustion burns coal in a bed of ash and limestone particles which are suspended in flowing air. The two types of fluidized bed designs are bubbling and circulating. Circulating fluidized-bed (CFB) is more common for power generation especially in plants larger than 100 MW. This technology is particularly suitable for high-ash fuels, such as lignite, brown coals and Indian coals. Moreover, if sulphur dioxide regulations are implemented in the future, CFBC technology will become all the more rampant and should be taken into consideration when building new plants. Most CFBs though are designed for subcritical steam conditions. There are reported to be more than 36 CFB units in operation in India representing 1200 MW of installed capacity, most of them are relatively small with the largest unit being 136 MW (Tavoulareas 2008).

Carbon Capture and Use (CCU)

This technology aims to reduce carbon dioxide emissions from fossil fuels by capturing it and transporting it to storage sites. The International Energy Agency (IEA) believes that this technology will contribute significantly when it comes to decreasing emissions by 50–85% by 2050 (Viebahn, Vallentin, and Höller 2013). Commercial viability of this technology before 2030 though seems improbable for India especially since it has not yet been proved. But this does not mean that there is no ongoing activity in this field. Most R&D work in the field occur under the Department of Science & Technology. Several small projects are taking place, such as the National Aluminium Company's (NALCO) plans to set up a carbon capture unit at its coal-fired at Angul in Orissa. Even NTPC has been conducting research along with National Geophysical Research Laboratory India (NGRI) to evaluate the Deccan basalt formation as a potential long-term CO_2 storage option (TERI 2013). But India is extremely cautious on the commercialization of this technology. One of the biggest barriers is the resulting increase in electricity costs with a net reduction in power output by implementing this technology. Moreover, lack of accurate geological storage site data also makes it unfeasible. Enhanced Oil Recovery (EOR) is one of the most attractive options for CO_2 storage, but few fields in India are sufficiently depleted that oil can be recovered from them using this procedure.

Conclusion

So far, subcritical PC power plants have been the backbone of the Indian power sector. However, this extended reliance has had several negative consequences. For instance, the low efficiency of the power plant impacts the cost-benefit structure of these plants. Further, there are harmful environmental consequences. Therefore, it has become imperative to shift to better technologies which not only use less coal but also improve the overall efficiency of the plants. But this shift requires a force of will from each and every stakeholder involved in the entire fuel chain, right from the producer to the government to the consumer.

Bibliography

Chikkatur P A and Sagar D A. 2007. *Cleaner Power in India: Towards a Clean-Coal Technology Roadmap.* Cambridge, Mass: Belfer Center for Science and International Affairs.

Chikkatur P A and Sagar D A. 2009. Rethinking India's Coal-Power Technology Trajectory. *Economic and Political Weekly*, 53–58.

Beér, J. (n.d.). *High Efficiency Electric Power Generation; The Environmental Role.* Retrieved from https://mitei.mit.edu/system/files/beer-combustion.pdf

EIAS. 2013. *Potential Of Clean Coal Technology in India: An SME Perspective*. European Business & Technology Centre.

European Commission. 2013. *PBL, Trends in Global CO2 Emissions.*

Governemnt of India. 2014. *Press Information Bureau.* Retrieved from Press Information Bureau: http://pib.nic.in/newsite/pmreleases.aspx?mincode=42

Hindu BusinessLine. 2013. *BHEL-NTPC-IGCAR effort to boost efficiency of power plants.*

Horbach, J., Chen, Q., Rennings, K., & Vögele, S. (n.d.). *Lead Markets for Clean Coal Technologies: A Case Study for China, Germany, Japan and the USA.* ZEW.

J-Power Group. 2012. *Sustainability Report.*

Ministry of Coal. 2005. *Report of the Expert Committee on Road Map for Coal Sector Reforms.*

Ministry of Coal. 2009. Guidelines for Allocation of Captive blocks for Underground Coal Gasification & Conditions of Allotment.

PIB. 2014. *Focus on 'Make In India'.* Retrieved January 15, 2015, from Press Information Bureau : http://pib.nic.in/newsite/PrintRelease.aspx?relid=110038

Planning Commission. 2006. *Integrated Energy Policy.* Government of India.

Planning Commission. 2013. Twelfth Five Year Plan (2012–17) Economic Sectors. *II*.

Power Line. 2013. Upcoming Technologies. *Power Line*, pp. 74-76.

Singh, A. Prasad, B, & Sahay, A. 2012. Tiger, Tiger, Burning Bright. *World Coal*.

Tavoulareas, S. 2008. Clean Coal Power Generation Technology Reivew: Worldwide Experience and Implications for India.

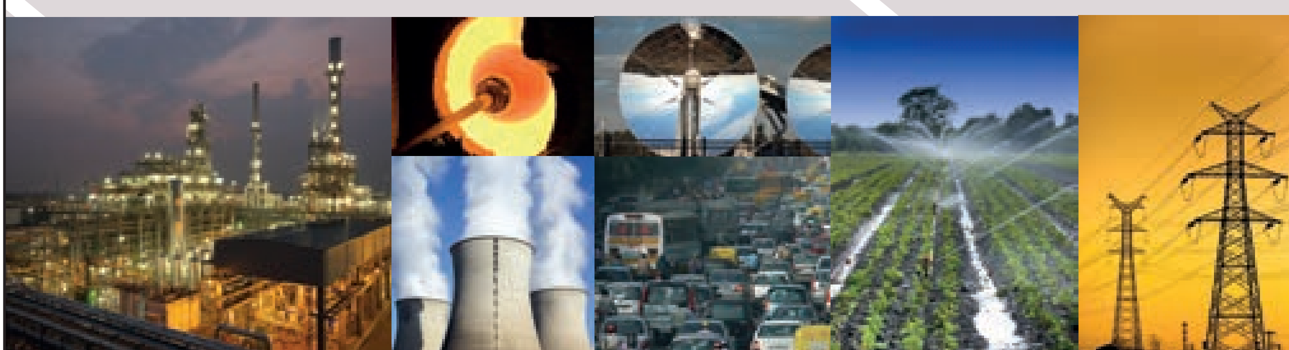
TERI. 2013. *India CCS Scoping Study: Final Report.*

TERI. 2014. *TERI Energy & Environment Data Directory and Yearbook - 2013/14.* New Delhi: TERI.

USEIA. 2013. *Updated capital cost estimates for utility scale electricity generating plants.* Retrieved January 15, 2015, from US Energy Information Administration: http://www.eia.gov/forecasts/capitalcost/pdf/updated_capcost.pdf

Viebahn P, Vallentin D, & Höller S. 2013. *Prospects of Carbon Capture and Storage in India's power sector.* Wuppertal Institute for Climate, Environment and Energy.

World Coal Association. (n.d.). *Improving Efficiencies*. Retrieved January 12, 2015, from www.worldcoal.org: http://www.worldcoal.org/coal-the-environment/coal-use-the-environment/improving-efficiencies/



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