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ORF POLICY BRIEF

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Coal Beneficiation
Policy Priorities for India

EXECUTIVE SUMMARY

- The government of India has stipulated that, as of June 2016, power plants of capacity of 100 Megawatt (MW) or above, located 500 to 749 kilometres (km) from coal mine pit-heads must utilise raw, blended, or beneficiated coal with ash content of 34 percent or less. The obligation of meeting this target rests with the coal supplier. This is a notable change in policy that will augment the use of cleaner coal in India. The policy finds its roots in environmental concerns; however, economic considerations must be examined for the policy to be successful and have sustained impact.
- Coal beneficiation is a physical process that separates burnable coal from associated un-burnable mineral matter, also known as ash, or rejects. High ash content is inherent in Indian coals, the ash having been deposited concurrently with the coal in the paleo-depositional environment. Due to the close specific

gravity of coal and ash, efficient separation becomes difficult. Washed coal continues to have ash content after beneficiation. Conversely, coal constitutes a small but nonetheless significant part of the rejects. This residual coal is a valuable economic resource that should neither be ignored nor discarded.

- Indian coals typically have ash content in excess of 40 percent. Attaining an ash content of 34 percent or less after washing at reasonable yields may be extremely difficult for the majority of Indian coal mines.
- Rejects contain combustible matter that cannot be safely disposed of, principally due to problems of self-ignition. A recommended solution is for coal to be washed to the extent practically possible; thereafter, rejects having gross calorific value of 1,800-2,000 kilocalories per kilogram (kcal/kg) could be diverted to power plants utilising atmospheric fluidised bed combustion technology (FBC).

- The above strategy will involve incremental costs such as the following:
  a) Additional mining of coal to make up for volumes lost due to washing
  b) Overall reduction in the thermal efficiency of power generation
  c) Capital investment in washeries and FBC plants
- Meanwhile, the benefits will include, among others:
  a) Reduced transportation costs
  b) Lower demand on rail capacity
  c) Reduced operating costs at power stations
  d) Lower emission of pollutants
- At the macro-economic level, beneficiation leads to economic efficiencies and to pollution control. Beneficiation also adds value to Indian coals and improves their marketability. This is particularly true with the decreasing thickness of coal seams in mature mines, which correspondingly leads to the quality of coal declining.
- More research needs to be done on the effects of beneficiation on energy saving and overall climate action.
- The economic and environmental benefits of coal beneficiation at the national level often do not translate to financial savings at the plant level. Therefore, public support is required. Disbursement of the National Clean Energy Fund (NCEF) for coal quality improvement, in general, and coal washing in particular, will offer unambiguous support for re-aligning the government's coal policy from "quantity based" to "quality based".

1. RATIONALE FOR COAL BENEFICIATION

The intrinsic quality of Indian coal, along with the dominant practice of open cast mining, has meant that run of the mine (ROM) Indian non-coking coal contains a huge share of ash and other minerals. ROM coal typically has high ash content from 30-50 percent and low calorific value (2,500-5,000 kcal/kg). In general, high ash content creates problems for coal users that include erosion, difficulty in pulverisation, poor emissivity and flame temperature, low radiative transfer, and generation of excessive amounts of fly-ash containing large amounts of un-burnt carbon. In addition, the transport of ROM coal across long distances is wasteful, as it carries large quantities of ash-forming minerals that results in infructuous use of rail and port capacity. The transport of high ash coal across long distances also contributes to emission of carbon dioxide (CO_2) and other greenhouse gases (GHG) from the mode of transport (rail and road).

Government policies favour the beneficiation of coal. The most recent measure is Gazette Notification G.S.R 02 (E), dated 02 January 2014 and issued by the Ministry of Environment, Forest and Climate Change (MOEF&CC), which states that "power plants of capacity of 100 MW or above located between 500-749 km from the pit head shall be supplied with raw or blended or beneficiated coal with ash content not exceeding 34 percent on quarterly average basis from 05 June 2016."[1] Further, all new coal plants have been mandated to use supercritical technology and 144 existing plants have been assigned mandatory efficiency targets that will require use of higher quality coal.[2] Despite the benefits and supportive policy interventions that have been in place for over two decades, coal washing has not been adopted on a large scale by coal producers and end users (particularly power generators).

There are two broad concerns over quality. First is the concern over consistency in physical quality such as size, and the second is chemical quality. The two concerns are interrelated, but may be addressed separately by coal beneficiation methods. Efficiency of beneficiation to improve chemical composition depends on liberation of inert matter, which in turn depends on physical quality as it varies with size ranges of coal.[3] Beneficiation may be carried out at the mining stage to eliminate stone and shale bands and by selective mining. Beneficiation can be continued at the post-mining stage through separation of stones, crushing and screening, followed by coal washing.

Coal Beneficiation is a process where coal is subjected to a medium of defined specific gravity. Heavier material sinks (rejects) and lighter coal floats (clean coal). This specific gravity is defined by the 'washability' characteristics of the coal seam. It varies for different seams in the same area and for different geographical areas. While Indian coal is generally believed to be difficult to wash, various indices like 'Washability Index' and 'Near Gravity Material Index' (NGMI) are used to determine the difficulty level. When raw coal of, say, 40 percent ash is washed to produce 32 percent ash clean coal, the yield is 75 percent in the Korba coalfield and 65 percent in the Ib Valley and Talcher coalfields.

There are two separate aspects to upgrading coal quality. One is the possible short-term benefits that result from using upgraded coals in existing power plant boilers, including reduction in emissions that contribute to local pollution. The other is the longer-term benefit arising from the use of advanced clean coal technologies which may demand upgraded coal by design to realise the potential for increased thermal efficiency. There are other process benefits of coal upgrading, but they are mainly second-order effects. For example, reducing the ash content of coal may make it easier to grind, so that the energy used by mills is reduced. The amount of pyrite, a hard and reactive mineral, present is also likely to be reduced in washed coal.

Inconsistency in the quality of coal supplied is a recurring problem with ROM coal use in India. It is possible that in the case of power plants which draw their supplies from individual mines, there would be greater consistency in the quality of coal. This is so in the case of some of the thermal plants that are linked to specific mines. At times, it was reported that four to five mines were linked to a single power plant depending upon the demand with greater variation in coal quality. Transportation and seasonal variations contributed to the deterioration in quality that was often beyond the tolerance of the power plant.

The ash content in coal, as delivered to power plants in India, currently averages about 40 percent.[4] With few exceptions, the majority of coal-fired power plants are likely to receive coal from more than one source. As most of the plants do not have blending and homogenisation facilities, the multiplicity of supply sources leads to the problems of inconsistency in coal quality.

1.1. Environmental Benefits of Coal Beneficiation

The main emissions from coal- and lignite-based thermal power plants in India are CO_2, Oxides of Nitrogen (NO_X), oxides of sulphur (SO_X) and air-borne inorganic particles such as fly ash, carbonaceous material (soot), suspended particulate matter (SPM), and other trace gases.[5] Thermal power plants were among the Large Point Sources (LPS) of environmental pollution, accounting for 50 percent of CO_2 and SO_X and about 20 percent of NO_X in 2013.[6] Coal beneficiation has the potential to reduce the level of these emissions.

1.1.1. Reduction in Carbon Dioxide Emissions

CO_2 emissions from power plants depend on the carbon content of the coal and the quantity of air used for combustion. When combustion of coal is incomplete, a small portion of the un-burnt carbon goes with the fly ash and the remaining un-burnt carbon goes in the bottom ash. Improvements in power plant efficiency through the use of clean (washed) coal can have significant benefits in terms of reduction in CO_2 emissions. Test results have demonstrated that CO_2 emissions in the range of 1.11 kilogram per kilowatt hour (kg/kWh) of power generated are reduced by 6.5 percent to 1.045 kg/kWh when using 30 percent ash coal versus 42 percent ash.[7]

Empirical studies have found that an increase in efficiency from 28 percent to 33 percent on account of using low ash coal would result in reduction in CO_2 emissions of up to 15 percent, or some 190 gram per kilowatt hour (g/kWh) generated. If the average efficiency is raised from 33 percent to 38 percent, a further reduction of some 175 g/kWh is achievable. With the widespread application of state-of-the-art technologies such as supercritical pulverised coal combustion (PCC) or integrated gasification combined cycle (IGCC) which also benefit from the use of upgraded coals, average efficiencies could be brought up to nearly 43 percent.[8]

1.1.2. Reduction in Other Pollutants

The emission of pollutants like SO_X, NO_X, and suspended particulate matter (SPM) from coal-fired power plants is a source of pollution for surrounding areas unless appropriate control measures are taken. In general, NO_X and SO_X are formed from the combustion of coal where air is used or where nitrogen and sulphur is present in the fuel. SO_X, mainly sulphur dioxide (SO_2), is produced from the combustion of the sulphur contained in coal of various types. SO_X emissions from coal combustion mainly depend on the sulphur content in the coal unlike the emissions of CO_2 and NO_X which depend on the operating conditions (air intake) and the design of the plant. Sulphur content in Indian coal (barring lignite, which has higher sulphur content) is much lower than that of coal from other countries. The range of SO_2 emission for Indian power plants was estimated between 5.210g/kWh-9.899g/kWh.[9]

A substantial part of NO_X is known to come from the use of air in the combustion of coal. To achieve complete combustion with high-ash raw coal, a higher percentage of air is used which may result in the formation of a higher percentage of NO_X. The emission of NO_X can be controlled with the introduction of low NO_X burners. Further, with the use of beneficiated coal which can be combusted efficiently with less air, the formation of NO_X can be reduced. The range for NO_X emissions from thermal power plants is between 1.612g/kWh-3.490g/kWh.[10]

The reduction of SO_X and NO_X components upon coal beneficiation can allow for a smaller emissions control device rather than a large one to control pollution, leading to savings in investment. Air pollution with respect to SPM can be reduced through lower dust emission during unloading and stocking of beneficiated coal, as it has more constant moisture content.

With the use of low ash coal, the concentration of SPM in the flue gas can be decreased, resulting in reduced load of particulates in the Electrostatic Precipitator (ESP)/bag filter. At any particular efficiency level of operation for the ESP/bag filter, reduction in the particulate load of inlet gas can reduce the emission of SPM, thus improving the quality of air. Ash from Indian coal with high silica content in the order of 55-65 percent and alumina content in the order of 25-35 percent has high resistivity, which in turn reduces ESP performance.[11]

The use of technologies such as ESPs involves additional costs, and points to a critical challenge in introducing technologies for reducing pollution in power generation in India. Power generators are under pressure to contain generation costs to keep power tariff levels stable, while at the same time they are also expected to invest in technologies to reduce pollution. Power generators are unlikely to pursue a public good such as clean air at the expense of investment that they cannot recover from tariff revenue. There is thus a case for public funding for pollution control technologies.

1.1.3. Reduction in Ash Handling

By reducing the ash content in coal in the pre-combustion stage through washing, not only is the harmful effect of ash reduced, but also the cost of handling ash. Coal washing reduces fly ash generation in the post-combustion stage and extends the life of ash disposal landfills. Using washed coal at a plant would extend a given ash disposal site by 12- 20 percent.

The utilisation of fly ash has increased from 6.64 million tonnes (MT) (less than three percent of the fly ash produced) in 1996-97 to about 103 MT in 2014-15 (about 55 percent). To reduce the requirement of land for disposal of fly ash in ash ponds and to address the problem of pollution caused by fly ash, the MOEF&CC has issued various notifications on fly ash utilisation. The first notification was issued in September 1999 and later amended in the years 2003 and 2009. The 2009 notification prescribes targets of fly ash reduction in a phased manner for all coal- and lignite-based power plants to achieve 100 percent utilisation of fly ash.

Fly ash is used by the cement industry as a pozzolanic material in the manufacturing of Portland Pozzolana cement. As this saves both precious limestone and coal, it is considered to be high-value added use. Many road and embankment projects have been completed across the country using fly ash. Other uses of fly ash include back filling/stowing of mines, making building materials like bricks, blocks and tiles, and also as fertiliser as it has many micronutrients.

1.2. Economic Benefits of Coal Beneficiation

1.2.1. Plant Operations

Power plants that use coal of higher quality have a performance advantage over those which use lower quality coals. In general, the higher the ash content of coal, the lower is the heating value per unit weight of coal. When the percentage of ash content is reduced, the heating value of coal is increased and so less raw coal has to be burnt to produce a given quality of electricity.[12] When low ash coal is used, plant operators can reduce the scheduled and unscheduled maintenance required to remove ash collection. Lower ash coal can also reduce corrosion of plant ductwork that reduces plant life.

Low ash coal can reduce damage to coal handling equipment such as conveyors, pulverisers, crushers and storage units. The use of higher ash coals increases the load on the plant that in turn increases the quantity of plant site energy needed to operate the plant. This then reduces the energy available for power generation, raises the plant operating cost, and reduces its profit potential.

Beneficiation improves overall power plant operations and directly affects the profitability of a coal plant over the long term. It also increases its capacity to avoid environmental penalties and disputes. It also improves the life of emission control devices.

1.2.2. Transport of High Ash Coal

India is unique among nations that use coal for power generation in that it hauls coal over much greater distances than most others, from mine to power station. Besides the detrimental effect of coal ash on the environment, the extra load which the railway system carries means greater cost to the economy, as well as added air pollution through the transport system. These issues favoured the introduction of the policy of reducing the ash to 34 percent for power plants situated over 1,000 km from the coal mines. The policy is expected to result in substantial relief in terms of reduced railway tonnage as well as improve the environment around the power station. Some six to seven percent of waste ash is expected to be disposed at the mine site where its disposal is environmentally benign.

Given the long haulage distances, lower ash coal will also result in reduction in freight costs for transporting the same energy content. India continues to use the same track for freight and passenger traffic, unlike most developed countries which use dedicated tracks for each. The difference in speed of the two (passenger and freight trains) erodes the capacity of the Indian rail network. Network congestion is further aggravated by coal traffic being concentrated on about a dozen routes.[13] Coal beneficiation may be among the most viable solutions towards reducing the pressure on the railways.

2. POLICY AND REGULATORY REGIMES

2.1. Environmental Regulations

With regard to ash content in coal, the first gazette notifications of the MOEF&CC – GSR 560(E) dated 19 September 1997 and GSR 378(E) dated 30 June 1998 – said that beneficiated/blended coal containing ash not more than 34 percent should be used in power plants located 1,000 km from pit-heads as well as in those located in critically polluted areas, urban areas and ecologically sensitive areas, with effect from June 2001. But compliance with these notifications was lower than desired, as noted in earlier sections of this report.[14]

The Gazette Notification (G.S.R 02 (E)) dated 02 January 2014 by the MOEF&CC contained some modifications to the initial draft text. It exempted from the above provisions thermal power plants using efficient and clean technologies – as notified by the Central Government.

The following are some of the key differences between the draft and final versions of the rule: (a) the requirement of using coal of Gross Calorific Value (GCV) 4,000 kcal/kg has been dropped in the final version; (b) the responsibility of coal beneficiation has been shifted to the supplier (the text says "power plants shall be supplied with", rather than "power plants shall use") as in the draft; and (c) the coal ash constraint limiting ash share to 34 percent is to be met every quarter rather than on a daily basis, as suggested in the draft. The shift in responsibility of washing coal – from the user to the supplier – is seen by experts as a positive move as the dominant coal supplier has access to vital resources such as land close to mines, railway linkages, and quality testing facilities that are inaccessible to third-party washery operators.

As for local pollution, the notification dated 7 December 2015 (SO 3305(E)) stipulates water consumption norms as well as norms for emission of local pollutants. On the utilisation of fly ash, the notification dated 25 January 2016 (SO 254 (E)) stipulates the use of fly ash in its detailed provisions. The use of fly ash has been increasing progressively on account of these enabling provisions.

2.2. Judicial Intervention

Poor compliance levels of the notification restricting ash content in coal transported over long distances have led to the involvement of the judiciary in the last few years. Noteworthy in this context is a public interest litigation (PIL) filed by a resident of Nagpur, alleging inaction by environmental regulatory authorities of the MOEF&CC and the Maharashtra Pollution Control Board (MPCB) regarding violation of the notification stipulating maximum ash content of 34 percent by coal-based thermal power plants of the Maharashtra State Power Generation Company Ltd (MAHAGENCO).

The order on the above PIL, issued in 2015 by the National Green Tribunal (NGT), Western Zone, stated the following: (a) the State Pollution Control Board (SPCB) and the Central Pollution Control Board (CPCB) shall incorporate the necessary condition for supply/use of required coal quality (standard) in the consent granted to coal mines/companies and coal based thermal power plants; (b) the SPCBs and CPCB shall develop necessary capacity for sampling and analysis of ash content of coal at their respective laboratories as per the relevant Indian standards; (c) the CPCB shall provide all the technical assistance for such infrastructure development and also provide training to scientific manpower and ensure compliance; and (d) till the automatic real-time online monitoring system is installed and operated by the coal companies and thermal power plants, SPCBs shall take monthly samples of the ash content of coal and ensure compliance with the notification.

While the order may be interpreted as a strong push for implementing the notifications of the MOEF&CC reducing ash content in coal, power generators may see this as one that does not consider the financial constraints under which they operate.

Overall, the expansion of coal beneficiation capacity and the use of clean coal in India for greater energy security and environmental protection, appear to be less of a technical or regulatory compliance problem, but rather one of economics. Coal washing increases the upfront cost of coal and in the short term, and raises the cost of the output such as electricity. In general, the cost of electricity from coal-fired power generation using clean coal was seen to be lower only when all the plant costs associated with using unwashed coal are included in the longer term.

3. BARRIERS TO ADOPTION OF COAL BENEFICIATION

The policy directive that influenced the setting up of washeries prioritised environmental desirability over economic viability and did not take into account the cost of compliance. Moreover, the directive was at variance with the growing influence of commercial and market forces on all segments of the coal mining and power generation value chain.

Although, in principle, coal users also recognise other benefits of coal washing (apart from savings in transport cost), they assign low monetary value to these benefits. The cost does not necessarily reflect the broad environmental benefit due to reduced land requirement, reduced handling and transport costs, other social benefits like reduced resettlement, reduced effects on cultivation in the impact zone, and improved health and living conditions.

The technical mismatch between a particular type of washed coal and the specific design requirement of the boiler gives rise to the inability of power plant operators to assess financial benefits accruing to the power stations on account of greater plant availability, increased efficiency or better flame stability from using beneficiated coal.

In the past, washeries of Coal India Ltd (CIL) or other users – such as those set up by some state electricity boards (SEBs) – were based on the policies of the government that allowed washeries by the coal producer or consumer for his own use. The open policy of allowing private entrepreneurs for merchant use has not been as successful as such entrepreneurs were outside the system of existing linkages between coal production and consumption.

At a more granular level, washing and the cost of using washed coal for power generation differs according to the type of coal, quality difference within each type, difference in distance between mine and power station, vintage of the technology used for power generation, and other parameters such as tariff structure in the particular state. All this meant that the benefits of using washed coal could not be generalised across different users from the power sector. The overwhelming power of the monopoly supplier of coal, its influence over regulation of the sector including defining and monitoring quantity and quality of coal as well as the transport of coal may be among the reasons for the lack of momentum in coal washing.

The contribution to energy security in terms of higher utilisation of domestic coal and the value of railway capacity released need to be considered in a much broader context than coal washing. They are presently unquantifiable in precise terms because of masking by cross-subsidy in the tariff systems (both railways and electricity).

3.1. Realisation of Economic Gains

The marginal beneficiation cost increases at an ascending rate for reduction of ash - below 30 percent.[15] Irrespective of the technology used, coal washing consumes energy and water and adds to the producer's cost. It is techno-economically feasible, in most cases, to selectively mine the coal, without the impurities. Selective mining is estimated to have great potential to improve the quality of coal in the Talcher mines of Mahanadi Coalfields Limited (MCL).

For power plants, variable quality is as much of a problem as overall poor quality of coal supplied. Large pieces of shale and stones in the coal supplied create problems in flame stability. Coal of consistent higher quality is desired by power plants but washed coal is not their first choice on commercial grounds.

Key among first-order challenges in adopting coal beneficiation are that of high transaction costs of involving a third party (a washery) between the coal supplier and consumer. In a fairly inflexible system of coal flows, sourcing of coal from one company and getting it washed by another agency is likely to skew preference in favour of raw coal.

Among numerous second-order challenges is the fact that the economic benefits of washing coal, while documented in theory, have not been realised in practice. The gains in heat value due to reduction in ash are often lost due to increase in moisture. The cost of rejects is included in the washed coal price, but this increase in cost of washed coal is often not compensated through economic gains such as savings in transportation cost. For example, the quantity of rejects varied from 18-20 percent for coal from the Korba field to 30-35 percent for coal from Talchar or Ib Valley coal when raw coal is washed to 34 percent ash. Plants that cannot accommodate this loss are likely to prefer blending of domestic coal with higher quality imported coal. Further, washing charges are not a 'pass through' item in power tariff when coal is washed by a private player.

The ability of the system to make up for the volume loss in terms of additional coal and the loss in heat value in rejects are two primary concerns of washeries and coal users. Making use of the residual heat content in rejects using suitable type of combustion system is unavoidable if washing is to be adopted on an economic basis.

Among various second-order financial, commercial and transactional issues is the penalty charged by power generators for short lifting of raw coal as well as for lower dispatch of washed coal in their work orders. When coal companies fail to supply raw coal or the railways fail to supply wagon capacity for dispatch of washed coal, washery operators are often penalised even though it is known that these issues are beyond the control of the washery operator. Coal producers follow a 'cash and carry' system for consumers who obtain coal through washeries, whereas they offer less rigid terms to consumers who procured raw coal directly. Those getting raw coal washed thus suffer a penalty in terms of interest payment loss due to advance payment to the coal company. This is likely to discourage consumers, especially financially constrained SEB owned power companies, from using washed coal.

Overall, the realisation of economic gains in using higher quality coal is undermined by skewed distribution of risks and rewards in the system that is biased against smaller parties in the value chain which are not part of the broader public sector dominated system. The regulation of power tariffs is also among the major constraints in adopting coal washing or any measure for quality improvement in the rest of the value chain.

3.2. Impact of the Regulatory Environment

The objective of the environmental policy set by the MOEF&CC regarding coal beneficiation is to ensure the achievement of environmental standards. However, the use of clean coal is seen as only one of several possible ways of achieving this policy objective. This may not be the most economic means to achieve the environmental policy goal. More flexible approaches to achieving environmental policy goals that take into account specific attributes of coal such as coal quality, transport distances, and boiler technology, on a case-by-case basis may elicit greater compliance of the directive limiting ash content. The disadvantage of flexibility is that it would require judgements to be made locally, which would in turn mean that local bodies such as the state pollution control boards would require high-quality local monitoring capacity. Development of local monitoring capacity could be a policy priority in this regard.

3.3. Structural and Institutional Impediments

The development and utilisation of coal washeries in the last few years has suffered not only because the economics is unfavourable but also because the flow of coal from the supplier to the consumer is mediated through a system of linkages administered by the government. The introduction of a third party (washeries owned by the private sector) in this relatively inflexible system does not favour washeries. Not only are washeries unable to obtain a firm commitment on the supply of requisite quality and desired quantity of raw coal from the supplier, but they are also unable to enter into agreements with public sector power generators, since the latter are reluctant to partner with the private sector. When power utilities enter into an agreement, terms are often unfavourable to washeries and washeries bear a disproportionate share of risks.

Coal is made available to washeries from a basket of mines (linkages granted company-wise and not mine-wise) leading to coal of different washability characteristics. Washeries that are designed for coal with particular characteristics are at a disadvantage as they are penalised for slippage in ash content as well as slippage in gross calorific value (GCV) by the power companies. Issues such as availability of land for setting-up washeries and land for disposal of washery rejects, access to infrastructure such as power, water and railway siding are also challenges for attracting private investment.

Grade slippage, the significant gap between quality of coal on paper and the quality of coal actually supplied, is a problem for coal washeries and coal users. The dependence on a single supplier and the absence of an independent regulator to monitor quality are challenges faced by both washeries and power generators. This problem may be addressed if the ownership of coal to be washed either remains with the coal supplier or with the power generators owning the linkage.

In the larger context, benefits of using washed coal – such as plant and environmental efficiency – primarily accrue to the nation (in terms of lower investment in additional capacity and lower pollution levels) and these benefits are not necessarily realised at the operating power station level. This strengthens the case for public funding support for coal beneficiation.

3.4. By-products of Coal Beneficiation

Beneficiation of coal is associated with discarding considerable quantities of 'rejects' through the process of washing. The amount of rejects to be disposed depends on the coal characteristics and the technology used for washing. As coal beneficiation is a physical process, an ideal separation between burnable (coal) and 'un-burnable' material (rejects) does not take place. Therefore, a small amount of burnable material is found within the rejects and vice versa, resulting in an overall loss of heat value.

There is also the concern over quantity of coal to be mined to make up for loss in the beneficiation process. With the use of beneficiated coal, there is a reduction in power plant heat rate (energy used by a power plant to generate one kilowatt hour (kWh) of electricity or the ratio of energy output to energy input). The reduction of the heat rate means that for the same quantity of electricity output, the power plant can use lower quantity of coal. This also reduces the overall cost of transportation of coal. However, the amount of raw coal to be mined to produce a sufficient quantity of washed coal is higher compared to the amount of raw coal supplied directly to the power plant. The additional production depends on the ash reduction in washed coal and on the raw coal's characteristics. In general, for Indian coal, the additional coal to be mined is estimated to be about 10 percent of the typical coal requirement.

Beneficiation of non-coking coal for supply to power plants results in generation of washery rejects having GCV in the range of 1,000-3,000 kcal/kg, with corresponding ash content of 75.7-54.5 percent, respectively.[16]

What to do with the rejects if the ash content is below a certain level is a concern, as this may lead to self-combustion of the rejects. Appropriate construction and shaping of the reject dumps, building only small layers with vibrating machines to prevent oxygen from entering the dump are among suggestions put forward. Though this is a relatively inexpensive way of preventing self-combustion, it is not deployed in India to the extent desired as it is seen to be cumbersome.

The economics of coal washing in India depends on how the heat value in rejects can be utilised. One of the most common strategies is to use rejects in a pit head power plant using fluidised bed combustion technology (FBC) that is capable of burning high ash coal with gross calorific value of 1,800 – 2,000 kcal/kg. The technology for fluidised bed combustion of rejects for the generation of electricity has been indigenously developed in India. The capacity of an individual unit for this purpose may be from 30-250 MW. There are constraints, however, on sufficient calorific value. A basic prerequisite is consistency in fuel quality for using high ash coal in FBC boilers. As the coal washing process normally aims at consistent quality parameters in the washed product, quality variations in the rejects are inevitable, a fact which limits the use of FBC technology.[17]

4. RECOMMENDATIONS

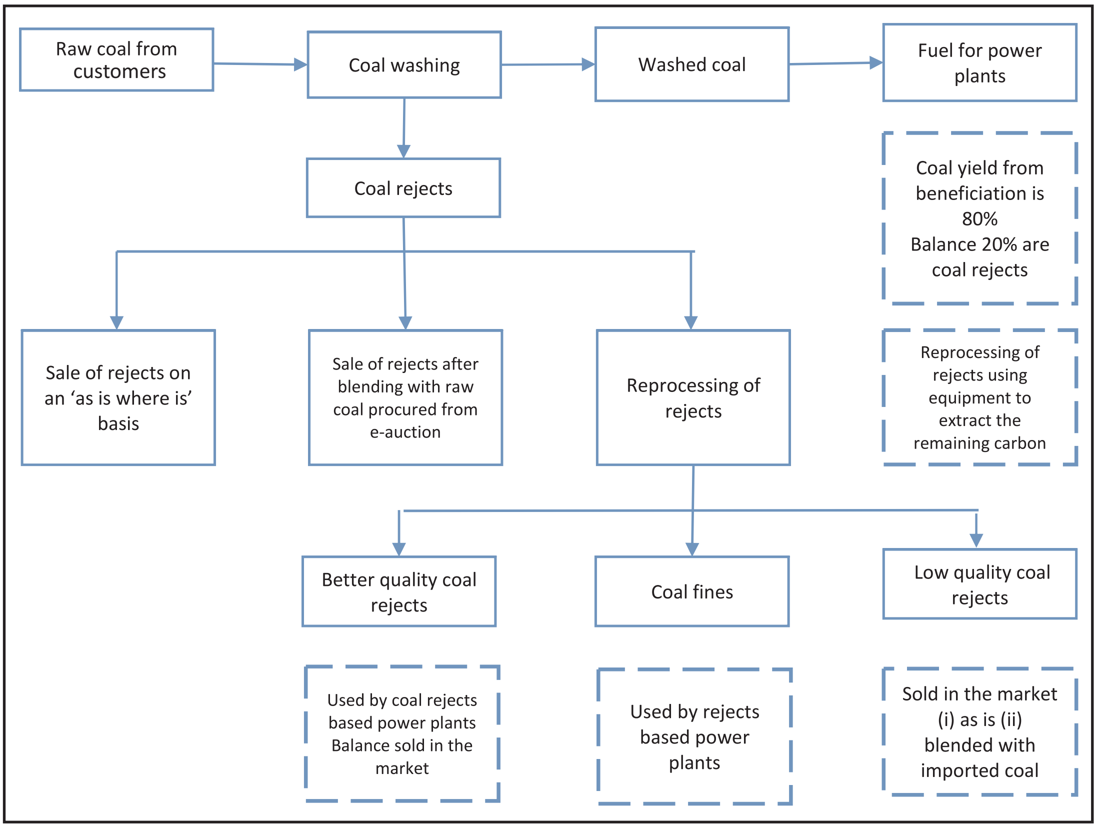
Deriving economic and environmental benefits from washing coal is not a new idea, especially with regard to non-coking coal used for power generation. However, these benefits do not come free. Some costs are financial – such as the increase in the cost of fuel – and others are transactional, such as how the process of coal beneficiation can be accommodated in the established system of coal supply and distribution.

4.1. Structural

Ahead of further de-control in the coal sector, widespread introduction of long-term coal supply contracts to address some of the issues raised may be desirable to protect producer and consumer interests. Such contracts are likely to serve as the natural medium to govern the supply of washed coal. In the future, coal may be supplied from new private sector miners. Should these private companies be required to produce washed coal, or otherwise see customer demand for clean coal, they would build, own and operate such plants themselves, following the general model adopted internationally wherein coal producers wash coal themselves.

As Indian coal is inherently difficult to wash, the loss in calorific value in rejects is often too high to disregard as 'waste'. Moreover, the rejects that contain combustible matter cannot be safely disposed due to problems of self-ignition. At the national level, the ideal situation would be for coal to be washed to the extent possible and the rejects used in an FBC boiler at the pit head. But this will involve incremental costs such as: (a) additional mining of coal to make up for the loss in the process of washing; (b) overall reduction in thermal efficiency in power generation using rejects; and (c) investment of capital in washeries and FBC plants.

Fig. 1: Flowchart of Coal Washery with Utilisation of Rejects in FBC



Source: Crisil

The environment would gain from coal washing, especially if pit head FBC generation is included. Land use may also increase, because of both the plant operation and the additional mining necessary. Water use and emission of dust and SO_2 could potentially be lower. CO_2 emissions will reduce without FBC, but emissions may increase with the FBC option for using rejects. There is a possibility that the value of freeing railway capacity may not be as high as presumed, as present tariff levels are high and often the largest component in the price of delivered coal.

If some part of the savings that are expected from coal washing is passed on to coal suppliers (including washeries) it can create an incentive to produce washed coal. Benefits at the national level could justify public support. Coal beneficiation offers a straightforward case for utilisation of the NCEF that is collected through a cess of INR 400/tonne on domestic coal production. The estimated NCEF collection for 2016-17 from CIL was about INR 239.44 billion (about $3.5 billion) out of which about a quarter is budgeted.[18] If the negative environmental externalities are internalised through environmental charges on power stations based on the 'polluter pays principle', it could attract private investment in washing. Free negotiation between the parties concerned may lead to a more optimum solution given that costs and benefits vary.

4.2. Environmental

A policy on coal beneficiation that is anchored in both economic and environmental considerations is likely to have greater impact than one based only on the latter. It is well known that for coal flows across long distances, washing coal leads to lower overall costs, so that environmental benefits are thought to be effectively free. Savings in transport costs is one element and it does not apply to all power plants. Other factors must also be taken into account, such as improvement in thermal efficiency, reduced land requirement for ash disposal, or reduced support fuel.

A system of permits, fees and fines, as used in some coal producing and consuming countries, may be considered.[19] Taking the land requirement for ash disposal under this system, a power station could be given a permit to dispose of a certain quantity of ash, the permit being case specific and agreed upon by a local environment enforcement agency. The fees are paid on actual disposals and are related to the environmental value of land used for dumping. The fees could also cover the future costs of full re-instatement of the lands used. Fines should be imposed on disposals in excess of permitted quantities. The permit limits should be set at a low enough level to act as a deterrent, so that the power stations avoid excess dumping by opting for washed coal. Environmental levies or fines imposed on plant operators for permits or for violating standards can be recycled to fund environmentally desirable projects.

Levies for ash disposal from a power station could also encourage the operator to sign a long-term clean coal supply contract with a potential Build Own Operate Transfer (BOOT) company, giving that company the firm foundation to raise funds for the washing plant.

4.3. Economic

Widespread concern about the quality of coal delivered to power plants is evident. However, this does not unambiguously point to setting up of washeries. Rather it points to an absence of quality assurance by the producers, an issue that can be addressed through policy and regulation. In most of the cases, the comprehensive balance of costs and benefits appears to justify coal beneficiation. At the power plant level, since only one part of the benefits (from freight savings) will be immediately visualised and other benefits (like improvement in plant availability and thermal efficiency) felt only in the long term, it is unlikely that demand for washed coal will materialise spontaneously without any push from policy.

Flexibility in choice between coal qualities will reflect a real option to users with widely different technologies. However, boilers currently in use may not be equally able to extract the final heat value of washed coal. Over time, inefficient boilers are likely to be replaced and would increase the scope for maximising benefits of washed coal.

The Ministry of Coal (MOC) has oversight of coal production and regulation, and the activities of state-owned coal companies. The MOC is most directly concerned with implementation of coal washing. Recent news reports suggest that the MOC favours increased beneficiation of coal. However, where public funding is involved, coal washing plants may be put at lower priority than investment to rehabilitate and expand coal production. Further investment from the private sector either for technology upgrade or for greenfield projects in washing is unlikely, given the dire state of the private washery sector. Unproductive washery assets of the private sector may be acquired by coal producers and utilised to the extent possible, as new capacity in washing will take some time to materialise.

The parameters that need to be emphasised for washery projects to become viable include the following: (a) firm source of coal supply; (b) commitment on supply of evenly spread and defined quantity of coal over a reasonably long period, say 15 to 20 years; (c) commitment on quality of raw coal feed (size, ash, moisture, etc.); (d) land for setting up of washery; (e) allowing backfilling of rejects into the mine; (f) sharing of infrastructural facilities such as power, water, and railways siding; (g) developing coal washeries in a cost effective manner is possible only if they are set up by the coal producer itself, wherein, it can make best use of sharing of common facilities. This will also eliminate risks associated with achieving the required parameters through contractual arrangements with washery developers.

(The detailed report on which this policy brief is based is available for download at www.orfonline.org, or can be made available upon request to energy@orfonline.org. Lydia Powell and Akhilesh Sati of the ORF's Energy Initiative compiled and arranged the contents of the policy brief. Questions and comments may be sent to akhileshs@orfonline.org)

DISCLAIMER

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ENDNOTES

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20, Rouse Avenue Institutional Area, New Delhi - 110 002, INDIA
Ph. : +91-11-43520020, 30220020. Fax : +91-11-43520003, 23210773
E-mail: contactus@orfonline.org
Website: www.orfonline.org