(*Contd.*)

11. Bihar	178	0.07
12. Arunachal Pradesh	95	0.02
13. Nagaland	22	0.01
Total	250,795	100.00

Source: ***Statistical Abstract of India,*** 2007.

The major states having large proportion of the coal reserves of the country are Jharkhand, Orissa, Chhattisgarh, West-Bengal, Madhya Pradesh and Andhra Pradesh (**Fig. 8.2**). A brief account of coal reserves in these states has been given in the following:

(i) Jharkhand The state of Jharkhand, accounting for about 29 per cent, has the first rank in coal reserves and its production. Most of the coal belongs to the Gondwana period. The districts of Dhanbad, Dumka, Hazaribagh, and Palamu are very rich in coal deposits. The main coal mining centres are Auranga, Bokaro, Daltenganj Giridih, Hutar, Jharia, Karanpur, and Ramgarh (**Fig. 8.3**).

(a) The Jharia Coalfield Out of all the coal mines of Jharkhand, Jharia is the largest and most important coal producing mine, which sprawls over an area of about 460 sq km. It contains the best metallurgical coal (bituminous). Nearly 90 per cent of the coking coal is produced from the Jharia mine. Its coal is mainly supplied to the iron and steel plants of Asansol and Jamshedpur.

(b) The Bokaro Coalfield This coalfield stretches in the valley of Bokaro river in Hazaribagh district, about 32 km to the west of Jharia. The Kargali seam (37 metres) of the Bokaro coalfield is one of the thickest of the Gondwana period in (India). Its coal is mainly supplied to the iron and steel plant of Bokaro.

(c) The Giridih or Karharbari Coalfield The Giridih coalfield stretches in the district of Hazaribagh. Its seams are very close to the surface. It provides one of the finest quality of bituminous coal used for the metallurgical industry. Its coal is supplied to the Bokaro and Jamshedpur steel plants.

(d) The Karanpur Coalfield The Karanpur coalfield is divisible into the North and the South Karanpur coalfields. It lies only about 30 km to the west of Bokaro. The thickness of its seam is about 25 metres. Much of the coal is, however, non-coking.

(e) The Ramgarh Coalfield Stretching over an area of about 100 sq km, the Ramgarh coalfield is only about 9 km to the west of the Bokaro coalfield. The coal of Ramgarh is of relatively inferior quality containing a high proportion of ash (about 30%) and carbon 35 per cent.

(f) The Hutar Coalfield Stretching over about 200 sq km the Hutar coalfield lies in the Palamau district. Its seams are however, thin and the coal is of inferior quality containing about 50 per cent carbon, 30 per cent volatile matter and 20 per cent ash.

(g) The Daltenganj Coalfield Sprawling over 55 sq km, this coalfield lies in the Palamau district. Its coal is either semi-anthracite or non-coking, of inferior quality which can not be used in metellaurgical industries.

(h) Deogarh Coalfields This coalfield lies in the Dumka district and stretches over an area of about 20 sq km. The coal is of inferior quality containing about 40 per cent carbon, 25 per cent volatile matter and 35 per cent ash content. Its coal is mainly used in the brick kilns.

2. Poor Quality of Coal Most of the mines of India are producing non-coking coal which can not be utilised for metallurgical industries.

3. Less Efficient Transport System Most of the coal in India is transported by trains. Adequate number of wagons are not available and railway system is not efficient enough to deliver the coal at distant places in a short time.

4. Obsolete Method of Mining The mining technology is outdated and the per worker production is low. The per tonne cost of production is high.

5. Shortage of Power Supply The shortage of power supply is a big barrier in the mining of coal.

6. Fires and Water-logging There occur heavy losses of coal because of fires and waterlogging in the mines and at the pit-heads.

Conservation of Coal

Coal is an exhaustible resource. It needs to be utilised judiciously. The following steps can go a long way in the conservation of coal in the country.

1. The coking and good quality coal should be reserved only for metallurgical industry.
2. Low grade coal should be washed and impurities removed by modern techniques.
3. Selective mining should be stopped by an act of law. All possible grades of coal should be obtained from all the mines.
4. Environmental safety laws should be effectively implemented.
5. The thermal power plants should be located at the pit-heads to enhance power generation.
6. The pilferages and theft of electricity should be minimised.
7. New reserves should be discovered.
8. The non-conventional sources of energy should be popularised.

Petroleum

Petroleum is an important source of energy which is much in demand to accelerate the economic development. Apart from an important fuel resource, it provides lubricants and raw materials for a number of industries. Its products include kerosene, diesel, petrol, aviation-fuel, synthetic rubber, synthetic-fibre, thermoplastic resins, benzene-methansol, polystertene, acrylates, detergents, aromatics, gasoline, carbon-black, dyes, colours, food-colours, pigments, explosives, printing ink, film-photography, greases, cosmetics, paints, lubricant oils, paraffin, and wax.

Crude oil is obtained mainly from the sedimentary rocks of marine origin. In India, crude oil is found in the sedimentary rocks of the Tertiary period (**Fig. 8.4**). Normally it does not occur at its place of formation. Being lighter than water, crude oil overlain with gas, gets accumulated in the anticlines above the water surface. The geologists propounded two theories about the origin of crude oil.

Origin: The origin of petroleum and natural gas is considered to be organic. According to organic origin, the living organisms (marine life, like fish) and vegetal matter got buried under the accumulated sediments of mud, silt and sand, etc. Due to pressure and heat, this undergoes chemical changes so as to form crude oil and natural gas after millions of years.

Oil in India was discovered near Margherita (Upper Assam); for the first time in 1860 by the Assam railway and Trading Company. Subsequently, oil was discovered at Digboi in 1889. In the beginning of the 20^{th} century (1917), oil was discovered at Badarpur (Assam). In 1954, production

Pipelines

Crude oil from oil-wells and finished products from refineries are generally transported through pipelines. Transportation of oil and petroleum through pipelines is cheap, effective and considered to be safe. Looking at these advantages, a network of pipelines has been developed in India. Some of the important pipelines are as under:

1. Pipelines of North-East India

(i) Noonmati-Siliguri-Pipeline to transport petroleum products from Noonmati to Siliguri.
(ii) Lakwa-Rudrasagar-Barauni Pipeline, completed in 1968 to transport crude-oil from Lakwa and Rudrasagar (Sibsagar District, Assam) to Barauni Oil Refinery (Bihar).
(iii) Barauni-Haldia Pipeline: This pipeline was laid down in 1966 to carry refined petroleum products to Haldia port and bring back imported crude-oil to Barauni refinery.
(iv) Barauni-Kanpur Pipeline: This pipeline was completed in 1966 to transport refined petroleum products to Kanpur city.
(v) Noonmati-Bongaigaon Pipeline: This pipeline was constructed to transport crude-oil to Bongaigaon petro-chemical complex.
(vi) Haldia-Maurigram-Rajbandh Pipeline: This pipeline was completed in 1998.

2. Pipelines of Western India

Bombay-High Mumbai-Ankleshwar-Koyali Pipeline: This pipeline connects the oilfields of Bombay High and Gujarat with the Koyali refinery of Gujarat. The city of Mumbai has been connected with a pipe line of 210 km length double pipeline to Bombay High to transport crude oil and natural gas. The Ankleshwar-Koyali pipeline was completed in 1965 to transport crude oil to Koyali refinery.

3. The Salaya-Koyali-Mathura Pipeline This pipeline, 1075 km in length was laid down from Salaya (Gulf of Kachchh) to Koyali and Mathura via Viramgram to supply crude oil to the Mathura refinery. It has an offshore terminal and the Sayala-Koyali sector of the pipeline was completed in 1978, while the Viramgram-Mathura sector was completed in 1981.

4. The Mathura-Delhi-Ambala-Jalandhar Pipeline This 513 km long pipeline was constructed to transport refinery products of Mathura to the main cities of north and north-west India.

5. Pipelines of Gujarat In Gujarat, there are a number of short distance pipelines to transport crude-oil and natural gas to the refineries and the refined products to the market. These include the Kalol-Sabarmati Crude Pipeline, the Nwagam-Kalol-Koyali Pipeline, the Cambay-Dhuravan Gas Pipeline, the Ankleshwar-Uttran Gas Pipeline, the Ankleshwar-Vadodara Gas Pipeline, and the Koyali-Ahmadabad products Pipeline (**Fig. 8.4**).

6. Mumbai Pipelines From Mumbai, pipelines have been laid up to Pune and Manmad to distribute petroleum products.

7. The Haldia-Kolkata Pipeline Through this pipeline, the Haldia products are sent to Kolkata and neighbouring urban places.

Table 8.9 *State-wise Main Hydro-Electric Power Plants*

States	*Names of the Hydro-Electric Power Plants*
1. Andhra Pradesh	Machkund, Nagarjun-Sagar, Nizam -Sagar, Sileru, Srisalem
2. Bihar	Kosi
3. Gujarat	Ukai (Mahi)
4. Jammu & Kashmir	Dool-Hasti, Lower Jhelum, Salal
5. Jharkhand	Maithon, Panchet, Tilaiya (all three under DVC)
6. Karnataka	Mahatma-Gandhi (Jog Falls), Sivasamudram (Kaveri), Bhadra, Munirabad, Saravati, Tungbhadra
7. Kerala	Idikki (Periyar), Kallada, Kuttiaddy, Pallivasal, Parambikulam, Poringal, Panniar, Sabarigiri
8. Madhya Pradesh	Jawaharsagar and Pratap-sagar on Chambal
9. Maharashtra	Bhola, Bhatnagar-Beed, Khopali, Koyna, Purna, Paithon, Vaiterna
10. North-eastern States	Dikhu, Doyan (both in Nagaland), Gomuti (Tripura), Loktak (Manipur), Kopali (Assam), Khandong and Kyrdemkulai (Meghalaya), Sirlui and Barabi (Mizoram), Ranganadi (Arunachal Pradesh)
11. Orissa	Hirakud (Mahanadi), Balimela
12. Punjab and Himachal Pradesh	Bhakra-Nangal on Sutlej, Dehar on Beas, Giri-Bata, Binwa, Andhra, Chamera, Pong, Siul, Bassi
13. Rajasthan	Ranapratap Sagar and Jawahar Sagar on Chambal river
14. Tamil Nadu	Mettur, Periyar, Aliayar, Kodayar, Moyar, Suruliyar, Papnasam
15. Uttarakhand	Tehri-dam on Bhagirathi
16. Uttar Pradesh	Rihand, Ramganga, Chibro on Tons
17. West Bengal	Panchet

1. Bhakra Nangal Project Constructed across the Satluj river near Bhakra gorge, it is the highest straightway gravity dam in the world. The dam is 518 m long and 226 m high. Its reservoir is known as the Gobind Sagar (named after Sikh Guru Gobind Singh, the tenth Guru of Sikhs). It is a multipurpose project funded by the Central Government, built to generate electricity, provide irrigation, flood control, soil conservation, silt control, recreation, navigation, pisci-culture, preserving wild-life, and cattle rearing.

2. Damodar Valley Project The Damodar River is a tributary of the Hugli River. It used to be called the 'Sorrow of Bengal'. The Damodar flows through Jharkhand and West Bengal. The Damodar Valley Corporation was established on February 18, 1948. Under this project, four dams were constructed namely, Tilaiya, Maithon, Konar, and Panchet Dams.

(i) Tilaiya Dam The Tilaiya dam has been constructed across the Barakar river. It is the only concrete dam in the area. Two power stations of 2000 kW each have been set-up here. The dam provides irrigation to forty thousand hectares of land. It has helped in the reduction of floods. This dam was completed in 1953. Its underground power station with installed capacity of 60,000 kW provides cheap power to the mica mines of Kodarma and Hazaribagh.

(ii) Konar Dam The Konar dam has been constructed across the Konar river—a tributary of the Damodar River in the Hazaribagh District. It was completed in 1955. It is an earthen dam with

Table 8.11 *India—Thermal Power Stations*

Projects/Stations	*Installed Capacity (MW)*
1. Badarpur	720
2. Farakka (West Bengal)	1600
3. Kahalgaon (Bihar)	840
4. Korba (Chhattisgarh)	2100
5. National Capital Thermal Power Plant Dadri (U.P.)	840
6. Ramadundum (Andhra Pradesh)	2100
7. Rihand /Obra (Uttar Pradesh)	1000
8. Singrauli (Uttar Pradesh)	2000
9. Talcher (Orissa)	720
10. Unchahar (Uttar Pradesh)	720
11. Vindhyachal (Madhya Pradesh)	1260
12. Gas Based Projects:	
(i) Anta (Rajasthan)	430
(ii) Auraiya (Uttar Pradesh)	600
(iii) Kawas (Gujarat)	600
Total	15530

Nuclear Energy

Looking at the exhaustible nature of the fossil fuels, nuclear energy development has become very vital for the economic development of the country. In India, it has a vast potential for future energy development. It is produced from uranium and thorium.

Table 8.12 *India—Atomic Power Stations*

Power Stations	*Unit*	*Year of Commissioning*	*Capacity*
1. Tarapur	First	1969	160
(Maharashtra)	Second	1970	
2. Rawatbhata	First	1972	200
near Kota	Second	1981	200
(Rajasthan)			
3. Kalpakkam	First	1984	235
(Tamil Nadu)	Second	1986	235
4. Narora (U. P.)	First	1989	235
	Second	1991	235
5. Kakrapara	First	1993	235
(Gujarat)	Second	1995	235
6. Kaiga	First	1993	235
(Karnataka)	Second	1995	235
7. Rawatbhata;	Third		235
Kota (Rajasthan)	Fourth		235
8. Tarapur	Third		500
(Maharashtra)	Fourth		500

(*Contd.*)

Geothermal Energy

India has very limited potential of geothermal energy. According to one estimate, the total geothermal energy is about 600 MW. There are 115 hot water springs in the country and 350 sites from which geothermal energy can be produced. The Puga Valley in Jammu and Kashmir, the Manikaran area in Himachal Pradesh, the western slopes of the Western Ghats in Maharashtra and Gujarat, the Narmada-Son Valley, and the Damodar Valley are the main areas which have potential for the generation of thermal energy.

Bio-Energy

Bio-energy is a clean source of energy which improves sanitation, hygiene and the living style of the rural population. The technique is based on the decomposition of organic matter in the absence of air to produce gas. Bio-gas is used for cooking, and lighting fuel in specially designed stove and lamps respectively. According to one estimate, India has a capacity to produce bio-gas to the extent of 25,000 million cubic metres. The left over digested slurry serves as manure. This can meet 50 per cent of the rural domestic fuel requirements. Moreover, it can produce 7 million tonnes to nitrogen, 3 million tonnes phosphate and 5 million tonnes of potassium, and over 50 million tonnes of compost manure.

Table 8.14 *Bio-Gas Development in Major Selected States of India—2005–06*

State	*Estimated Potential*	*Production*	*Percentage of estimated potential*
1. Uttar Pradesh	2,021,000	356,300	18
2. Madhya Pradesh	1,491,000	192,950	13
3. Andhra Pradesh	1,065,600	308,520	29
4. Bihar	939,900	119,110	13
5. Rajasthan	915,300	66,025	7
6. Maharashtra	897,000	662,120	74
7. West Bengal	2,021,000	356,310	18
8. Karnataka	680,000	306,845	45
9. Tamil Nadu	615,800	187,265	27
10. Gujarat	554,000	343,700	62
11. Orissa	605,500	171,760	28

Source: ***Ministry of Non-Conventional Energy***.

It may be seen from **Table 8.14** that Uttar Pradesh has the highest potential in bio-gas, followed by Madhya Pradesh, Andhra Pradesh, and Bihar. The highest production of bio-gas is, however, in the state of Maharashtra (74%) followed by Gujarat (62%) and Karnataka (45%).

The development of bio-gas is adversely affected because of the non-availability of cattle dung, water, labour, space, and low temperatures in certain parts of the country, especially during the winter season.

ENERGY CRISIS

With the rapid growth of population and increase in the per capita income, there is an increasing