

Roadmap For Indian Coal Sector

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Current Status of Energy Consumption –Primacy Of Coal

Coal continues to be the primary source of commercial energy supply in India. The major sources of primary commercial energy supply in India are Coal, Oil products, natural gas and primary electricity produced from non-fuel sources such as hydropower, nuclear power and renewable energy technologies.

Table 1: Share of different Fuels in total energy consumption.

	Total PCES In Mtoe	Coal Mtoe (%)	Oil Mtoe (%)	NG Mtoe (%)	Primary Electricity Mtoe (%)	IMPORTS Mtoe (%)
1980-81	97.9	58.5 (59.7)	34.0 (34.7)	1.3 (1.3)	4.2 (4.3)	23.7 (24.2)
1990-91	191.5	114.4 (59.7)	59.7 (31.2)	10.9 (5.7)	6.5 (3.4)	32.1 (16.8)
2000-01	314.1	175.2 (55.8)	107.4 (34.2)	23.9 (7.6)	7.6 (2.4)	93.6 (29.8)
2003-04	351.8	200.5 (57.0)	117.1 (33.3)	26.5 (7.5)	7.8 (2.2)	109.0 (31.0)
Growth Rate 80-03	5.7 %	5.5 %	5.5 %	14 %	2.8 %	6.9 %

Total PCES=Total Primary Commercial Energy Supply

Mtoe=million tones of oil equivalent

Coal includes Lignite

Primary electricity=produced from non-fuel resources

The pattern of fuel consumption is fairly in conformity with the fuel resource endowment of India. Though in relation to the population and needs, our overall energy resources are small, among the available commercial energy resources coal reserves are the largest followed by oil and natural gas. Our hydro-potentials are large but the extent it could be exploited is constrained by inter-state and environmental issues.

The current knowledge regarding the energy resources of India could be roughly summarized as set out in the table below:

Table 2 : Summary of energy resource potential

Resource	Total potential	Usable Resource	Level of Use 2005	Years of use At 2005 level	Remarks
Coal *	92.96 Billion Tonnes BT Proved reserves	52.24 BT	400 million tonnes	130 years	With 7-8% growth of production it might last 50 years More reserves likely to be proved.
Oil reserves	739.1 Million Tonnes (MT)	739.1 MT	33.98 MT	22 years	New discoveries appear remote
NG reserves	922.8 Billion Cubic Meters (BCM)	922.8 BCM	31.78 BCM	29 years	New discoveries Very likely
Hydro-potential	150,000 MW at about 40% load factor	150,000 MW	30936 MW	-	Future projects mostly peaking

Notes: Coal does not include Lignite. Several deposits of lignite are becoming usable

Long term energy needs forecast

In the past there have been several forecasts of India's future energy needs made by various agencies. They were based on different assumptions of the likely growth rate of GDP, population and other variables. The recently completed Report on Integrated Energy policy (IEGP) has made an authoritative forecast on the assumption of 8% per year growth of GDP and assuming that the past long term trend in energy-GDP elasticity would continue in future. For the analysis in this paper IEGP forecast is taken as the basis.

This exercise was done in five steps as follows:

- 1) Using the estimated GDP- Energy consumption elasticity trend in future the total PCES required in the Indian economy in end year of the future five year plans was projected till the year 2030.
- 2) Using the GDP-Electricity elasticity in future the demand for electricity in Kwhrs was estimated for the same period.
- 3) Using trend elasticity and some econometric models the non-electricity demand for Coal, oil products and natural gas was projected.
- 4) Considering the price trends and the limited availability of fossil fuels the forecast was made of possible levels of production of electricity from hydro, nuclear and renewable were projected on the most optimistic basis.
- 5) From step 3 and step 5 the quantity of electricity required to be produced from either coal or natural gas was derived. Assuming that in future years also the share of NG based would be about the same in percentage terms the likely energy demand for the next twenty five years was projected.

The summaries of these estimates are set out in the tables below:

Table 3 : Forecast of energy demand fuel-wise under IEP Report Preferred Scenario

All in Mtoe

Year	Hydro	Nuclear	Coal & lignite	Oil	Natural Gas	Total PCES
2006-07	9	7	204	125	36	381
2011-12	15	15	269	157	52	508
2021-22	24	54	456	259	108	901
2026-27	34	79	632	334	155	1234
2031-32	43	115	816	435	224	1633
Growth rate per annum 06-31	6.7	12.2	5.8	4.1	7.6	5.9

This scenario is based on the view that coal production cannot increase at rates different from the past and the large increase in power demand should be met by pushing the growth of Hydel and nuclear generation to the maximum limit and use NG to produce the thermal power to

supplement coal based power generation. However this scenario wishes away the major issues in increasing Hydel and nuclear power generation to the levels projected in the scenario, though the IEP report clearly lists the problems. For the current analysis we would assume that non-fuel based power generation could be as projected in this scenario. In thermal power generation the choice of fuel is decided by the relative cost, availability and supply reliability of the fuels. Among the fuels, oil has priced itself out In future either Coal Or NG could be used. At each Plant location the cost of fuel, capital-cost of the plant, availability and reliability would determine the fuel choice.

- A coal-based power plant costs about Rs. 4.2 crores/MW resulting in a fixed cost of Rs.1.20 per Kwhr of electricity. Coal delivered to a power plant at 600 kms would cost Rs 1500/tonne leading to a fuel cost of Rs 1.05 per the cost of Power would be Rs. 2.25/unit.
- A gas based combined cycle plant would cost Rs.3.0 crores/mw resulting in Rs.0.95 per Kwhr. Even if the cost of gas delivered at the plant-gate is \$4.00 per million btu, the fuel cost would be Rs. 1.40 which makes power cost Rs. 2.35 which is higher than coal based power.
- Further, imported gas price may be indexed to oil price, leading to uncertainty and volatility of future price. If on a later date Gas price rises very high, the variable cost of the plant might reduce the dispatch level.
- If Coal is available at Rs.1500/t; NG for power at more than \$4.00/mmbtu would be unacceptable. The current policy of import-parity pricing (IPP) for oil and natural gas obliterates completely the difference between indigenous and imported oil and NG. Under this price policy, NG price has become unpredictable. The chances of getting into a long term contract linked to a fixed price appears remote even if more NG is discovered in Indian waters under NELP.

In view of these considerations we shall adopt this scenario of IEP. This also has related issues-

1. The availability of coal to achieve this scenario is doubtful as the information and knowledge we have of the coal reserves do not give details of the quantity, which can be extracted economically.
2. There are several developments like townships and industrial establishments, which have come up in the mining area where we could take up mining only after incurring huge amounts in rehabilitating the existing population.

3. The new levels of environmental standards are so high that many of the areas covered by the identified coal deposits might not get environmental clearance.
4. The Coal industry is dominated by two public sector companies namely: Coal India Limited and Singareni colliery company limited whose ability to increase production beyond a growth of 5% per year may be limited. The introduction of competition by allowing private industry in coal mining is not possible under the existing laws governing the coal industry.
5. The coal transport is very costly in India, as the tariff for coal transport by rail has been fixed with a large element of cross subsidy to the passenger transport. There are places in India far away from the coalmines where the cost of coal including transport cost is almost equal to the cost of imported coal at the current levels. It would therefore be reasonable to use either imported coal or imported gas at an appropriate price instead of using Indian coal of low calorific value and taking it over long distances.

Availability of Coal

The achievement of the production level of 1900 million tonnes in 2031–32 would be feasible only if adequate deposits of proved resources are established and the mine development reports are completed about one Plan Period ahead of the Mines construction:

“CMPDI has given a tentative estimate of extractable reserves in the country as a whole in the Coal Vision document 2025 as on 1.1.2005 on the basis of the following criterion:

Detailed exploration connotes confidence level of 90% in the reserves established Regional exploration establishes the reserves in Indicated and Inferred categories. Confidence level of 70% is paced for indicated reserves and 40% for inferred reserves as worked out by the Association of German Metallurgists and Mining Engineers.

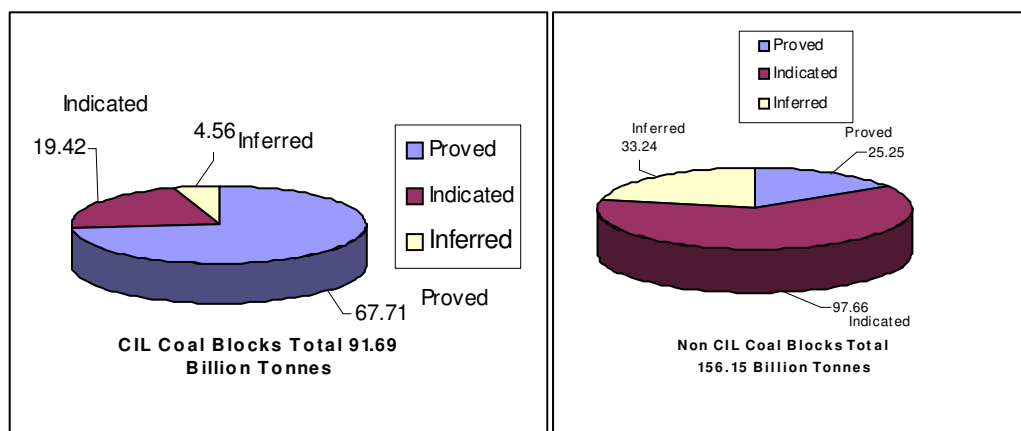
Average RP (Reserves to Production) ratio of 4.7:1 is assumed in making a broad assessment of production possibilities from Proved, Indicated and Inferred reserves. This establishes CMPDI's extractable reserves although this ratio would vary widely for individual projects

Table below gives the National inventory of Extractable Reserves as estimated by CMPDI upto 1200 m depth.

Table 4: Tentative Extractable Reserves of the National Coal Inventory

All in billion tonnes

Area	Geological Reserves				Extractable Reserves
	Proved	Indicated	Inferred	Total	
CIL Blocks	67.71	19.42	4.56	91.69	30.03
Rest	25.25	97.66	33.24	156.15	22.21
Total	92.96	117.08	37.80	247.84	52.24



These details reported above clearly highlights the fact that the data on India's inventory of coal reserves as also the estimates of extractable reserves could benefit immensely by an independent assessment. As a matter of institutional design, any structure wherein all detailed exploration for coal is done exclusively by a single entity is bound to be sub-optimal. This would be so in any field and though CMPDI is a highly competent coalmine-engineering group one cannot act always on the opinion of that single agency. The situation is further complicated by the fact that CMPDI is a subsidiary of CIL, the dominant player in the sector. There is a strong feeling among the new aspirants for coal mining that CMPDI, under the present structure, is likely to be guided by what is technically feasible and economically advantageous for Coal India. Clearly the entire debate on India's coal reserves, optimal strategy for extracting these reserves and the appropriate mining technology need to be debated more openly without any bias. There should be multiple technical agencies to assist India in strategizing coal exploration and exploitation efforts. Most importantly, if one accepts CMPDI's estimates of extractable reserves and domestic production is assumed to increase by 5% per

annum, India's coal reserves may serve us only for 30-40 years which will of course get extended as CMPDI every year adds around 2.8 to 3.0 billion tonnes of proved reserves. While, our knowledge as mapped by CMPDI does not support the view that we have "huge resources", it does provide confidence that at least in the next thirty years coal requirement of all sectors including power could be met from our resources. This opens the window of opportunity to speed up our efforts to accelerate the pace of regional surveys and drilling to complete the comprehensive coal resource assessment exercise and to re-examine the foundations of our energy security policies and programmes.

The Expert Committee has concluded that in order to derive the level of confidence needed to plan for long term coal dependence, there should be a time-bound plan to cover the entire country by regional mapping in 15 years by GSI, CMPDI and MoC. Funding for this should commence from the XIth plan. The MoC must launch a program of detailed exploration and drilling, in the 11th Plan, aimed at increasing proved category reserves. The Committee has recommended the creation of a Revolving Fund of Rs. 500 crores for this purpose. The fund would recover the outlays once the mining leases are granted for the reserves so proven. Such an enhancement in the capacity for detailed exploration could potentially add about 10 billion tons of coal to the proven category annually

In view of the enthusiasm for coal mining now appearing in the major coal users, their efforts should be enlisted even for exploration for coal resources. There is need therefore to introduce exploration-cum-mining leases in coal industry on the lines of NELP (New Exploration Licensing Policy) in the Oil Sector.

Institutional Capability

Since the time of nationalizing the coal industry, only two major coal companies are responsible for the production of coal, which is supplemented by the projection for self-consumption by the steel industry. The average increase in coal production over the last 25 years has been about 5%. The Nationalization of the coalmines Act does not permit coal to be mined by private companies except for self-consumption. This in effect means that coal can be mined and sold and traded by any state or central public enterprises and the act does not give the monopoly rights to CIL and SCCL. The Ministry of Coal and EC have strongly advocated that encouragement must be given to large consumers of coal especially the power plants to take up captive coal mining. Though

this policy has been in force for a few years, the proven coal blocks have all been declared as reserved for mining by CIL and the blocks available for allocation to private sector for captive mining were small reserves and at relatively inaccessible locations. But, in the last two years this situation has been changed and the blocks which have been not planned to be open up before 2016 have all been now freed from CIL and are being made available to private industry for captive mining and to state level public sector mining corporations. Recently, GOI have decided to permit 100% foreign private participation in coal mining and have also de blocked some large coal potential areas to be given as a package for mining and setting up power plants up to 4000MW capacity. The Sasan plant would be based on local coal and the Mundra plant would be on imported coal. Both would be based on super-critical technology and the Sasan plant would get a coal block for captive mining. The introduction of new players in the coal mining through captive mining route is bound to introduce a large element of competition.

There is also need to restructure the public sector coal companies to make them world class. CIL, in size is comparable to the largest coal companies of the world. The question for consideration is whether CIL should be considered as functioning as one company or several companies linked only by ownership. The subsidiaries are incorporated as individual companies with a governance structure, where the Government appoints the Chairman and Managing Director and the Directors directly and one or two Directors on the Board are nominated as representative of the Corporate Office of CIL. The subsidiary companies pay corporate taxes on the basis of financial results of the individual subsidiary companies. The subsidiaries get the production targets settled at the ministry level, though CIL actively participates and plays a significant role.

There are advantages of the largeness of the size of a company. It helps in building and nurturing a Brand and a corporate culture. Large size helps to recruit and retain the best technical and management personnel. It helps in import and export negotiations and in building and managing potential coal mines abroad. Large size of a company helps in managing its training activities economically and efficiently. Size plays an important role in managing efficiently the procurement and maintenance of new and costly mining equipment, new technology

The issue of restructuring the CIL has been examined on several occasions in the past. The most significant suggestions have come from the Chairman's observations in the Report of the Committee on Integrated

Coal Policy (1996) (Chari Committee) and the Report Of KPMG. Mr.Chary had expressed the view that in the long run interest, each of the present subsidiary companies of CIL should become an independent company and gradually CIL should wither away. He felt that this alone will make them independent, competent and commercial units. This would also prepare these companies for adjusting themselves to the liberalized new economic policy which might lead to opening the Coal Sector to private players. KPMG had made elaborate study of the various alternatives from the point of view of finance and taxes and operational efficiency. The KPMG report concluded that from tax and financial point of view complete merger of CIL and subsidiaries into a unitary company on the pattern of NTPC would be advantageous whereas operational efficiency would considerably improve if there is total desegregation of the subsidiaries into autonomous companies. EC examined the issue de-novo and had wide consultation with the management and workers of all Coal entities including CIL, CMPDIL, operating subsidiary companies of CIL, SCCL and NLC. Taking all the suggestions and fears and threats as perceived by the Coal Industry executives and workers, the Committee felt that while entrusting a very onerous responsibility to increase its production from the current over 400 million tonnes to nearly a 1000 million tonnes in the next ten years, it would not be appropriate to make major changes in the structure of CIL. At the moment, such restructuring would give rise to a number of issues relating to relative seniority of the personnel and their positioning of staff. However, the Committee felt that the current structure of CIL and the role and responsibility given to the CIL as the Corporate Company and the subsidiaries would require some changes at the corporate level only and defer major organizational changes to XII plan.

As the current structure of Coal India Limited creates substantive imbalances between authority and accountability, EC has recommended that Chairman CIL should be made Chairman of all subsidiary companies. As he may not be able to attend all the meetings, he should have the facility and power to send an alternative to the Boards of the subsidiaries

or for each of the companies there could be a chairman and another representative of CIL on its Board. The current CMD of the subsidiaries can be re-designated, as Vice Chairman and Managing Director (VC and MD). The Chairman, CIL should be given authority to transfer functional directors of the subsidiaries from one company to the other. CIL should be given the authority to encourage and approve the subsidiary companies taking up coal mining activities in the geographical command area of the other subsidiaries. The current system of earmarking specific areas as

the geographical command area of each subsidiary does not help competition and also does not permit the transfer of technical capabilities from companies which are facing exhaustion of economic, viable coal reserves in their area. In short, Chairman CIL who is given the mandate to deliver coal to the extent anticipated in the 11th and 12th Plan Periods should have the authority to deploy all resources of men, material and machinery to different subsidiaries as per the requirements. Needless to say, for specific services rendered by one company to the other, the receiving company will make a payment to the providing company. The blocks transferred to a coal company in an area beyond its command area will naturally form part of the subsidiary who takes up such mining activities.

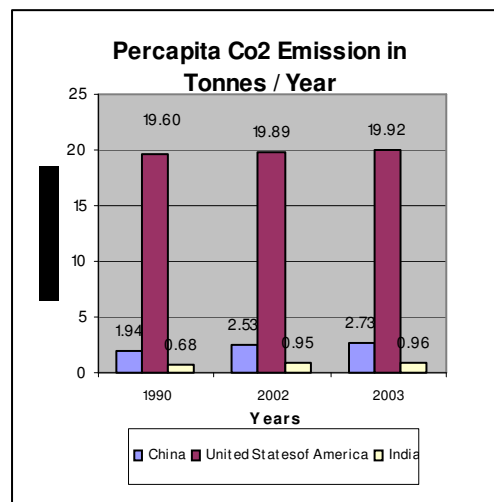
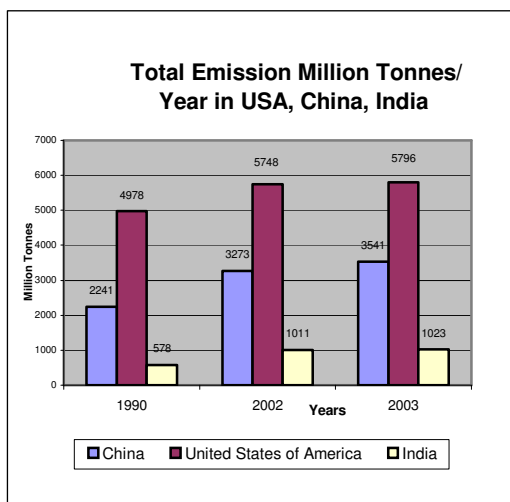
Environmental Issues:

There is a view among environmentalists that India's coal production is environmentally damaging and the plans to increase the production and consumption of coal in India will be disastrous from the point of view of Climate Change. EC does not agree with this view. While, any carbon burning would lead to addition of the load of carbon dioxide on a global scale and would have an impact on climate change, the issue of climate change and reduction of carbon dioxide emission is a matter covered by agreements between countries on the basis of the Kyoto protocol. India is an important participant in these discussions and would play its part. As of today it is not among the countries which need to arrest the level of carbon emission to a specified rate. The total carbon emissions per year

and the per capita, Co2 emissions of the three large users of coal are listed below:

Table 5 : Carbon Dioxide Emission in USA, China, India

Name of the Country	Total Emission in Million tonnes/Year			Per Capita Emission in tonnes/year		
	1990	2002	2003	1990	2002	2003
China	2241	3273	3541	1.94	2.53	2.73
United States of America	4978	5748	5796	19.60	19.89	19.92
India	578	1011	1023	0.68	0.95	0.96



As seen from this table, India's total carbon emission is not even 1/3rd of China and 1/6th of USA. In terms of per capita emission India is far below US. In the next 25 years, even if India's population grows to be around 1.6 billions and coal consumption is about 2 billion tonnes, as discussed in the section of demands, India's contribution in terms of total CO2 emission and per capita emission, would be far below the current level in US and in China. India should however assume its role as a responsible user of coal and take every effort to reduce the emission level or to eliminate it by developing and adopting clean coal technologies at the stage of production of coal as well as its consumption. If the environmental issues are adequately addressed, India can use more coal as projected and can also become an exporter and importer of coal like China and USA and play a significant role in the world market in coal trading.

Productivity Improvement

The key challenge for increasing production to the levels anticipated is to increase the productivity of coal mines in India. This is low compared to the productivity in other countries. This issue has been examined and the Expert Committee has made several recommendations. The Committee has noted that on record, the coal productivity has been slowly increasing and has reached from 0.58 in 1974-75 to 3.05 in 2004-05. But this has been achieved by increasing the share of open cast mines in the total quantity of coal mine in each company. The large increase in coal production envisaged now can be achieved only by focusing on the technology and productivity in both underground and open cast mine. This would call for increasing the level of mechanization, introducing the state-of-art machines and ensuring their optimal utilization as per international standards. Very specific recommendations have been made for improving the underground mining technology.

Under-ground coal mining technology has made rapid strides in technology up gradation in the world though it has been relatively stagnant in India. The technologies presently in vogue in the underground mines are as follows:

1. Conventional Bord and Pillar system
2. Semi-mechanised Bord and Pillar system with Side Discharge Loaders (SDLs)/Load Haul Dumpers (LHDs)/Universal Drilling Machines (UDMs)
3. Mechanised Bord & Pillar/Room & Pilar system with Continuous Miners (CMs)
4. Mechanised Longwall(PSLW) mining system
5. Special methods (i.e. site specific methods) like Blasting Gallery (BG) method; Cable bolting method, wide and stall method, steep mining methods, etc.

Alternative technologies for extraction of resources by underground mining in geologically disturbed areas and deep-seated coal resources will depend primarily on the intensity of geological disturbances and depth of occurrence. The prevailing technologies will also find their applicability in most cases with or without modifications.

Some of the alternative mining technologies can be:

1. B & P with SDL/LHD/UDM (Universal drilling machine)
2. PSLW/Longwall Mining
3. CM Technology – Wongawilli method

4. Shortwall Mining and
5. Other Special Methods,

At present in CIL, in UG mines there is a mix of manual, semi-mechanized and mechanized mines. This needs to be changed more speedily, towards 100% mechanized mines. The presently available methods, namely, Long-wall and Bord & Pillar(B&P) methods will continue to be used dominantly with the limited application of other methods like Blasting Gallery, etc. The thrust areas may be the replacement Of the B&P methods with higher degrees of mechanization like, Continuous Miner (CM) technology. However, the use of Long-wall technology, will be continued as a mass production technology, particularly for deep-seated reserves. So there will be a judicious mix of B & P with CM, B&P with SDL/LHD combination, mechanized Long-wall and other special mining methods.

In underground mining, new technologies will have to be introduced in mine development to reduce the gestation period of underground mines, introduce better mine support through appropriate strata control investigation, development of suitable methods for induced caving such as hydro-fracturing for hard roof management for shallow and medium depth of cover and also in the other areas like drilling and blasting, transportation, etc.

In brief we have lagged behind other countries in adopting new technologies and in updating the old ones. Public sector Coal companies alone need not bear the responsibility. Methods can be devised to incentivise the adoption of the state-of-art technologies for UG mining by providing special incentives for agencies which take the risks of opening very large UG mines.

Ultra-Mega UG Mines.

There is a perception even among those closely connected with coal industry that large scale mining of coal using modern underground technologies will be fraught with many risks. There is need to provide special incentives to stimulate interest in a large-scale underground coal mining in India. The procedures followed in the power industry to mobilize investment for ultra mega power projects provide a model, which could be adopted in coal industry.

Towards this end it should be possible to identify coal blocks, which are amenable for exploitation as large size mechanized UG mines and could support 10 million tonnes of production per year. For these blocks, CIL or CMPDI may be directed to promote a shell company as SPV and take up

all pre-production work of obtaining the required legal and administrative clearances, including environmental approval and forestland use conversion approval. MOC should set up a High Level Empowered committee to call for bids on international competitive bidding basis from Indian companies permitted to take up coal and captive coal mining to bid along with a well established foreign coal company with experience in modern mechanized UG mining operation. The criteria for selection should be the cost at which about 10 million tonnes of coal could be delivered at the mine mouth, in say, 4-5 years. All prospective bidders could be allowed adequate time to do adequate due diligence before filing the bids. The cap price for the bid could be the price of imported coal of equivalent quality at the location of the mine. This coal could be offered on linkage basis to large users. If the lowest bid is higher than the prevailing price of coal at that location Government could provide a subsidy. Such a contingency might not arise and the price of coal produced by this method is likely to be competitive. The design of this proposal can benefit from the experience of the Ultra-Mega Power projects selection and approval recently completed. At least two UG mines may be taken up for allotment on this basis in the XI plan period and on the basis of experience such operation could be continued in the subsequent periods.

Unless special attention is paid to UG mining by introduction of modern methods of mining already adopted in other countries which help to increase OMS in such mines and reduce the costs of mining in UG mines, there will be neglect of high value coal which could be mined only by such methods and precious coal resources of India would be lost for ever. The Expert Committee, has recommended the launching of a specially designed “UG COAL INITIATIVE” to increase the share of UG mine production gradually from the current less than 15% to 25 % in the next fifteen years. The Initiative suggested should examine comprehensively the suggestions discussed above and training of large number of engineers within the country and abroad who would enthusiastically take positions in UG mines .

Coal Washing and Transportation

Optimizing the Cost of coal at the mining stage alone will not serve the interests of coal users especially those who are located at long distance from the mines. It is well recognized that the two outstanding features of the Indian coal resources are the high ash content often exceeding 40% in most cases and the skewed distribution of the resources by which coal is available in nine States only and consumed in over 20 States. The use in

States like Gujarat and Kerala involves over 1500 kms of transportation. Coal washing is important as it reduces the cost of transporting coal for a given requirement with less of “coal” after washing than before washing. The high railway tariff of coal transportation makes the cost of coal in far away states prohibited. Washing coal also reduces the mineral content in the coal and thus improves thermal efficiency. Most of the Indian coal have high gritty material which damages the power plant equipment. Using wash coal in power plants improves life of the plant availability factor and reduction in capital cost requirement. Further, the Ministry of Environment and Forest (MoEF) has issued orders that power houses situated beyond 1000 kms from linked pitted coal mines or situated in critically polluted areas or sensitive areas or urban areas irrespective of distances from the pitted mines must use power coal having ash content below 34%. Till recently, India had installed capacity of 31 MT (million tonnes) a year for coking coal washeries and only 20 MT for non-coking coal. With the introduction of the third party investment in coal washing on “build-own-operate” (BOO) basis, there has been additions to non coking coal washeries and the current capacity is nearing 100 MT. MoC should review coal washing on BOO basis and introduce incentives for CIL or other users of coal to set up washeries.

As already indicated, the railway tariff is very high for coal transport as it involves a very large element of subsidy which is used as Railways to subsidize the passenger transport. While, passenger transport should get all necessary assistance, it is counter productive for national development to load an essential commodity like coal with such a heavy subsidy element. This is the result of railways using their monopoly market power. The railway tariff should be subjected to a review at least in respect of coal. The other ways of bringing down the cost of coal transport by having special railway corridors, where Railways would maintain the track and rolling stock would be owned and maintained by the coal companies. The implementation of these proposals for coal should be expedited and enlarged in scope to cover the transport from all coalmines in the east to consuming centers in western and southern destinations. Furthermore, a well thought out railway-cum-sea route to southern and western ports should be given consideration in the 11th and 12th Plans.

The coal slurry pipeline transport has been discussed in India several times, but availability of water and high cost of pipeline have proved the proposition as unviable. No study has been made to update the earlier

studies after 1992. There is a case for reviewing the earlier studies in the light of current international experience.

Environmental Issues

Environmental clearance includes approving the Environmental Impact Analysis (EIA) and the Environment Management Plan (EMP). The long delays in EMP approval was mostly due to the delays in convening and holding the public hearing in the area affected. Under the new rules, the public hearing has to be fixed within 45 days of publishing the notice in the newspapers. If, there is a failure to do so, hearing will be held by a different agency and the entire public hearing (PH) proceedings will be covered by videography and preserved for use by the other agencies to give their approvals later. While holding the PH, it is necessary for all parties to keep in mind that the basic objectives of PH is to focus on the environmental impact issues arising out of the mining project. No doubt, the objective is also to protect the stakes of local people on environmental aspects effectively mitigate all possible adverse ecological damages. The rehabilitation and land compensation packages have to be decided on the basis of national policy and norms and not to be given importance during the PH.

In the preparation of the EIA reports, the absence of proper pollution modeling in the mining area surrounded by other polluting entities like power stations, cement factories and large industries, it is difficult to arrive at the Base Line Data (BLD). The Environmental Ministry should take up the task of modeling the air pollution and water characteristics of these areas and update them periodically.

Towards the long term preservation of forest wealth and enlarged energy security it is necessary that:

- The forest area should be totally surveyed and digitalised forest maps should be created for the whole country at the earliest possible time. Priority for such mapping and digitalization should be given to areas with mineral wealth like Bihar, Chattisgarh, MP, Jharkhand, and Andhra Pradesh.
- The forest may be classified into three categories –
 - **Category A:** Totally prohibited areas – These will be genuinely selected after due process and public notice of areas where there is valuable bio-diversity or having flora or fauna of great value which have to be protected. In the

assessment of coal resources of the country the resources

found in such Category A forests may be removed and shown in a separate foot-note.

- **Category B:** Forest Areas which are having reasonable forest growth and needs to be preserved but which could be released for non-forest uses, if legitimate users could establish that the economic value added by such use would exceed the value received by retaining it as forest land; the release of the land would be subject to the creation of a compensatory forest area and payment of the prescribed compensation.
- **Category C:** Forest areas where the forests have been depleted and are available for allocation for non-forest purposes on payment of compensation and can be allocated towards compensatory forest to be created by users who are given approval for conversion of forest land to non forest users.

Green Credit System

The present system of mining companies applying for opening new mines having to show equivalent land for compensatory afforestation leads to a lot of delay. Since the coal mining agencies are aware of their likely requirements in the next five years and even in the period thereafter, they can be encouraged to take up afforestation in advance and given “green credits” for specify acres of new forest created. These could be used in view of compensatory of afforestation when new applications are made. The State Governments and the forest departments can notify areas where the creation of forests and maintaining the trees for a period of five years would entitled the parties for “green credits”. In fact a market may be created for “green credits” which will bring in institutional knowledgeable in afforestation to take this up as a useful venture.

Cutting Edge Technologies

These milestones along the roadmap for coal development in India should not stop at meeting the projected demand. The road should take the coal industry to several new uses of coal and to several emerging technologies

for using coal as the base for more refined fuels. These have been termed as cutting edge technologies and examined by EC

The EC examined the issues of developing technologies which though currently in wide use but which has the potential for ensuring the sustained use of coal after a few years. The Committee has listed the following for detailed consideration:

- 1 In-situ Gasification (Underground Coal Gasification).
- 2 Coal Bed Methanation (CBM)
- 3 Clean Coal Technologies – Carbon sequestration and storage
- 4 Coal to Gas Technologies (CTG)
- 5 Coal to Oil Technologies (CTL)

UG Coal Gasification (UCG)

In India, a large amount of coal exists beyond present techno-economically viable mining depth. Such coals have immense potential to yield energy through UCG. Additionally, there is a huge occurrence of lignite in India, which has not even been brought into lignite resource inventory, but otherwise known in course of oil and gas exploration in the country. These lignite fields need proper exploration and may be taken up for UCG in addition to known lignite deposits.

Though the earlier attempts have been given up on environmental considerations, interest has been revived and an MoU has been signed between CIL and ONGC for a pilot project study on underground gasification. ONGC as the implementing agency has engaged Skochinsky Institute of Russia as Consultants. The IEP Report 2006 has specially emphasized this issue

Coal Bed Methanation

CBM is emerging as an environment friendly alternate energy source in different countries. It is well known that CBM availability in India is significant. CBM resources are prognosticated to be 3381 BCM extended over an area of 35,326 sq.km. In 1997, CBM policy was framed by which Ministry of Petroleum and Natural Gas (MoP&G) has been made the administrative ministry. Under this, prospective blocks are delineated in consultation with the MoC and global tenders are invited as in the oil and natural gas blocks. There were already three rounds of bidding and over seven blocks have already been allotted and others are under way.

A consortium of CIL and ONGC has been awarded two blocks in Jharia and Raniganj coalfields. 16 deep seated borewells have been undertaken. As

the recovery of methane is a high priority area in the field of coal mine related CBM recovery and aided demonstration project with assistance from GEF – UNDP has been taken up in Moonidih and Sudamdih mines of BCCL. There are attempts by some private sector allottees to develop CBM on a commercial basis in the near future.

Carbon Sequestration and Storage

The issue of carbon sequestration in our country has not received the required level of attention. World over, research is ongoing for reducing the CO₂ emission to separate carbon and store it in geological formations. Advanced countries like USA, Canada, Japan, Australia and European Union, have coordinated ongoing programmes on CO₂ Sequestration and the long term Technology Road Maps have been developed. India along with several other countries has joined Carbon Sequestration Leadership Forum (CSLF) at the invitation of USA and Ministry of Power as the nodal agency. The objective of the Indian participation is to develop cost-effective technologies by organizing collaboration in R & D on an International basis within the legal, financial and regulatory frameworks. It is now decided that evaluation of coal bearing sedimentary basins as a potential CO₂ sink can be assessed in a best possible manner by CMPDI.

India, which is the third largest producer and user of coal and proven technological capability in areas like Nuclear and Space research and technology should take a lead in organizing R&D efforts to be self-reliant in this technology in the long run. India has the capability to undertake adequate research on its own or in collaboration with internationally recognized institutions working in the area of carbon capture and storage. The number of major research organizations in the world are keen to work in India and develop appropriate technologies towards this end in India and China. China has recently agreed to collaborate with some European companies with European Union assistance to set up a 5 million tonne coal mine, along with a coal preparation unit and a power plant to use all the coal. Under this proposal, China will only bear the costs which they would incur for a normal coal mine and power plant of this size. The foreign companies would bear the capital expenditure of adding **equipment** developed by them for carbon capture and storage and run the plant. It is designed to determine the real costs of introducing this technology. There are a number of companies that would like to set up plants for similar nature if NTPC or BHEL could collaborate with them.

Coal to Oil Conversion

As oil is a convenient form of fuel and is transportable to short and long distances in any desired parcel size and is most essential in most developing countries for transport sector, efforts have been made in several coal producing countries to convert coal to liquid fuels.

In view of India's poor resources in terms of oil and the perceived abundance of coal, there has been a persistent demand to take up the conversion of coal into oil. Several expert committees were constituted in 70s and 80s to recommend measures towards this end. Most of the studies could not recommend the conversion purely on commercial grounds. However, the recent steep increase in oil prices has led to a renewal of interest on this subject. In January 2007, the Investment Promotion Committee headed by Shri Ratan Tata had indicated that coal to oil will be a feasible proposition and investment should be invited for this purpose.

There are several methods of converting coal to liquid fuel but the most advanced and well experimented methods are the following:

- Indirect Liquefaction by coal gasification and subsequent conversion of synthesis gas to liquid products through Fischer-Tropsch (FT) process.
- Direct Liquefaction of coal by catalytic hydrogenation of coal based on Bergius-Pier process.

Laboratory as well as pilot plant scale investigations have been carried out in different places in the world on these routes. However, at present, there is no commercial coal liquefaction plant in operation except SASOL in South Africa, which uses indirect coal liquefaction technology.

In India, it is generally considered that direct liquefaction technology is feasible only with high caloric value coals in Assam and in some mines of Orissa. Currently, oil India is pursuing this process and is in contact with M/s H T I (Hydro Carbon Technologies Incorporated) in USA. The progress is very slow.

Coal to Gas Technologies (CTG) – Coal Gasification:

Coal Gasification is the process of converting coal, a solid product into a gaseous product through reactions with gasifying media like air, oxygen or steam. Coal gas can be classified according to the energy content per volume as low or lean gas, or medium gas or high or rich gas. Depending on the process and the composition of gas in terms CO, H₂ or N₂ or CH₄

and CO₂ (There appears to be some gap here) of plants in India as they are Neyvelli Lignite Corporation and Fertilizer Corporation of India. The NLC plant is at Neyvelli as an 8.6 lakh cubic meters per day capacity produce gas as the route towards fertilizers manufacture. It has been shut down as Naptha proved to be a better raw material for fertilizers. The fertilizer corporation plants were located at Talcher, Orissa and Ramagundam, A.P. Each plant had three gasifiers with a capacity of 40,000 cubic meters per hour. They are both shut down as they proved to be unviable. Currently interest in coal gasification has been revived due to growing relevance of introducing fuel efficient IGCC power generation and as an intermediate product to produce liquid fuel from coal.

The coal gasification by itself may not be of interest in India today, unless it is a route to higher value products like liquid products or fertilizers. In specific locations coal gasification to produce Town-gas might be of some interest.

Summing Up:

When the issues of Energy Security is being hotly debated and the need to produce and utilize wisely our relatively larger resources of coal are accepted as the major plank on which energy security is to be planned, the coal sector has paid very little attention compared to oil or nuclear power sectors. The road map for development of the coal sector indicated in the discussion above is the summary of the larger report made in two parts by the Expert Committee to draft the Road Map for Coal Development in India. This Report was based on extensive discussions with all the stakeholders in the Coal Industry. The EC has felt that in view of the importance of coal industry to national energy security, the recommendations should be subjected to a review by all sections of the general public. The draft Report has been placed on the website. The discussions by very knowledgeable in the World Energy Council would help in formulating the Road Map on a firmer basis.
