

A Synthesize Analysis of Coal Energy Utilization in Indian Power Plant

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Abstract

India is fast growing country in the world arena and leading to development with respect to all major changes happening around the world. Energy is the first and foremost requirement of every person residing in the society and willing to have the access source of electricity supply. Energy related to electricity is changing in demand day by day and electricity is now essential need for each and every person. Secure electricity and reliable power supply is dream of each and every person. For providing electricity to each and every household the major factors are reliability of the fossil fuel and on availability of the Coal Energy. Proper utilization and management of this energy is very much required. In this paper we have tried to broadly elaborate the coal energy management as per the future requirement keeping the view of mitigation and Basic cycle of thermal power plant.

Keywords

MTOE, GSI, ST (Supercritical Technology), HR (Heat Recovery), CGT, CTL.

I. Introduction

Coal as an energy sources is widely used for the electricity production and used in the various other industries for economic growth [14]. Coal is now prompts used because of the good energy density and flexible coal transportation in the most difficult location of the world.

India has ample coal resources and needs proper technology to explore the coal reserve and also and use it. The geological reserve of coal is such that the coal exploration is possible only with latest technology [2] and its wide application in the industry and power generation process. Indian coal is of poor quality and having more ash with low calorific value. Indian geographical coal reserve is mostly located in the eastern belt [9].

As the electricity demand is going on increasing day by day and now it is required to use appropriate technology in the Thermal Power Plant so that efficiency is to be high and also PLF in the plant is high. The power generation capacity is adding more and more [6] and it is expected to be 8, 00,000 MW by the 2031-32 keeping in view of electricity need. We require to add more capacity of plant. For adopting the latest technology with use of proper coal utilization and its management in the power station to be improved to promote the leakage losses in new modern power station [8].

For reliable and safe electricity requirement a constant and elevated growth is required for fuel demand and supply, which is basically depend on the projection plan of each and every country vision for their energy security. Fuel energy demand is increasing day by day and around 1500 MTOE (million tonnes of oil equivalent) is required by 2030[1]. For the power generation process coal demand is increased since 1970 and almost 76% of total coal production the country is going to be used in the power generation process. New technology has evolved to change the phase of the coal to gas or oil with the help of chemical reaction and this technology is called Coal Conversion Process. Phase change from Coal to gas is called Coal Gasification technology (CTG) and change of Coal

to liquid is called Coal to Liquid Technology (CTL) [5].

Energy is playing a vital role for powerful economic and social development of the country and it is going to impact on the environmental conditions of the nation and surroundings [1]. The energy is generated by the different sources of energy conversion which is playing a vital role but the source of primary energy is the important factor for the same. The fuel-wood or coal is playing a leading role for energy generation [5].

The commercialization of energy is basically depending on the how much quantum of energy is going to be generated by the help of the primary sources of energy. In many countries the commercialization of energy with primary sources will depend on how much energy efficiency [11] is going to be proximate on the Utilization of the coal. In Indian context the commercialization of energy is related to growing demand of electrification for use in power station [2, 17].

II. Availability of Coal

India has an estimated 22,400 square kilometers (sq. km) of potential coal-bearing area, and accordingly as per Geological survey of India 45% only explored (around 10,200 sq.km).

For better utilization of coal energy in thermal power plant to make the coal consumption to be less for per unit generation of electricity from coal and to make PLF to be high. The use of coal will also tend to change the pattern of technology selection for power plant and also to make the logistics support management for best utilization of coal.

The deposition of Indian coal in the India is found in two beds.

1. Lower Gondwana sediments (Permian)
2. Early Tertiary sediments (Eocene)

Table 1: Indian Coal Estimation

Formation	Proved	Indicated	Inferred	Total
Gondwana Coals	125315	142407	32350	300072
Tertiary Coals	594	99	799	1493
Total	125909	142506	33149	201564

III. Coal Reserve & Types

A. Total Reserve of Coal (World & India)

Table 2: Total Reserve of coal

	1993	2011	2020	% Growth 1993-2011
Population Billion	5.5	7	8.1	27%
TPES Mtoe	9532	14092	17208	48%
Coal Mt	4474	7520	10108	68%
Oil Mt	3179	3973	4594	25%
Natural Gas bcm	2176	3518	4049	62%
Nuclear TWh	2286	2767	3826	21%
Biomass Mtoe	1036	1277	1323	23%

B. Coal Reserve of Top 5 Countries

Table 3: Coal Reserves - Top 5 countries

Country	Reserves (Mt)		Production (Mt)		2011 R/P Years
	2011	1993	2011	1993	
United States of America	237295	168391	1092	858	>100
Russian Federation	157010	168700	327	304	>100
China	114500	80150	3384	1150	>34
Australia	76400	63658	398	224	>100
India	60600	48963	516	263	>100
Rest of World	245725	601748	1805	1675	>100
Global Total	891530	1031610	7520	4474	>100

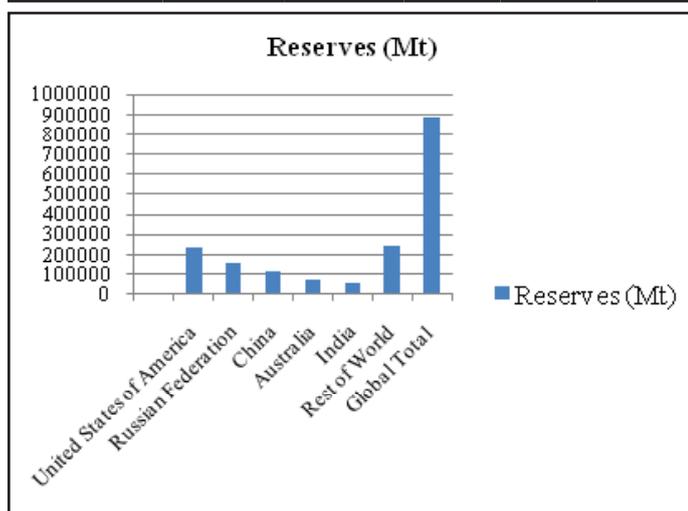


Fig. 1: Reserve of Coal

C. Categorization of Coal Reserve State Wise

The major availability of coal resources is available in older Gondwana and younger Tertiary formation of northeastern region.

Table 4: Categorization of Coal Reserve

State	Proved	Indicated	Inferred	Total
West Bengal	13403	13022	4893	31318
Jharkhand	41377	32780	6559	80716
Bihar	0	0	160	160
Madhya Pradesh	10411	12382	2879	25673
Uttar Pradesh	16052	33253	3228	52533
Maharashtra	884	178	0	1062
Odisha	5667	3186	2110	10964
Andhra Pradesh	27791	37873	9408	75073
Assam	9729	9670	3068	22468
Sikkim	465	47	3	515
Arunachal Pradesh	0	58	43	101
Meghalaya	89	17	471	576
Nagaland	9	0	307	315
Total	125909	142506	33149	301564

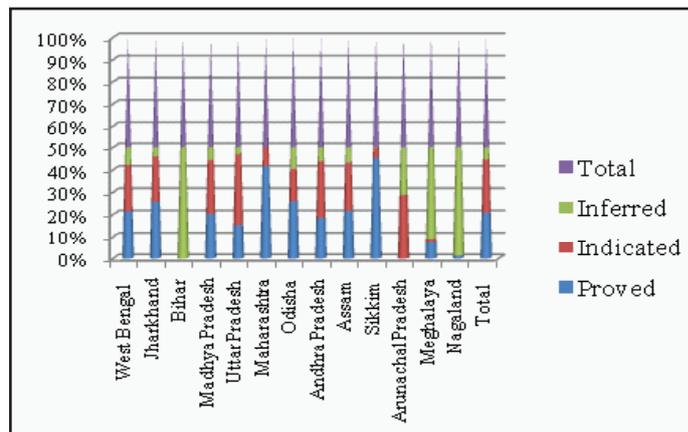


Fig. 2: Categorization of Coal Reserve

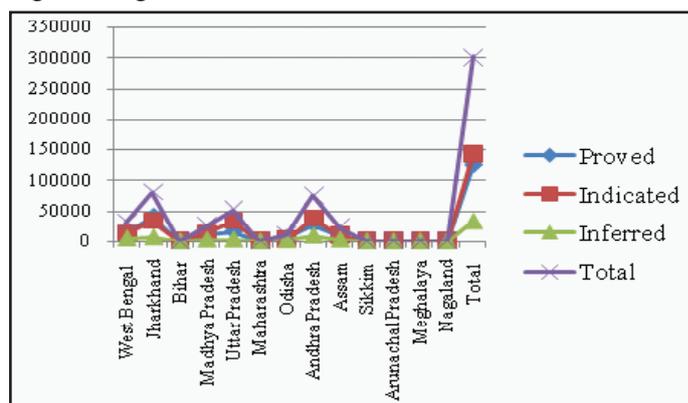


Fig. 3: Categorization of Coal Reserve

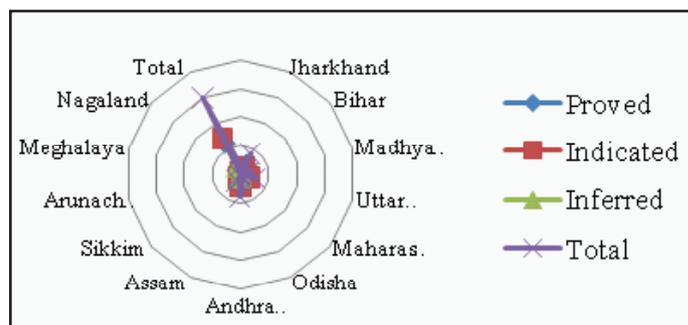


Fig. 4: Categorization of Coal Reserve

D. Inventory Estimated by Geological Resources of Coal in India

With reference to exploration [3] carried out the estimated depth of the exploration is 1200 m as the report of CMPDI, GSI & MECL etc. As per the report of CMPDI an estimated sum of 301.56 Billion Tonnes of Geological Resources of coal as on 01.04.2014.

Table 5: The Type and Category-wise Coal resources of India as on 1.4.2014

Type of Coal	Proved	Indicated	Inferred	Total
(A) Coking:-				
-Prime Coking	4614	699	0	5313
-Medium Coking	13303	11867	1879	27049
-Semi-Coking	482	1004	222	1708
Sub-Total Coking	18400	13569	2101	34070
(B) Non-Coking	106916	128838	30249	266002
(C) Tertiary Coal	594	99	799	1493
Grand Total	125909	142506	33149	301564

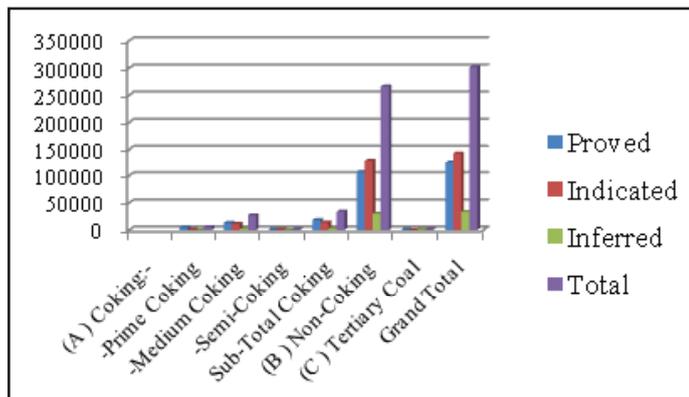


Fig. 5: Coal Resources of India as on 1.4.2014

Table 6 : Geological Reserve of Coal Available in India During Last Five Years

As on	Geological Resources of Coal			
	Proved	Indicated	Inferred	Total
1.4.2009	105820	123470	37920	267210
1.4.2010	109798	130654	36358	276810
1.4.2011	114002	137471	34390	285862
1.4.2012	118145	142169	33183	293497
1.4.2013	123182	142632	33101	298914
1.4.2014	125909	142506	33149	301564

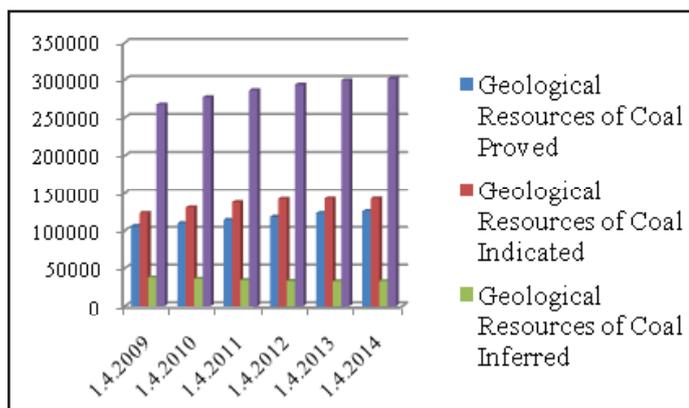


Fig. 6: Geological Reserve of Coal Available in India

E. Lignite Reserve in India

Estimated Lignite reserves in India have been around 43215.86 million ones. Lignite deposits mostly occur in the southern part of India. About 2.4 billion tonnes in the Neyveli area of Tamil Nadu have been stated to be regarded as ‘mineable. Annual production of lignite is currently in the region of 32 million tonnes, almost all of which is used for power generation [4]. The state wise distribution of lignite reserves as on 1.4.2014 is as follows:

Table 7: Lignite Reserve

State	Area		Geological Reserves (M.T.)
Tamil nadu & Puducherry	A.(i)	Neyveli Region	4150.00
	(ii)	Jayamkondacholapuram	1206.73
	(iii)	Eastern part of Neyveli	562.32

	(iv)	Veeranam	1342.45
	(v)	Others	987.82
	(vi)	Pondy (Bahur)	416.61
B.		Mannargudi Lignite Field	24202.34
C.		Ramanthapuram	1896.05
Total			34764.32
Rajasthan			5689.52
Gujarat			2722.05
Jammu & Kashmir			27.55
Kerala			9.65
West Bengal			2.77
Total			43215.86

IV. Road Map for Coal Demand & Supply

Coal is the primary resource of electricity generation in India for the next 25 years as the demand and supply situation is going to increase day by day and for the strong economic growth the cheaper electricity is now required [4]. Coal shall remain prominent fuel in India and major source of energy supply till 2031-32 and possibly beyond [6].

Various effective utilization techniques are required for the utilization of coal energy in India and for better utilization of coal energy Operational & Regulatory reforms are also required for Indian coal sector. Government has made sufficient incentives for coal productivity increase as per global standard and also the cost of coal production is to be reduced. For the better utilization of coal energy sources the qualified manpower is also required which can efficiently utilize the coal energy in to the thermal power plant. For increasing demand of coal energy for the sustained energy security growth for the next coming future various new technology had to be implemented for utilization i.e deep ground mining, Removal of Moisture, coal to gasification, in-site gasification, clean coal technology [2, 16] development for the power sector taking a view keeping carbon sequestration and storage.

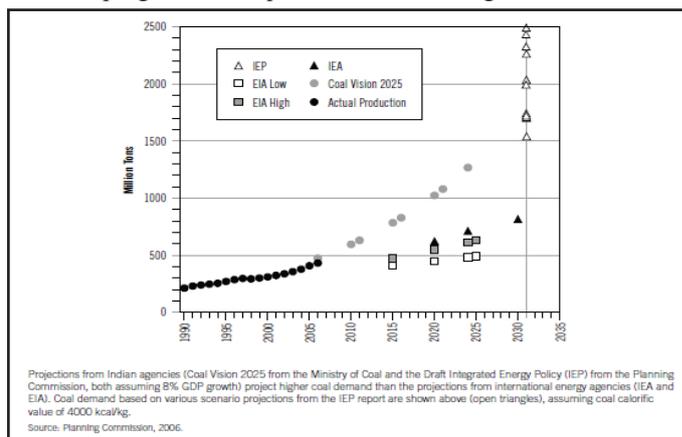


Fig. 7: Projected Demand of Coal in India

1. The demand forecasts of Twelfth Plan for coal would call for an increase in consumption from an annualized rate more than 7%. It is required to maximize a foot increase of coal production in India by not only increasing domestic coal production but also importing power grade coal [2] from international market keeping in view demand of power sector. By adopting the new coal exploration technology [3] in India the production of coal

exploration is increasing and many current mining exploration companies are adopting new technologies for exploration. Keeping the future need of coal for power the high grade coal is importing from international market with the help of Indian coastal belt associated with Maharashtra, Gujarat, Karnataka and , Kerala, Tamilnadu [10].

2. More attention is needed for analysis of gaps (demand-supply) for coal resources in India. While the available data is adequate to rely on coal as the primary source of supply of commercial fuels for the next 25 years. But as the demand of coal consumption is increasing keeping in view of proved reserve which provides a confidence for coal to be available for the 2031-2032 keeping in view of effective energy policy.

India is in a position to play a crucial role in the International coal market in the next coming future. In terms of coal consumption, China is number one with over 2 billion tonnes and United States is number two with 1300 million tonnes, India is the third largest consumer with only 460 million tonnes which is way behind United States. Increasing coal demand both in power sector & other sectors, India and China would continue to consume more of coal [9, 18]. In India whole country should be made aware of the importance of coal utilization in power sector [10] and necessarily need of appropriate policies at the national level. Coal for the power sector should be given due recognition to make India as an Electricity secure country. India is not the only country which has substantial quantities of relatively poor quality coal resources but in the world more than 28 countries are there producing poor quality of coal. In United states coals having ash content more than 33% are not included in the coal resource assessment unless these can be easily washed to produce good coal for utilization [12]. Gondwana coals of india are of much better quality coal compared to that of South America (Brazilian coals generally have high ash and high sulphur) and these low grade coals are being used for generating power.

V. Fuel Requirements for Power

The generation of electricity from domestic coal is cheaper in comparison, because of the availability the utilization of this domestic coal has to be done well in advance and for proper use [12]. Hence the consumption of domestic coal has to be made first and it should be more than 1,100 million tons (Mt) by 2031-32. As technology is developing and its requires good quality equipments for efficient use of coal and it's by product ash. It is also having good quality of ash collection [8] in the confined equipment called as Electrostatic Precipitator [10]. For The amount of imported coal used as per the necessary need of electricity sector was different based on the consumption at the rated, high & base load. The projection plan for the Total imported coal in the power sector was given below.

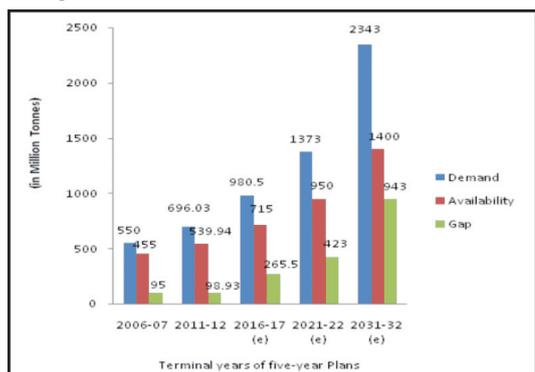


Fig. 8: Demand vs Gap vs Availability Analysis of Coal

Table 8: Projection Plan for Total Consumption of Imported Coal by the Power Sector (Mt)

Year	2011-12	2016-17	2021-22	2026-27	2031-32
Base	73	88	138	266	355
Low	61	28	27	28	61
High	76	106	158	295	460

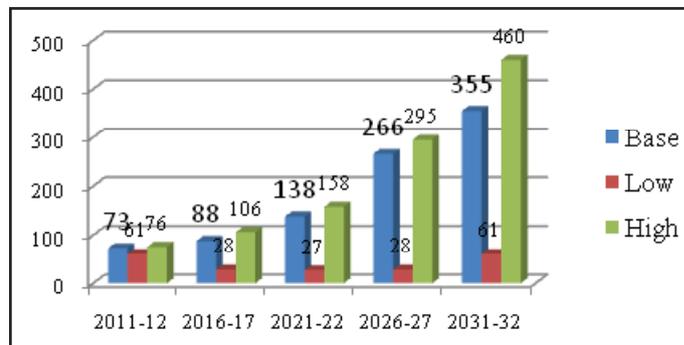


Fig. 9: Projection Plan of Total Coal Consumption from Imported coal

VI. Mitigation of Exploration of Coal & Its Utilization in Thermal Power Plant

A. Exploration of coal energy Storage

Coal used in thermal power plant having high ash content which will be extracted out when this coal is to burnt in the boiler and by product is termed as Ash [9]. The Ash will be termed as fly Ash and Bottom Ash. And the availability of coal is coming from Exploration. Using good and efficient technology for the pollution control will lead to environment norms and will provide a good kind of environment [15]. In the Indian context the exploration of the coal is widely implemented by the two ways detailed exploration and Regional exploration of the coal for the various uses. The wide range of coal exploration through regional exploration is carried out by the Government Bodies and the detailed exploration of coal is mainly carried out by the coal companies and subsidiaries. The detailing of the coal exploration in India is widely covered by the way of coal technology and its exploration strategy.

A. Regional Exploration

In the beginning of exploration Govt of India with due consultation of the Geological Survey of India (GSI) looking for Exploration of large and spread areas to find out the availability of Coal seams, geological belt for coal and other resources if any. Ministry of coal is taking the regional exploration of coal on the promotional basis with systematic and routines planning. The main concentration and promotion for the regional exploration is because of the first stage of coal exploration and it is going to decide the seam availability and its operability throughout the belt. Govt of India introduced regional and promotional exploration of coal scheme for Coal and Lignite in the year 1989 and implemented on plan to plan basis with the help of Mineral Exploration Corporation, Central Mine Planning and Design Institute, Various State Govt, etc The Exploration activity is in the vast manner and it requires the nodal agency for various activity and CMPDI plays a nodal agency for disbursement of funds for Regional Exploration besides carrying out technical supervision of MECL's work in Coal Exploration sector. As per XII plan of Regional Exploration it is proposed to explore 8.14 lakh metre of drilling (4.80 lakh metre in Coal and 3.34 lakh metre in lignite) along with Auxiliary components

of creation of Coal & lignite information system and Coal Bed Methane.

B. Detailed Exploration

After the promotional exploration studies the detailed exploration is to be carried out and these blocks total geological assessment to bring the reserved capacity. For detailed exploration the mine feasibility reports are prepared and on the basis of mining plans the exploration [3] is to be carried out. Geological Reports of such detailed exploration is executed on the basis of Mine Feasibility & Mining Plans. National Coal Inventory is formed on the basis of total coal availability. Ministry of Coal Plan scheme of Detailed Drilling in Coal Blocks/Captive Mining Blocks aim at covering exploration of Coal blocks in order to reduce time Gap between allotment and development of blocks. The scheme of Exploration is developed on the basis of plan-to-plan basis. In the XII plans 20.13 lakh meter of drilling of coal seams through the CMPDIL

VII. Technology Development of Thermal Power Plant

Coal Energy is playing a vital role for delivering electricity because of its availability, reliability and low cost for generation [13]. One of the biggest challenges facing the world at present that approximately 1.2 billion people live without any access to modern energy services. Access of electricity is the pre-requisite demand for modern life and plays a key role to take out from the poverty line. Cheap and safer electricity plays a vital role for development of base-load to be feeded in the national grid. Thus coal based energy plays a vital role to feed all this to national grid for the economic growth. Now the pattern of coal utilization in India is changing from last one decade and the efficiency of utilization [12] is also increasing [11] because of the proper identification of heat recovery process and fuel consumption. The efficiency of fuel is maximizing because of the reducing the fuel consumption not in India only but also in China [9], Europe, and North America. The next generation of power plant coming in India is basically based on the advanced technology of steam generation i.e Supercritical Technology (ST) and Heat Recovery (HR), Process Recovery plant. The below figure is an overview of power plant technology.

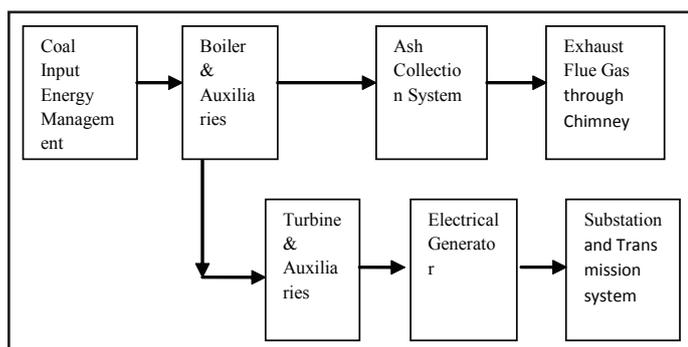


Fig. 10: Review Cycle of Thermal Plant

VIII. Conclusion

The above paper is going to represent the condition of the coal structure in India and its availability outline. The process requirement for change of coal energy to the electricity is required good utilization techniques and also at the same moment of time a good management. In this paper we have tried to represent the technology view for the electricity generation process and coal management.

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