ROLE OF LOGISTICS AND INFRASTRUCTURE IN THE DEVELOPMENT OF COAL MARKET IN THE COUNTRY

Jawahar Lal Goel
Chief General Manager (S&M)
Coal India Limited

1. Introduction

Coal is the mainstay of commercial energy catering 55% of the total demand. Therefore, developing a thriving coal market would go a long way for reaching the targeted growth of the country. **Creating transport infrastructures and managing logistics to transport coal from point of origin to consumption centers are major challenges for sustainable development of coal market.** *This paper will discuss the role of logistics for development of coal market in the perspective of emerging growth in energy requirement of the Country.*

At the time of Independence, the country had poor infrastructure in terms of energy production and supply logistics. Per capita consumption of energy had been abysmally low and the access to energy was very inadequate for the common people. The economy was dependent largely on the non-commercial sources of energy for meeting the requirements of the households and on animal and human energy in case of agriculture and transport. During the 60 years that followed Independence, the demand for energy, particularly for commercial energy, registered a high rate of growth contributed largely by the changes in the demographic structure. Rapid urbanization necessitated need for socio-economic development and attaining sustainable self reliance through economic development of different sectors.

Over the years, the high rate of growth of energy demand could be sustained primarily through increased dependence on commercial energy sources such as **coal, oil, natural gas and hydel**. However, the energy supply system that has developed over the years has tended to depend more and more on **non-renewable energy resources, coal in particular.** The development of these energy sources has made possible progress in the infrastructure front mainly transport sector like rail, ports, with shipping and intermodal means of transport as well as handling infrastructure at loading and terminal ends.

2. The Primary Energy Resource Endowment

Per se India is not endowed with large primary energy reserves in keeping with her large geographical area, growing population and increasing final energy needs. The current assessment in regard to the primary commercial energy resources indicates that **coal is the major energy resource of the country.** The gross reserves of coal are presently estimated at around 264 Billion Tonnes (Bt). The proven resources of coal are placed at 98 Bt. Therefore, if the rate of growth in coal consumption continues to be 8%, the reserve would be exhausted by the Seventies of current century. There are some lignite deposits also which are estimated to be more than 27 Bt. As far as hydrocarbons are concerned, the balance of recoverable reserves is placed at about 73 Million Tonnes (Mt) of crude oil and 660 Billion Cubic meter of natural gas. The hydro-electric potential as assessed by the Central Water Commission and the Central Electricity Authority is 600 TWh. The available energy resources compelled planners to stress more on coal to meet the growing need of power generation. In fact, 80% of coal production of the Country is consumed for power generation only.

FUEL WISE BREAK UP OF POWER GENERATION CAPACITY (All India)
(End of July, 2008)

Type	MW	%
Total Thermal	93,115	64%
Coal	77199	53%
Gas	14716	10%
Oil	1199	1%
Hydro	36159	25%
Nuclear	4120	3%
Renewable	12194	8%
Total	145588	100%

3. Skewed regional distribution of Coal Reserves:

The distribution of primary commercial energy resources is quite skewed. Whereas the Eastern region accounts for nearly 70% of the total coal reserves, the Western region has over 70% of the hydrocarbons reserves in the country. Similarly, more than 70% of the total hydel potential in the country is located in the Northern and the North-Eastern regions put together. The Southern region, which has only 6% of the coal reserves and 10% of the total hydel potential, has most of the lignite deposits occurring in the country.

The above spread and distribution of energy resources entail a complex matrix of movement and the supporting logistics. **Since coal is the bedrock of commercial energy resources in the country, this paper will try to deal in the logistics associated with movement and transportation of coal through out the length and breadth of the country** through the various modes of transport.

Coal deposits occur largely in the east-central and south-eastern region of geographical India. The state wise inventory of geological reserves of coal indicates that the proved category of coal is mainly distributed in Jharkhand and Orissa followed by West Bengal, Chhattisgarh, Andhra Pradesh and Madhya Pradesh. However, the industrial load centers are mainly located in North India in the Capital region, Punjab & Haryana, in the West in Maharashtra & Gujarat and in South in Tamil Nadu, Northern Karnataka and in the eastern Andhra Pradesh. Coal based thermal Power plants as well as large industrial plants have been built up in these states. **Coal markets thus are all located away from coal sources necessitating long distance coal haulage in most cases.**

4. Modes of coal transport

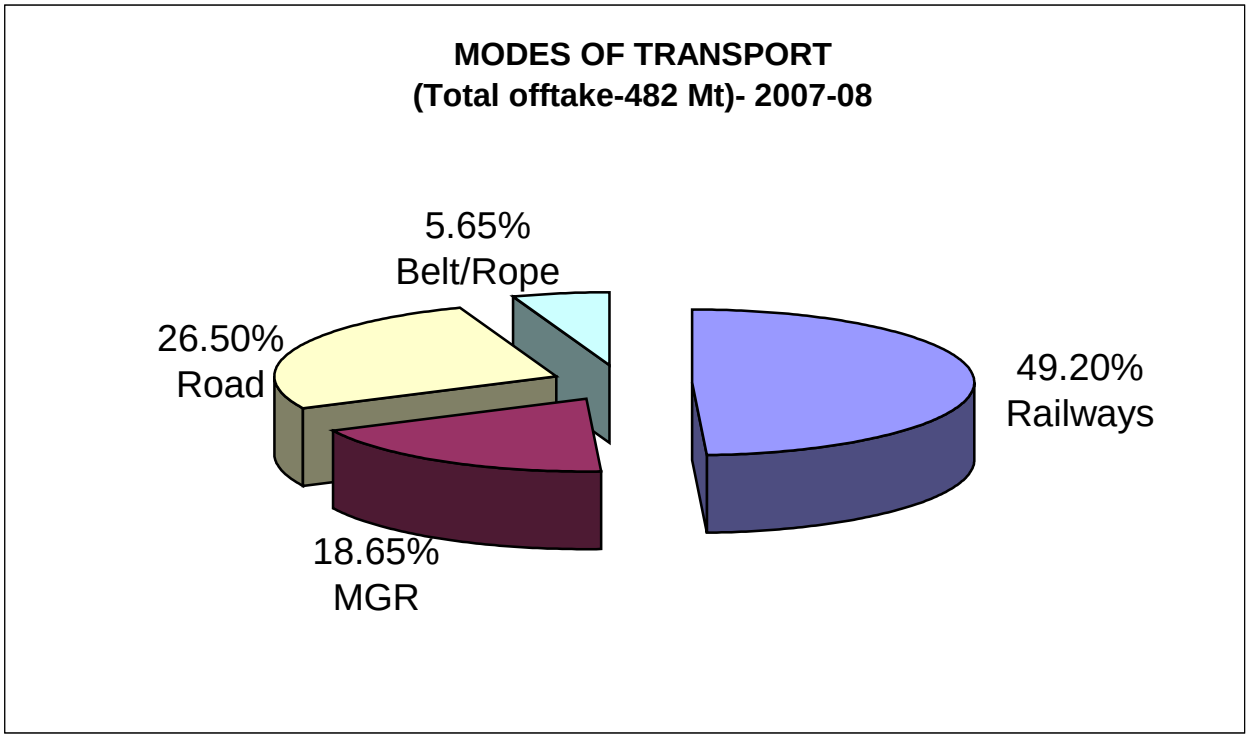
Coal is consumed in bulk to produce energy or to be used as feedstock. Likewise coal is moved in bulk and the external dispatches of coal from the collieries are through a variety of modes. Important modes of transport of coal are Rail, Road and the Rail-cum-Sea route and captive modes such as, Merry-Go-Round (MGR) Systems, Conveyor Belts & Ropeways. Mode wise dispatch details of coal and coal products (external and internal movement) in the country for 2007-08 are as follows:

Modewise Despatches of Coal & products during 2007-08 (All India)

(in Mt)

Source	Type	Rail	Road	MGR	Belt	Rope	Total
CIL	Raw coal	186.78	72.49	81.35	7.36	6.16	354.14
	Coal pdts	17.10	0.22				17.32
	Internal Raw coal	1.67	18.66				20.33
Other Public units	Raw coal	21.67	12.46	8.64		0.49	43.26
	Coal pdts		0.59				0.59
	Internal Raw coal				0.42	0.15	0.57
Private sector	Raw coal	4.32	16.72				21.04
	Coal pdts	5.32	5.66				10.98
	Internal Raw coal		0.79		10.04	2.60	13.43
Country	**Raw coal**	**212.77**	**101.67**	**89.99**	**7.36**	**6.65**	**418.44**
	Coal pdts	**22.42**	**6.47**				**28.89**
	Internal Raw coal	**1.67**	**19.45**		**10.46**	**2.75**	**34.33**
	Total	**236.86**	**127.59**	**89.99**	**17.82**	**9.40**	**481.66**

The following pie-chart illustrates the shares of various modes of transport (internal and external) in 2007-08 in India.



Economic consideration in choosing a coal transportation mode

Coal is consumed in bulk quantities by Utilities and Industries throughout the length and breadth of the country while coal production is mostly concentrated in a few states only. Indian Coal contains high ash to the extent of more than 40% by weight. This is essentially an in-built handicap for coal transport logistics system. Reliability of the transport system has a direct bearing on cost of inventory and its management. All these issues are required to be factored into a cost-efficient coal transportation system. It is important to note that there cannot be a straightjacket best system applicable for transportation of coal to all consumption centres. In fact, depending upon the situation and specific needs, the market does use various options available in modes of coal transportations, sometimes singularly and sometimes in a mix. It is needless to mention that most suitable transportation system from among various optional modes is critical to the nation's economic well-being and energy security and therefore, special attentions are needed to develop assets accordingly.

The practical considerations

By the end of 2030, country's coal production and consumption will increase almost five folds. Transportation of such volume in itself is a gigantic task, as bulk of the coal has to be transported to power utility and user industries. Depending on the volume of annual coal consumption by the user and the distance that the coal has to move from the source, the choice of mode will be determined.

With the technological advancement in reducing transmission loss and development of national grid, more power plants are being planned **near pitheads. These mega pithead power utilities would be using a large share of the total coal**. In other words, there would be a perceptible shift in the location of the coal market. Pithead power utility companies will be developing their captive transport infrastructure like Merry-Go-Rounds, a closed-circuit railway system, or medium distance cross-country conveyors and short to medium distance aerial ropeways. This endeavours, in fact would be saving a substantial portion of the cost so far involved in hauling about 40% of un-useable part of coal.

An alternative means of transportation of coal is **the option of coal slurry pipeline technology**, as in vogue in USA. Initial studies, during 1976-78 and detailed study in 1992, have observed that the pipeline transport is high capital intensive but cheaper than rail only for throughputs of over 10 million tonnes per year, and for distance over 800 Km in flat terrain. If the technology is proved to be techno-economically attractive, one cross country pipeline from Northern Karanpura to Northern power houses and another pipeline from coalfields in Orissa to the Western Sectors power houses could be contemplated. Incidentally, in our country throughputs of more than 10Mt is applicable for Utilities and in view of the successful operation of the national electricity grid, this mode of transportation for Utilities appears to be not-so-attractive, particularly in view of the quantum of investment involved.

The larger circuits, i.e. those going beyond 50 km. have to operate through rail or road systems. The major share of coal will however move by Rail since road transportation is cost effective up to 250 Km. in comparison to rail.

Creating an integrated rail system planning for optimum outcome.

The High Density (Rail) Network (HDN), which connects the four metro cities of Delhi, Kolkata, Chennai & Mumbai and is popularly called as Golden Quadrilateral including the diagonals though comprising only 16% of the network, carries about 65% of the freight traffic and 55% of passenger traffic. These lines are apparently saturated. Hence for future transport of coal

dedicated rail lines comprising special north-south corridor and east-west corridor for freight transport may have to be considered by railways.

It is well known that payload to tare weight ratio of wagons in Indian Railways is one of the lowest in the world. Payload to tare weight ratio of BG wagons varies between 2.0 to 2.6 only, which in US railroad and Western Railroads are in between 3.5 to 4.5. While Indian Railways carry about 450Kg of dead weight for every 1000 kg freight, in US the dead weight does not exceed more than 170Kg. The net to tare ratio could be improved by introducing lighter wagons.

In order to optimize utilization of upgraded axle load, Railways are required to introduce lighter wagons with higher volume capacity so that payload tare weight ratio is more than 4. Considering average bulk density of crushed coal as 0.75 Tonnes/cubic meter, wagons having volumetric capacity of around 129 cubic meters would be required to accommodate about 97tonnes of net weight of coal. If the tare weight of lighter wagons is around 23 tonnes, then only payload to tare weight ratio could be of about 4.

In other advanced countries, for example, in Australia, railway transport of coal is by rakes, which are having, as many as six locomotives, capable of hauling 148 wagons aggregating to a length of 2 kms. A rake of that size carries about 8500 tonnes of coal. The latest move is to have wagons of maximum payload of 80 tonnes has designed for maximum speed of 115 kms per hour with Axle loading up to 25 tonnes to accommodate further increase in its standards. Also an important infusion in Queensland (Australia) is the development of aluminum wagons equipped with rotate coupling which enable the wagon to be entailed by paying turn up side down to reduce unloading time.

For transportation of such large volume of coal, railways shall have to consider increasing the payload of the wagons and/ or the train size to have fast turnaround cycle through the dedicated coal corridor. In case railways are not in position to build such network all by themselves then such network may have to be constructed on BOO basis by a consortium of user industries utilizing the coal corridor. This could also be built on public-private partnership basis.

In fact, there is immense scope on developing core business competence in coal transport logistics encompassing activities in road/belt transportation of coal from pithead to railway siding, managing tracks and rolling stocks for rail transportation of coal and then shifting coal from railway terminals to points of consumptions. Only specialized Coal transport Companies, can possibly offer definite run schedule for coal movement by commissioning advanced Information Technology based cargo tracking system, which would be saving both inventory costs of buyers and infrastructure idling costs of coal producers.

5. Logistics requirement for coal transportation in 2030 – an overview

Based on the present trends available in the rate of urbanization, the share of urban population is projected to increase from 25.38% in 1990-91 to 43% in the year 2020 and say 50% by 2030. The growth in GDP and its structural changes will have an effect on the demand for energy and the energy supply mix in future. The GDP, which grew at a rate of almost 7% in X Plan Period, is targeted to grow by 9% in XI Plan period. It is projected that these upward trends in GDP growth are likely to continue in future as well. The high rate of economic growth is likely to be accompanied by an increasing per capita income and changes in life styles. This will have an effect on the energy demand as well. In view of the rising awareness in regard to the environmental protection and conservation, the future growth in energy sector must consider such concerns in order to develop in a manner which is environmentally benign.

The Integrated Energy Policy (IEP) report (Planning Commission May, 2006), has projected the total energy demand in terms of different fuels with reference to a GDP growth of 8% and 9%. The IEP Report has estimated that the **coal market for power generation would then be 1659**

million tones by 2031-32. This coal requirement excludes the non-power use of coal which has additional market for about 684 million tonnes. The total indigenous market demand for coal in 2031-32 thus adds **upto 2343 million tones** that includes lignite anticipated to be consumed for power generation amounting to 120 million tonnes (coal demand net of lignite consumption being 2223 MT.). Another 30 million tones of lignite would be consumed in industries, which in any case is not included in coal requirement of non-power uses. The total coal requirement for power generation as per IEP Report should have been 1539 (1659 –120) million tones assuming 9% growth in GDP.

However, traditionally any shortfall in the production of electricity from non-fuel resources is being met from coal. Therefore, the total demand for coal for 2031-32 can only be noted in broad magnitudes. In the road map for coal sector reforms drawn up by the Expert Committee, the total of demand for coal including both non- power and power uses in 2031-32 adds up to 2373 million tones inclusive of lignite consumption of 150 million tones. The rate of growth implied in this forecast of coal demand is around 6.50% per year as against 5.2% achieved in the past 25 years. **Thus an estimate of 2223 million tones of coal demand (excluding lignite) can be taken for long term planning of logistics for coal movement**.

The steep increase in the growth of coal demand and production puts up a challenge before the country because the projected demand satisfaction and production can be achieved only by taking up well planned execution of infrastructure and logistics for transportation of coal. As a strategic measure, both in the perspective of economic and environmental consideration, the Country may decide to source a portion of its coal requirement from overseas properties or through straightaway international trade. In any case to meet the demand of metallurgical coal and low ash steaming coal, the Country has to depend on imports. Therefore, development of port infrastructure for coal handling and movement of coal from Ports to hinterlands also need to be seen in proper perspective. These issues add new dimension to the logistics problems.

Coal transport scenario - AD 2030

By the turn of 2030, India's coal production is slated to increase to **2000 million tonnes** from various sources, which would include sources owned, by private, public and captive etc. Transportation of such volume in itself is a gigantic task and bulk of the coal would get transported to power utility companies. It is envisaged that many of the new power plants will be located near pithead and more than 800 million tonnes of coal will be used by such pit head power utility companies. These pithead power utility companies will transport their coal by MGR system or by long distance cross-country conveyors. Assuming that 50% of the raw coal feed is beneficiated at the pit-mouth, about 700 Million tones (both raw and clean coal) would be carted by captive modes like MGR/Aerial Ropeway and Belt-conveyors. This would leave about 1200 million tones of coal meant for power utility companies and other sectors, 90% of which it is assumed would be utilized only after deshaling and beneficiation. About 85% of the output of coal washeries/ coal products would be move by rail-transport network including carting of bulk coal to load ports within the country and by shipment thereafter to unload ports within the country thus entailing double movement of coal by rail system. **By estimating various demand projections, it is considered that such coal traffic by rail mode would surpass 830 Million tones including coastal rail –sea mode (which would cross 100 million tones by 2030 from the present level of about 20 million tones).** Besides, the road transportation to various consumers upto a cut-off level of 400 Km. would take care of external movement of coal to an extent of 125 Mt.

Projection showing the share of coal transport by various modes by 2031-32 (external dispatches only)

Envisaged coal supply (Mt per year)	% of share	Proposed mode of transport	Remarks
800 Mt(400 Raw coal & balance eq. clean coal)	40.0	MGR system or cross-country conveyors/ropeway	Pit head power plants & other ultra mega projects
1075 Mt (110 Raw coal & balance eq. clean coal)	53.75	National Rail network/Rail cum sea	For consumers located beyond coalfield areas
125 Mt (Mainly raw coal)	6.25	Coal by road	For consumers located within 400 km. of coalfield areas
2000	**100**		

The projections above are exclusive of internal coal movements mainly as feed to washeries.

REQUIREMENTS OF RAIL NETWORK & INFRUSTRUCTURE IN COAL TRANSPORTATION – THEN, NOW & FUTURE

From a level of 78 Mt in 1971, coal production reached to 456 Mt in 2007-08. **During 2007-08, coal including imported coal moved by rail was 245 Mt which is more than 50% of indigenous coal production.**

It is an accepted and established fact that rail transportation is the most economical means of moving coal in bulk. Rail-links also reduce logistics cost for transporting coal and is the mainstay of the coal transportation in the country. This dependence on the rail system would increase further in the coming decades. Moreover **the coalfields are located on the east central & southeastern part of the country and larger volumes of coal need to be transported to Northern & Western part of the country**. This places burden on the already heavily loaded rail network. Hence for future transport of coal, dedicated rail lines comprising of special east-north corridor and east-west corridor for freight transport need to be considered.

THE DEDICATED RAIL FREIGHT CORRIDOR PROJECT:

As outlined above, to meet the growing demand for logistic support arising from impressive growth of **over 9 percent of the Indian economy**, the Ministry of Railways announced in its budget of 2006 that Indian Railways (IR) shall construct two dedicated Freight Corridors (DFCs) at an estimated cost of about Rs.28181 crores. This can be termed as the single largest project of independent India to be carried out by an SPV styled as “Dedicated Freight Corridor Corporation of India Ltd.” (DFCCIL)

These two DFCs, one referred to as the Western Corridor (i.e. connecting Jawaharlal Nehru Port Trust in Mumbai to Dadri/Tuglakabad near Delhi) and another known as the Eastern Corridor (i.e. from Ludhiana in Punjab to Sonnagar in Bihar) would run parallel to so called golden quadrilateral linking Delhi, Kolkata, Mumbai, Chennai and other high density corridors.

The first 2 lines will be:

Delhi- Sonnagar with a length of around 1279 km.
Delhi-Mumbai with a length of around 1483 km.

In the first phase of the Eastern Corridor Project, a separate freight corridor will be built from Ludhiana to Sonnagar via Ambala, Saharanpur, Khurja and Allahabad. The primary feeder routes from Sonnagar to Durgapur via Gomoh, Sonnagar to Tatanagar via Garhwa Road and Barkakana to Bokaro via Chandrapura would be upgraded in order to carry heavier trains of coal and steel traffic. In the subsequent budget proposal of 2008, Railway Minister had already declared that the Eastern Corridor would be extended from Sonenagar to Kolkata to ensure Port Connectivity with hinterland. The primary feeder routes are expected to be converted to dedicated freight corridor at the appropriate time.

The Western Corridor would start from Jawaharlal Nehru Port and will be routed via Vadodara, Ahmedabad, Palanpur, Jaipur and Rewari to Tuglakabad and Dadri. Both the corridors would be joined by a link between Dadri and Khurja. The feeder routes of the Western Corridor connecting ports of Gujarat would be upgraded. While DELHI-HWH corridor will be a Heavy haul corridor mainly to cater the bulk traffic, DELHI-MUMBAI freight corridor will be a state-of-the-art multi-modal rail freight corridor, which would serve the western and northern hinterlands from Mumbai, the country's premier port and smaller ports of Gujarat. **Both corridors would also have several small feeder routes to bring in goods traffic from ports and plants in nearby towns and the hinterland.**

Development of Feeder Routes for coal :

East-North DFC between Ludhiana and Sonnagar will cater largely to coal traffic. **Feeder routes linking high growth colliery area and power houses** are identified and being strengthened as follows :

1.Sonnagar- Garwa Road- Barkakana (311 Kms)
2.Patratu- Gomoh including PD Branch Line (128 Kms)
3.Sonnagar-Gaya-Gomoh (249 Kms)
Gomoh-Pradhankhunta (39 Kms) including Kusunda -Tetulmari (4.5 Kms),
4.Katrasgarh – Nichitpur, Pradhankhunta - Pathardih links (24 Kms)
5.Pradhankhunta-Asansol-Andal including coal branch lines (75 Kms)
6.Andal-Sainthia-Pakur (151 Kms)
7.Chandrapura- Dhanbad (36 Kms)
8.Bhojidih –Mohuda –Gomoh (44 Kms)
9.Aligarh – Harduaganj (15 Kms)
10.Kanpur – Paricha (198 Kms)
11.Mughalsarai – Unchahar via Janghai, Phaphamau(205 Kms)
12.Varanasi-Sultanpur-Utratia –Rosa (558 Kms)
13.Zafrabad – Tanda (99 Kms)
14.Ludhiana –Beas-Govindwal Sahib (112 Kms)
15.Rajpura – Dhuri – Bhatinda (Lehra Mohabbat) (173 Kms)
16.Sirhind – Rupnagar – Nangal Dam (104 Kms)
17.Hissar-Bhatinda-Suratgarh (298 Kms)

There is another route, viz. Howrah-Nasik which requires augmentation in order to cater to increased evacuation of coal in the future. While a dedicated third track is necessary exclusively for coal, some rail infrastructure developments in the connected IB –Valley, Talcher coalfields and Korba C.F. feeding the east-west trunk route and Paradeep Port are also vital for evacuation of coal.

OTHER RAIL INFRASTRUCTURE DEVELOPMENTS

Talcher area

- Sambalpur-Jharsuguda doubling
- Khurda Road-Barang third line

•Rajatgarh – Barang doubling
•Talcher-Paradeep electrification
•Talcher-Bimlagarh new line

Korba / IB Area

•Bilaspur-Anuppur doubling
•Jharsuguda bypass
•Champa-Bilaspur-Bhilai-Durg third line
•Bina-Kota electrification
•Jharsuguda-Sardega new line to serve the new collieries in IB area

Public – private partnership to augment infrastructure facilities:

To bolster logistics and links for coal evacuation in the not too distant future, the non-mining infrastructure required to handle the coal would be gargantuan as compared to the present.

At present, coal companies in both private and public sectors have built up coal handling plants with capacity of about 300 MT per annum so as to maximize dispatches of crushed/sized coal to the consumers. In addition, the washeries at BCCL, CCL, WCL and NCL have adequate crushing/sizing facilities to the tune of about 39.4 million tones in their system for generation of different washery products. Therefore the existing facilities can barely handle the current annual production of raw coal in the country. Similarly about 200 sidings move out only 235 Mt of indigenous coal per annum by rail presently. A massive siding build-up is required to evacuate coal by rail @ 1 BT per annum.

To crank up the coal evacuation from 450 **Mt per annum to over 2000 Mt** in a span of 20 years, a huge effort is required to bring about a quantum jump in coal processing and coal delivery systems. A whopping investment is required in terms of **creation of sidings, washeries and CHPS** for which the coal producing companies may not be in a position to mobilize the required funds fully and look after the day to day management of such non-mining affairs. **There are two ways to handle the logistics gap in the coal-mining sector.**

1) Outsource these capital infrastructure projects through suitable Build - Operate - Maintain schemes.
2) Create a SPV to take up the infrastructure development and tap private investors for bridging the capacity gaps.

Innovation in logistics development:

Coal-by-wire – Power-grid networking, over the years, have immensely helped in curbing requirement of physical movement of coal, particularly in long haul. It is envisaged that generation capacity of pithead power stations would grow @ 13.3% in XI Plan from a level of 2.7% in X Plan.

Coal Beneficiation - CIL by end of XI Plan would be dispatching only beneficiated coal to all consumers excepting those who are located at pitheads. This would likely to reduce haulage need by 6-10%.

Coal-by-pipeline – In-situ coal gasification and Coal Bed Methane exploration would be the major ventures in years to come in the energy market of the Country bringing a new vista in transportation logistics.

Conclusion

The use of energy is slated to go up exponentially in the country. Coal will remain the mainstay of the energy mix and along with it the tables will be set for increased transportation of coal to feed the new emerging coal markets. Adequate demand satisfaction can be possible only with the augmentation of infrastructure in a holistic manner. The colliery projects need to add up sidings and associated equipments, plants/ machineries to handle and deliver the coal in ever increasing volumes. The loading infrastructure at the mine end needs to be fully mechanized and a similar infrastructure built-up is necessary at the terminal end where coal is unloaded in bulk round the clock. The rail-cum-sea transportation of coal beyond 100 Mt per year as envisaged by 2030's will be a reality once large no. of dedicated coal berths come in place along with matching bulk reclaiming equipments in the various load / unload ports in the country. In sequel to this development of hinterland connectivity of ports would be another important issue. In a similar vein, the **captive modes of coal evacuation** viz. Aerial ropeway, Conveyor –belt and Merry-Go-Round rail systems etc. are required to be created and re-vamped wherever necessary as part of the users' coal-handling infrastructure.

In the end it may be stated that only a synergic augmentation and up gradation of related infrastructure capacities as outlined above in tune with the transport capacity for coal in the country can make possible the projected coal delivery @ 2 Billion tonnes per annum. Possibly, coal transport logistics would emerge as a specialized business area in the emerging coal market, independent of traditional transporting enterprises like Railways, Port Authorities or Roadways, connecting coal producers and consumers.

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