International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 - 5161

Available at http://inpressco.com/category/ijcet

Research Article

Production, Consumption and Future Challenges of Coal in India

Shadman Hussain Qaisar[Å] and Md Aquil Ahmad[Å*]

[Å]Department of Mechanical Engineering, Faculty of Engineering and Technology, Jamia Millia Islamia (Central University), New Delhi 110025, India

Accepted 01 Oct 2014, Available online 10 Oct 2014, **Vol.4, No.5 (Oct 2014)**

Abstract

In this paper, an analysis of present scenario of coal in India has been made. In particular, energy requirements for the developing countries are met from coal-based thermal power plants. In India, about 75% coal output is consumed in power sector. In addition, other industries like cement, fertilizer, chemical, paper and thousands of medium and small-scale industries are dependent on coal for their process and energy requirements. Since the country's dependency on coal is increasing, therefore it becomes mandatory for the government to seek for better technologies for fulfilling its needs. Also, increased allocation and better exploitation of coal within the country will moderate the quantity of coal imports, thereby fostering the independency and development of the country.

Keywords: *coal, production, consumption, power-generation, pollution, environmental concerns*

1. Introduction

Coal is the most important and abundant fossil fuel in India. It accounts for 55% of the country's energy need. Coal occupies the center-stage of India's energy scenario due to the limited reserve potentiality of petroleum & natural gas, eco-conservation restriction on hydel project and geo-political perception of nuclear power.

The Ministry of Coal frames policies and strategies for exploration and development of coal reserves. It exercise its functions through its public sector undertakings, namely Coal India Limited (CIL), Neyveli Lignite Corporation Limited (NLC), Singareni Collieries Company Limited (SCCL) and joint sector undertaking of Government of Andhra Pradesh and Government of India. The Geological Survey of India (GSI), the Mineral Exploration Corporation (MEC), SCCL, and CMPDIL map India's coal resources by under taking prospecting surveys in areas with potential coal resources. The Coal Ministry is held responsible for the administrative control of the Coal Controller's Organization, which gives grants for opening new mines, collects and publishes data on the coal sector, collects excise duties and monitors progress in captive mining (Ministry of Coal, 2006).

2. Coal Quality

Indian coal is considered to be of low quality since it contains ash as high as 45%, high moisture content (4–20%), low sulfur content (0.2–0.7%), and low calorific values (between 2500–5000 kcal/kg) (IEA, 2002). On the other hand, coal imported from other countries has low ash content of the order of 10-15%. However, Indian coal has lower sulfur content in comparison to other coals, although it has relatively high amounts of toxic trace elements, especially mercury (Masto et al., 2007). Thus, coal washing is necessary from economic and environment point of view. The present installed capacity of washeries for coal is about 131.24 million-tons per annum for both coking and non-coking coal (Energy Statistics, 2013).

Generally, ash is well intermixed into the coal structure and hence coal washing using physical methods is difficult. The high ash content also leads to technical difficulties for utilizing the coal, as well as lower efficiency and higher costs for power plants. Some specific problems with the high ash content include high ash disposal requirements, corrosion of boiler walls, fouling of economizers and high fly ash emissions (IEA, 2002). The directive of Ministry of Environment & Forests (MoEF) restricts the use of coal containing more than 34% ash content in power stations located 1000 km away from pit heads.

3. Coal Reserves and Production

India is the world's third largest producer of coal. It produces about 565.64 million-tons coal in the year 2013-14 compared to 556.41 million-tons in the year 2012-13. India has 301.56 billion-tons (Ministry of coal, Annual report 2013-14) of geological resource of coal estimation from whole country.

From figure1, it can be seen that the Indian coal deposits generally occur in the Lower Gondwana sediments and the early Tertiary sediments. Most of the major coal deposits are Gondwana coals in the eastern and south-eastern parts of India. The Tertiary coals are located in Assam and other north-eastern states, as well as Jammu and Kashmir. Coal deposits are mainly located in states

*Corresponding author: **Md Aquil Ahmad**

like Jharkhand, Odisha, Chhattisgarh, West-Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra. The Lignite reserve in the country has been estimated at around 43.22 billion-tons, of which 90% occur in the southern state of Tamil Nadu (Ministry of Coal, Annual report 2013-14). Coal India ltd. and its subsidiaries accounted for 452.21 million-tons in 2012-13 which increases to 462.53 million-tons during 2013-14.

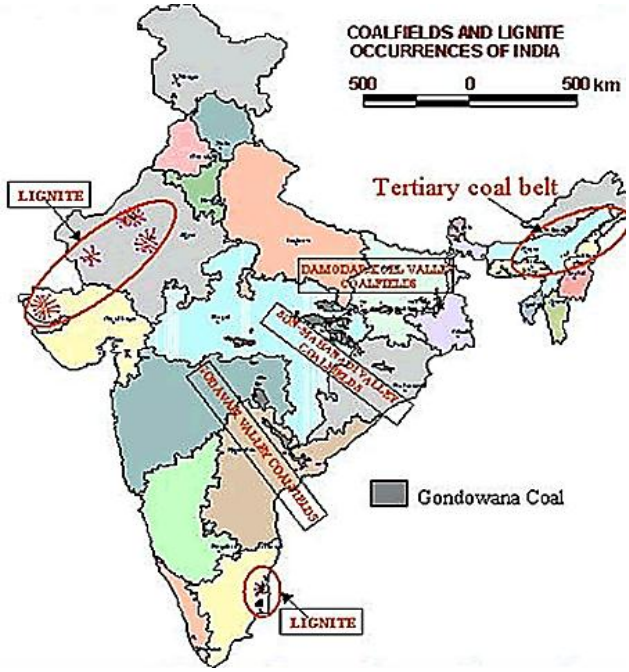

Fig.1 Map of India showing coal reserves in different parts of the country. *(Source: Geological Survey of India)*

Table 1 Production of Coal in India from different companies *(Source: www.coal.nic.in)*

Production of Coal in India (in million-tons)			
Company	2012-13	2013-14	Growth (%)
CIL	452.21	462.53	2.3
SCCL	53.19	50.47	-5.1
Captive	34.23	38.88	13.6
Others	16.78	13.76	-18.0
Total	556.41	565.64	1.7

Table 2 Inventory of Geological Resources of Coal in India *(Source: www.coal.nic.in)*

India's Coal Inventory				
State	Million-tons			
	Proved	Indicated	Inferred	Total
West Bengal	13403	13022	4893	31318
Jharkhand	41377	32780	6559	80716
Bihar	0	0	160	160
Madhya Pradesh	10412	12382	2879	25673
Chhattisgarh	16052	33253	3228	52533
Uttar Pradesh	884	178	0	1062
Maharashtra	5667	3186	2110	10963
Odisha	27791	37873	9408	75072
Andhra Pradesh	9729	9670	3068	22467
Assam	465	47	3	515
Sikkim	0	58	43	101
Arunachal Pradesh	31	40	19	90
Meghalaya	89	17	471	577
Nagaland	9	0	307	316
Total	125909	142506	33148	301563

4. Coal Consumption

In India, the demand and consumption of coal have grown enormously which is primarily dominated by the electricity sector. Since 1970, the demand for coal has increased due to the rapid installation of thermal power plants. About 13 million-tons of coal is consumed in electricity generation in 1970-71, which is about 20% of total consumption where as in the year 2009-10, it is consumed about 411.06 million-tons which is nearly 75% of total consumption (India Energy Book, 2012).

Other major coal-consuming sectors include iron and steel production and cement production. The iron and steel industry, which primarily consumes coking coal and some high-grade non-coking coal, is the second largest consumer of domestic coal, although its consumption has decreased from 19% of total consumption in 1970-71 to about 7% in 2009-10. The third largest consumer of coal in India is the cement industry, which accounts for 4 to 5% of total consumption. Other smaller consumers include the fertilizer industry, the textile industry (including jute and jute products), the paper industry and the brick industry. Table shows the consumption of raw coal (in million-tons) by different industries from 1970-71 to 2009-10.

Table 3 Consumption of raw coal (in million-tons) by different industries from the period 1970-71 to 2009-10 *(Source: India Energy Book, 2012)*

Year	Electricity	Steel & Washery	Cement	Others	Total
1970-71	13.21	13.53	3.52	40.97	71.23
1973-74	16.64	13.78	3.65	43.59	77.66
1978-79	24.8	20.26	4.88	50.21	100.15
1979-80	30.03	19.85	3.87	51.78	105.53
1984-85	57.66	25	7.29	51.5	141.45
1989-90	108.32	30.61	9.53	54.96	203.42
1990-91	113.71	30.91	10.43	58.31	213.36
1991-92	126.84	34.03	10.8	60.66	232.33
1996-97	199.62	39.76	10.08	49.16	298.62
2001-02	265.19	30.03	14.84	39.68	349.74
2002-03	267.9	30.6	16.35	46.89	361.74
2003-04	279.95	29.67	16.63	53.15	379.4
2004-05	305.34	34.43	18.09	49.54	407.4
2005-06	316.48	32.41	18.08	66.28	433.25
2006-07	331.58	34.9	19.67	76.17	462.32
2007-08	360.73	39.01	21.35	81.57	502.66
2008-09	407.49	40.98	21.78	67.54	537.79
2009-10	411.06	41.11	21.34	113.97	587.48

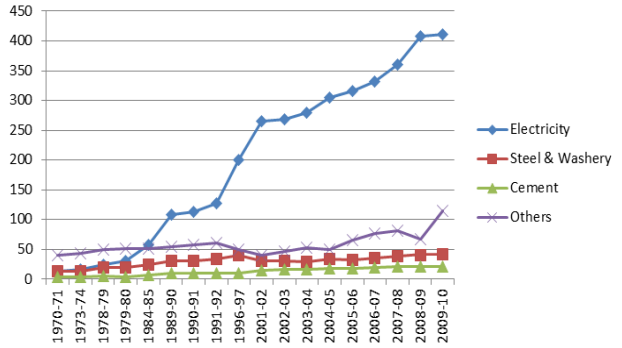

Fig.2 A graph showing trend in consumption of raw coal by various industries from the period 1970-71 to 2009-10 *(Source: India Energy Book, 2012)*

5. Foreign Trade in Coal

Since the average quality of the Indian coal is not very high, it becomes mandatory to import high quality coal to meet the requirements of steel plants. There has been an increasing trend in the import of coal from 20.93 million-tons during 2000-01 to 102.85 million-tons during 2011-12. During the above period, the quantum of coal exported increased from 1.29 million-tons to 2.03 million-tons (Ministry of Coal, 2013).

There was an increase of 49.24% in gross import and 56.29% in net imports of coal in 2011-12 over the previous year. However, there was a decline of 53.91% in export of coal during the same period. Figure 3 shows a graph for the import and export of coal (in million-tons) from the period 1980-81 to 2011-12

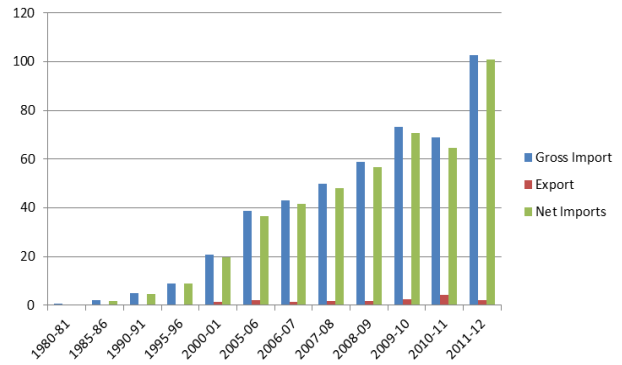

Fig. 3 A graph showing the import and export of coal (in million-tons) from the period 1980-81 to 2011-12 *(Source: Office of Coal Controller, Ministry of Coal, 2013)*

6. Environmental Concerns

In India, issues around local environment such as air pollution, water quality, and inadequate waste management continue to affect a large proportion of the country's population. The Environmental

Performance Index (EPI), a metric developed for 132 countries, placed India in the category of "weakest performers" at the 126th position overall and last in the terms of air quality. According to the World Bank report, environmental degradation would cost India US$80 billion per year or 5.7% of its gross domestic product (Ananth et al, 2008).

The all-India annual mean temperatures have shown a significant warming trend with an increase of 0.51°C per 100 years (Kothawale et al, 2010). The all-India annual mean temperature anomalies for the period 1901–2009, based on the 1961–90 average, show that the annual mean temperatures have risen by 0.56°C (Attri et al, 2010).

The significant impact of coal-based power plants on the local environment results from construction and ongoing operations (Chikkatur et al, 2007). These include

- flue gas emissions—particulates, sulfur oxides (SO_x), nitrous oxides (NO_x) and other hazardous chemicals
- pollution of local streams, rivers and groundwater from effluent discharges and percolation of hazardous materials from the stored fly-ash
- degradation and destruction of land, water, forests and habitats
- degradation of land used for storing fly-ash
- displacement, resettlement and rehabilitation of people affected by mining operations
- noise pollution during operation

In India, the development of technologies for limiting local air pollutants is still in process. Presently, flue-gas clean up technologies are mainly considered to be part of coal-utilization technologies. However, it is also important to discuss emission cleanup technologies separately because the country is routinely dependent upon one pollution reduction technology i.e. the electrostatic precipitator.

Table 4 A Table showing the available pollution control techniques *(Source: Chikkatur and Sagar, 2007).*

Cleanup Technology	Category	Emission cleaned	Applicable Technologies
Coal washing/ beneficiation	Pre-combustion	fly-ash, sulfur, mercury, carbon dioxide	PC, IGCC
Electrostatic precipitator (ESP)	Post-combustion	fly-ash	PC, FBC, IGCC
Bag-house filter	Post-combustion	fly-ash	PC, FBC
Cyclone	Post-combustion	fly-ash	FBC, IGCC
Sulfur removal plant	Pre-combustion	sulfur	IGCC
Limestone	In-combustion	sulfur	FBC
Flue gas desulfurization (FGD)	Post-combustion	sulfur	PC
Low-NO_x burners	In-combustion	nitrogen oxides	PC
Selective Catalytic Reducers	Post-combustion	nitrogen oxides	PC
CO_2 shift reactor	Pre-combustion	carbon-dioxide	IGCC
Amine scrubbing	Post-combustion	carbon-dioxide	PC, IGCC, FBC

(PC: Pulverized Coal, IGCC: Integrated Gasification Combined Cycle, FBC: Fluidized Bed Combustion)

From Table 4, it can be seen that emission-reducing technologies can be categorized into pre-combustion, in-combustion and post-combustion technologies. Coal washing and beneficiation can be considered as pre-combustion cleanup technologies since they increase plant efficiency, reducing the overall amount of emissions. Gas cleaning technologies in an IGCC plant to remove particulates and sulfur from the syngas are considered pre-combustion cleanup technologies, as the cleanup occurs prior to combustion. Low-NO_x burners in PC boilers and gas turbines, and the use of limestone for sulfur removal in fluidized-bed combustion, can be considered as in-combustion technologies. End-of-pipe technologies for PC plants—such as ESPs, flue-gas desulphurizers (FGDs), and selective catalytic reducers—are considered to be post-combustion technologies (Chikkatur et al, 2007).

7. Future Challenges

The XIIth Five Year Plan (2012-17), working group for Coal & Lignite has assessed a coal demand of 980.50 million-tons by the year 2016-17. The indigenous coal supply projection in the terminal year is projected to be 715 million-tons. The demand-supply gap emerging from these projections would be 265.50 million-tons, which will be met by imports of 35.50 million-tons of coking coal and 230 million-tons of non-coking coal (Indian Bureau of Mines, 2012). In the XII Plan period production from Existing and Completed projects of CIL is expected to decline from 218.37 Mt in 2011-12, Terminal Year of XII Plan, to 192.42 million-tons in 2016-17. Production from ongoing projects is programmed to increase from 227.63 million-tons in 2011-12, to 300.18 million-tons in 2016-17. Another 63.8 million-tons is envisaged to come from future expansion projects to be taken-up during XII plan. As many as 70 new projects and around 50 spillover projects of XI Plan are to be taken up in the XII Plan period (Planning commission of India, 2011).

The Ministry of Coal is planning to adopt web based monitoring system of coal-related activities on MS Projects software. Also, package based contract management eliminating delays to be devised and powers at various levels as per the enhanced empowerment of coal companies to be delegated down the line.

Conclusion

Coal plays a pivotal role in India's sustainable development. The demand for coal is increasing enormously since a large portion of electricity generation in India is dependent upon coal-based power plants. Despite huge allocation of coal reserves in the country, it is required to import it from other countries. Thus, it becomes necessary for the government to explore advanced technologies for enhanced extraction and processing of coal. Also, the environmental problems caused due to coal-related activities are serious issues and, thus, needs to be checked. Therefore, it is critical for policy makers not only to consider and implement technologies that meet the near-term needs of the country, but also to set the coal-based power sector on a path that would allow it to better respond to future challenges.

References

Annual Report (2013–14), *Ministry of Coal*, Government of India

Annual Report (2012–13), *Ministry of Coal*, Government of India

Energy Statistics (2013), National Statistical Organization, *Ministry of Statistics and Programme Implementation*, Government of India

Haque, Emamul M (2013), Indian Coal: Production and Ways to increase Coal supplies, *International Journal of Scientific and Research Publications*, Vol. 3, No 2.

Ananth P. Chikkatur, (2008), A Resource and Technology Assessment of Coal Utilization in India.

Ahmad M.A., (2014), A Statistical Review of Current Scenario of Generation and Utilization of Fly-Ash in India, *International journal of Current Engineering & Technology*, Vol. 4, No. 4.

India's Energy Sector, 2013 Centre for Monitoring Indian Economy (CMIE) Pvt. Ltd., Bombay

IEA (2002). Coal in the Energy Supply of India, *International Energy Agency*—Coal Industry Advisory Board.

IEA (2006), Coal Information 2006, *International Energy Agency*.

Masto, R.E., Ram, L.C., Selvi, V.A., Jha, S.K., Srivastava, N.K., (2007), Soil contamination and human health risks in coal mining environment.

India Energy Book (2012), *World Energy Council*, Indian Chamber Committee

TERI, (2005). TERI Energy Data Directory and Yearbook (TEDDY) 2004–05.

Kothawale, D. R., A. A., Munot, and K., Krishna Kumar (2010). Surface air temperature variability over India during 1901–2007, and its association with ENSO. "*Climate Research"* Vol.42, No.89, pg-104

Attri, S. D. and A., Tyagi. (2010). *Climate Profile of India*. New Delhi: India Meteorological Department

Chikkatur, A., Sagar, A., Abhyankar, N. and Sreekumar, N.,(2007). Tariff-based incentives for improving coal-power-plant efficiencies in India.

Planning commission of India (2011), Formulation of twelfth five year plan 2012-17, *Ministry of Coal*, Government of India.

Annual Report on Fly-ash utilization 2012-13, *Central Electricity Authority*, Government of India.

Annual Report on Fly-ash utilization 2011-12, *Central Electricity Authority*, Government of India.

Indian Bureau of Mines, (2012), Indian Minerals Yearbook 2012, *Ministry of Mines*, Government of India.