

Is India Moving Towards Green Energy Technology? A Bird's Eye View

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INTRODUCTION

Energy plays a key role in the economic development and quality of human life. India is the 3rd largest energy consumer and 5th largest energy producer. India is the second largest populated country after China and is the third-largest and fastest emerging economy in the world. The demand for energy has been increasing rapidly because of the growing energy consumption of all sectors such as the agriculture sector, industrial sector, commercial sector and residential sectors. The government of India is set to accomplish the USD 5 trillion economies by 2024-2025. Thus, it is expected that there will be a heavy demand for energy.

India's energy demand has been met by two different energy sources namely fossil fuel sources and renewable energy sources, of which the former met maximum energy demand. The power sector depended mostly on fossil fuel a source because of the production of highest quantity of the electricity is by coal. The demand of remaining sectors namely transport, industries and residential sectors have been met by oil and biomass sources. In the sector-wise final energy consumption in India, the industry sector stands in the first place followed by the residential sector, transport, service, and agriculture sectors come next in order. Most of the energy demand was fulfilled by the conventional sources which are exhaustible and anti- environmental. Deployments of these sources will create different major environmental problems.

Key Words: India's Energy, Conventional energy and per capita energy

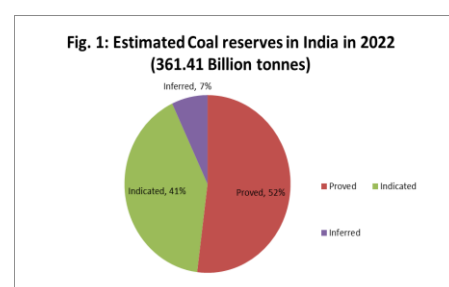
Reserves and potential of energy sources in India

There are various sources of energy potential in India. The following are important reserves of conventional energy sources.

Coal

Coal is an important energy source in India is a part of the conventional energy sources from which a higher percentage of electricity is generated in India. India is ranked fifth in reserving largest Coal possessed by China, Australia, Russia and US (Bp Statistics, 2019). As of 01.04.2022, India's total reserve of coal was 361.41 billion tonnes, (Fig.1) an addition of 9.29 billion tonnes, over the corresponding period of previous year

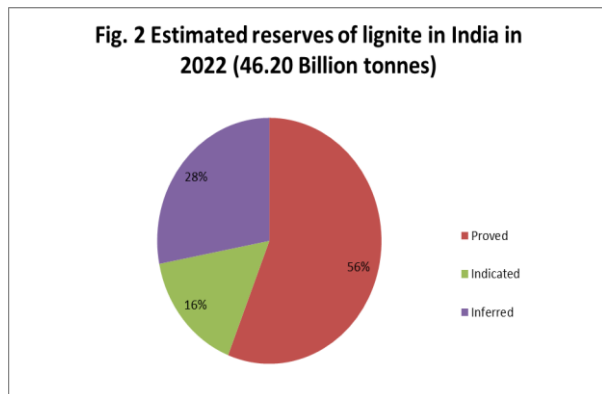
The top three states with highest coal reserves in India are Odisha, Jharkhand, and Chhattisgarh, which accounted for approximately 69% of the total coal reserves in the country.



Source: Government of India, Energy Statistics India 2024, New Delhi.

Lignite

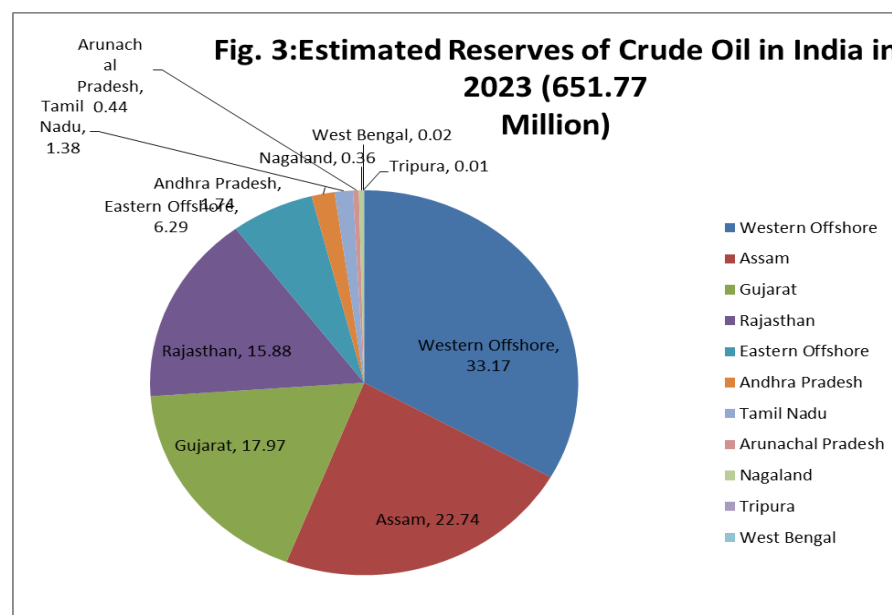
Total estimated of lignite as on 01-04-2022 were 46.20 billion tonnes, an addition of 0.19 billion tonnes over the corresponding period of previous year. In terms of percentage, there has been a growth of 0.40% in the total estimated lignite reserves during the year 2022-23 over 2021-22. The highest reserves of lignite are found in the state of Tamil Nadu. Out of the total Lignite reserves in the country, proven reserves account for almost only 16% of the total as depicted below in Fig 2.



Source: Government of India, Energy Statistics India 2024, New Delhi.

Crude Oil

The estimated reserves of crude oil in India as on 01-04-2022 stood at 653.02 million tonnes against 591.92 million tonnes in the previous year. An increase of over 10% over last year. Geographical distribution of Crude Oil indicates that the maximum reserves are in the Western Offshore (33%) followed by Assam (23%) (Fig.3)

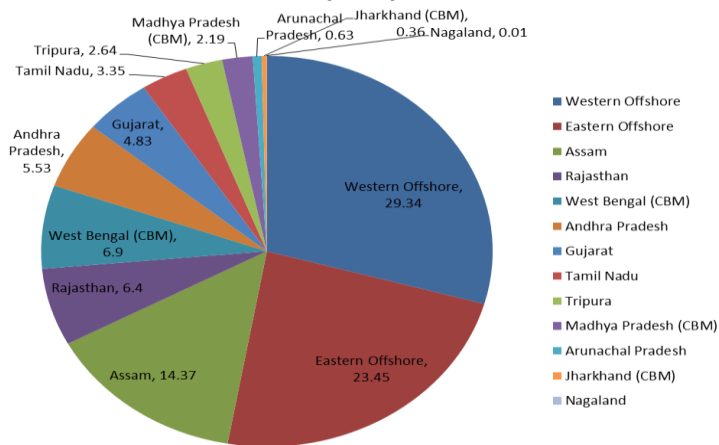


Source: Government of India, Energy Statistics India 2024, New Delhi.

Natural Gas

The estimated reserves of Natural Gas as on 01-04-2022 was at 1149.46 Billion Cubic Meters. The maximum reserves of Natural Gas are in the Western Offshore (29.3%) followed by Eastern offshore (23.4%) (Fig. 4).

Fig. 4: Estimated reserves of Natural Gas in India in 2023 (1149.46 BCM) Estimated Reserves (BCM)

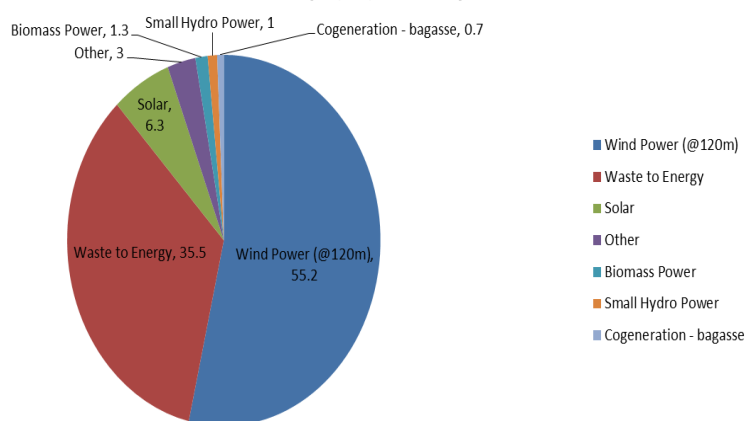


Source: Government of India, Energy Statistics India 2024, New Delhi.

Renewable Energy

There is a high potential for generation of renewable energy from various sources like wind, solar, biomass, small hydro and cogeneration bagasse in India. The total potential for renewable power generation in the country as on 31.03.2023 is estimated at 2,109,654 MW (Fig.5). This includes solar power potential of 7,48,990 MW (35.50%), wind power potential of 1,163,856 MW (55.17%) at 150m hub height, large hydro power of 133,410 MW (6.32%), SHP (small-hydro power) potential of 21,134 MW (1%), Biomass power of 28,447 MW (1.35%) and 13,818 MW (0.66%) from bagasse-based cogeneration in sugar mills.

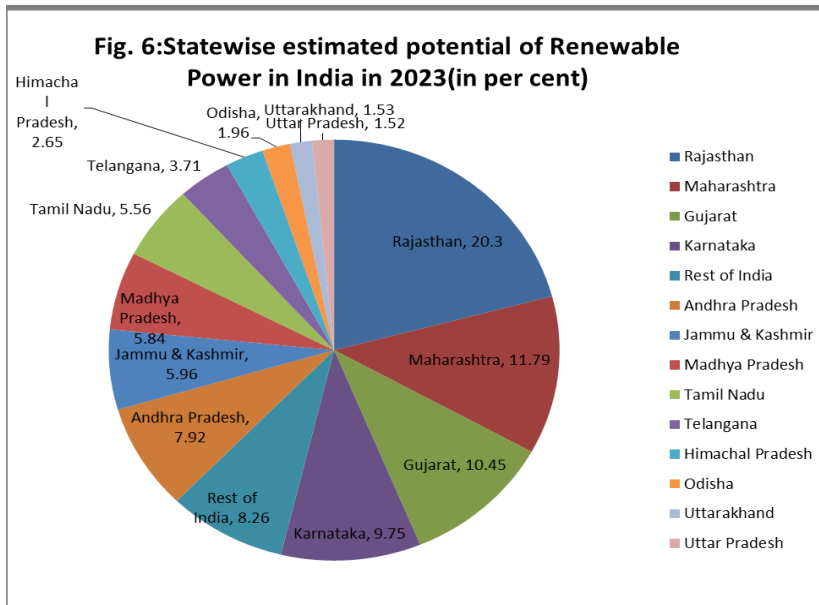
Fig. 5: Source wise estimated potential of Renewable Power (in per cent) in India in 2023 (21,09,654 MW)



Source: Government of India, Energy Statistics 2024, New Delhi

State-wise estimated potential of Renewable Power in India in 2023 (in per cent)

The geographic distribution of the estimated potential of renewable power as on 31.03.2023 shows that Rajasthan has the highest share of about 20.3% (428322 MW) (Fig.6). This is followed by Maharashtra with 11.79% (share 248665 MW). Gujarat and Karnataka come next with a 10.45% and 9.75% share (220505 MW and 205648 MW respectively). These four (4) states are having more than 52% of the total potential of Renewable Power in India.



Source: Government of India, Energy Statistics India 2024, New Delhi.

Production of Conventional Energy Sources in India

Globally, the production of energy has been increasing to meet the growing demand of energy. Generally, coal has been produced in several countries. Few of countries produce a large quantity. In this respect India is in fourth place in producing the coal after Indonesia, US, and China.

Table 1 presents coal production in the country during the year 2022-23(P) was 893.19 million tonnes as compared to 778.21 million tonnes during 2021-22. There is an increase of 14.77%. The overall trend of production in the last ten years i.e. 2013-14 to 2022-23(P) has shown a steady increase, except 2020-21, with a CAGR of 5.20%.

Table 1 Production of Conventional Energy Sources in India

Year	Coal (Million Tonnes)	Lignite (Million Tonnes)	Crude Petroleum (Million Tonnes)	Natural Gas (Billion Cubic Metres)	Electricity# (GWh)
2013-14	565.77	44.27	37.79	35.41	2,34,595
2014-15	612.43	48.26	37.46	33.66	2,38,908
2015-16	639.23	43.84	36.94	32.25	2,24,571
2016-17	657.87	45.23	36.01	31.90	2,41,842
2017-18	675.40	46.26	35.68	32.65	2,66,308
2018-19	728.72	44.28	34.20	32.87	2,99,465
2019-20	730.87	42.10	32.17	31.18	3,40,579
2020-21	716.08	37.90	30.49	28.67	3,40,576
2021-22	778.21	47.49	29.69	34.02	3,69,652

2022-23(P)	893.19	44.99	29.18	34.45	4,11,512
Growth rate of 2022-23 over 2021-22(%)	14.77	-5.27	-1.72	1.25	11.32
CAGR 2013-14 to 2022-23(%)	5.20	0.18	-2.83	-0.30	6.44

Electricity from Hydro Nuclear and other renewable energy resources(utility)

Source: Government of India, Energy Statistics (various issues) New Delhi.

The Lignite production during 2022-23(P) has been decreased to 44.99 million tonnes from the figure of 47.49 million tonnes in 2021-22; a decrease of 5.27% over 2021-22(Table 1). However, the production of crude oil for 2022-23 (P) came out to be 29.18 MT as compared to 29.69 MT during FY: 2022-23 which is a decline of 1.72%. The CAGRs for Crude Oil and Natural Gas, w.r.t FY: 2013-14, are having negative of -2.83% and -0.30% respectively. Electricity (generated from Hydro, Nuclear and other Renewable energy sources) is having the highest CAGR of 6.44%, showing the remarkable growth of Renewable Energy in India

Table 2 Consumption of Conventional Energy Resources in Physical Units

Year	Coal	Lignite	Crude Petroleum	Natural Gas	Electricity (GWh)
2013-14	739	44	222	52	8,74,209
2014-15	822	47	223	51	9,48,522
2015-16	837	42	233	53	10,01,191
2016-17	837	43	245	56	10,61,183
2017-18	898	46	252	59	11,23,427
2018-19	968	46	257	61	21,09,972
2019-20	956	42	254	64	12,48,086
2020-21	906	38	222	61	12,30,208
2021-22	1028	49	242	64	13,16,765
2022-23(P)	1115	57	255	60	14,03,400
Growth rate of 2022-23 over 2021-22(%)	8.48	-4.53	5.60	-6.53	6.58

CAGR 2013-14 to 2022-23(%)	4.67	0.72	1.54	1.52	5.40
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Source: Government of India, Energy Statistics (Various issues) New Delhi

Consumption of Conventional Energy Sources in India

Table 2 reveals that India's total consumption of coal was 1,115 million tonnes in 2021-23(P) an increase from 739 million tonnes in 2013-14. The increase of 376 million tonnes naturally raised CAGR by 4.67 per cent throughout the decade which indicates that the increase in consumption of coal was steady. In the case of lignite consumption there was a fluctuation but it finally reached 57 million tonnes in 2022-23 showing an increase by 13 million tonnes. The raise of 13 million tonnes increased the CAGR by 0.72 per cent. The consumption of Crude petroleum raised to 255 million tonnes in 2022-23 from 222 million tonnes in 2013-14. The consumption of natural gas was 60 BCM in-2022-23 an increase from 52 BCM in 2013-14. The increase of 8 BCM raised CAGR by 1.52 per cent. The consumption of electricity raised to 14,03,400 GWh in 2022-23 from 8,74,209MGh in 2013-14. The increase of 5,29,191 GWh raised CAGR by 5.40 per cent. It is observed that the among the conventional energy source in terms of consumption, the highest amount of CAGR was found in coal (4.67 per cent), followed by crude petrol (1.54 per cent), natural gas (1.52 per cent) and Lignite (0.72 per cent) during 2013-14 to 2022-23.

Table 3 Per Capita Energy Consumption in India

Year	Per capita Energy Consumption(MJs)
2013-14	21,419 (1.2%)
2014-15	22,434 (4.74%)
2015-16	22,629 (0.86%)
2016-17	22,866 (1.05%)
2017-18	23,569 (3.07%)
2018-19	24,629 (4.49%)
2019-20	24,243 (-1.57)
2020-21	21,965 (-9.39)
2021-22	24,095 (9.69%)
2022-23(P)	25,424 (5.51%)
CAGR	1.30

Note: Figures in parentheses denote annual growth rate.

Source: Government of India, Energy Statistics

(Various issues) New Delhi.

Per capita Energy Consumption in India

Table 3 shows the trend of per capita energy consumption in India. The per capita energy consumption is a significant indicator for economic development of any country. India's per capita energy consumption was increasing steadily increased from 2013-2014 to 2022-23. As of March 2023, India's per capita energy consumption was 25,424 Mega Joules.

It is observed that the highest annual growth rate (4.74 per cent) was found in 2014-2015, whereas the highest negative growth rate was found in 2020-21(-9.39%). The CAGR of per capita energy consumption of India was 1.30 per cent during 2013-2014 to 2022-2023.

CONCLUSION

Globally, the production of energy has been increasing to meet the growing demand of energy. India is in fourth place in producing the coal after Indonesia, US, and China. The top three states with highest coal reserves in India are Odisha, Jharkhand, Chhattisgarh, which account for approximately 69% of the total coal reserves in the country. There is a high potential for generation of renewable energy from various sources like wind, solar, biomass, small hydro and cogeneration bagasse in India. The overall annual growth rate of per capita energy consumption of India was fluctuating during the period of the study.

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