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Energy Consumption Trends in India and Its Impact on Indian Economy

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ABSTRACT

In the current scenario, various energy studies and surveys have projected India as one of the fastest growing Economy (with last 5-year GDP average equal to 7.178%) and that the energy demand will continue growing in India. In the previous decade, the energy demand has consistently soared steadily for all sectors including agriculture, industry, commercial and residential, and is expected further increase at a fast pace. This paper represents the present and the future Indian trends up to 2050 for energy consumption and production from various resources such as coal, petroleum, nuclear energy and renewable energy including hydro energy, biofuels and wind and solar energy. This paper also compares the Indian energy consumption and production trends with those of the developed countries like China and USA; the largest energy consumers at present. This paper points towards the various challenges that lie ahead for India to reduce energy demand and supply gap. This work focuses on the fact that proper planning, development and management of the energy resources is required to make the road of India's development smooth and to lower the burden of various energy imports.

Keywords: Energy Scenario, India Energy Trends, Energy Resources, Energy Planning

INTRODUCTION

The three "Es"; Energy, Economy and Environment, are closely associated with each other. Population and Economy are the driving factors of the Energy demand of any country and energy consumption is the indicator of country's development. A developed country has the more consumption of energy due to advancement in the industry, agriculture and transportation sector. India is still among the developing countries. The population has increased by 30% in the last 2 decades and is projected to be over 1500 million by the year 2036 [1]. At present, the population of India is 1339 million as compared to 1443 million of China and 332 million of United States of America [2]. China is the world's largest consumer of energy with annual consumption of 3284 million tonnes of oil equivalent (MTOE) in 2019[3]. Both USA and China have 40% share of world's energy consumption. United states, though having very less population as compared to India and China has the higher per capita energy consumption in the world at 6.87 tonnes of oil equivalent (TOE) per capita, which is approximately 12 times that of India having per capita energy consumption of 0.6 TOE [3]. Table 1 reflects the present energy scenario of the world and other countries as compared to India. It can be clearly concluded from the table 1 that India is far behind in energy supply and production than USA or China. India is steadily progressing on its development journey. However, the nation's energy resources are limited in comparison to its population size. While having nearly one-sixth of the global population, India possesses only about 0.8% of the world's total geological reserves. It holds 5.7% of the total confirmed coal reserves and a mere 0.4% of proven hydrocarbon reserves [3].The efforts are always being made by the government to make

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Table 1. Various energy indicators (World Energy Scenario 2018-19) [3-5]

Country/ Region	*Population (Million)*	*GDP (Trillion USD)*	*TPE Consumption (MTOE)*	*Per Capita Energy Consumption (MTOE)*	*TPE Production (MTOE)*	*Co_2 Emissions (Gt)*
World	7577.1	98.63	13371	1.912	14421.15	33.51
Africa	1373.4	2.6	733	0.55	1168.72	1.24
Middle East	456.1	3.63	681	3.19	2039	1.773
USA	332.9	20.81	2298.7	7.3	2172.52	4.77
China	1444.2	14.86	2972.1	2.19	2562.24	9.57
India	1393.4	2.59	637.8	0.506	573.558	2.3

India stand among the developed countries. There are many developments in technology in Industrial and the agricultural sectors. Also, the electrification of the remote areas, where electricity has yet not reached, is being done. The number of vehicles, both passenger as well as goods, are increasing. In short, the demand of energy is increasing at a high rate. It is projected in various world energy surveys [1-7] that India will be the top consumers of energy in the world along with China in the future. Therefore, India needs to be self reliant for its energy needs and reduce the gap between the demand and supply to keep on moving smoothly on the path of development. Energy consumption also has the effect on the environment. The high energy demand can push to the exploitation of the conventional energy resources on one hand and also affect the environment with various types of pollution. Global warming, air pollution, water pollution, food pollution and overuse of non biodegradable materials are the results of the high energy use which have forced the researchers and the lawmakers to look for clean and green alternatives to the conventional energy resources. An attempt has been made in this paper to analyze the present and the future Indian trends up to 2030 of energy consumption and production from various resources and the challenges that India faces in becoming self reliant for its energy needs.

INDIA ENERGY SCENARIO

Present Energy Balance

According to India energy statistics 2018, the total primary energy supply in the year 2017-18 was 837.4 MTOE and the final energy consumption for the same year was 553.904 MTOE. The energy Import was 419.11 MTOE. Figure 1 shows the sector wise energy consumption for the year 2017-18. It is clear from figure 1 that Industrial sector is the largest consumer of energy with 307.49 MTOE (55.51% share). The non energy uses include energy transformation, industry and chemical industry, etc.

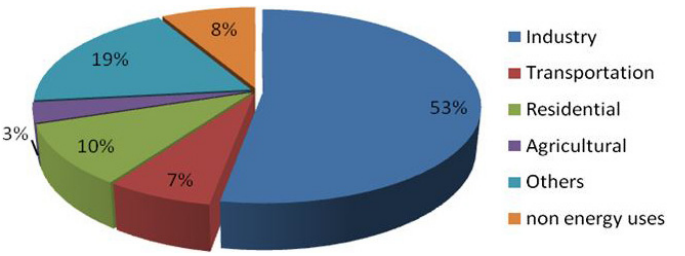

Fig. 1. Final energy consumption sectorwise (2013-14) [8]

In the current scenario, various energy studies and surveys have projected India as a fastest growing Economy (with last 5-year GDP rate equal to 6.5%) and also that the energy demand will continue growing in India at the rate of 6.3% [1,6]. The Twelfth Plan document from the Planning Commission projected that domestic energy production is expected to reach 669.6 million tons of oil equivalent (MTOE) by 2016-17 and increase to 844 MTOE by 2021-22. (figure 2) [7]. This production level is expected to cover approximately 69% energy demand in 2021-22, with the remaining energy requirements being fulfilled through imports.

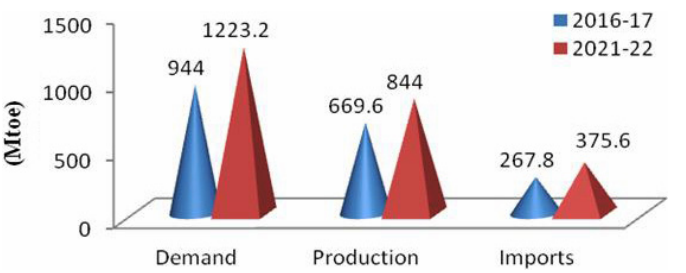

Fig. 2. Trends of demand and production of energy as projected in 12th planning commission report

The last 10-year trends from 2004 onwards show the average growth of energy demand of 6.26% [2]. As a result of continuous economic growth backed by the strong government policies, it can be expected to 8% average. Figure 3 shows the shows the energy

requirement by 2030 in these scenarios (i.e. at average rate 6%, 7% and 8%).

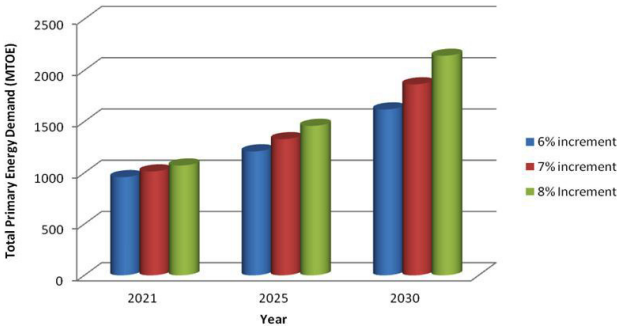

Fig. 3. Future trends of demand and production of energy as projected in 12th planning commission report

Considering the 6% average rise in demand annually, about 1525 MTOE would be required by 2030. The present resources will not be enough to cope up with the surging demand. India is presently an energy deficient country and has to export crude oil and various other energy sources. There is also a great challenge before government in managing the present energy resources and developing the new ones so that the demand of the required energy can be filled indigenously. Presently the burden lies on conventional energy resources like coal and crude petroleum which are limited in numbers in India. The share of non conventional energy resources is 12.1% of the total supply. These resources need to be developed so that the burden on conventional resources as well as the export burden may be reduced.

Future Energy Trends Sector-wise

The demand for energy is projected to increase due to the population growth, economic policies, and growth in Industry. Various Energy surveys and research works [9-11] have analysed and predicted the growth rate of energy in each sector, viz., Industry, domestic, transport and agriculture. The trends of energy consumption for these sectors according to these predictions are shown in Figs. 4–7.

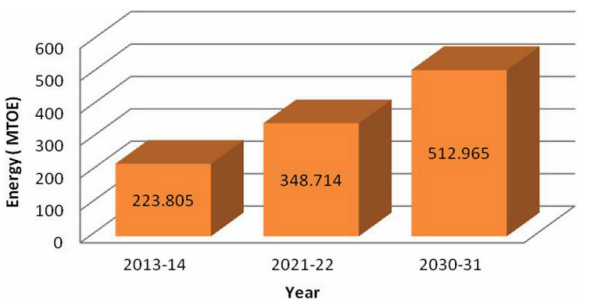

Fig. 4. Trends in energy demand for industries [9]

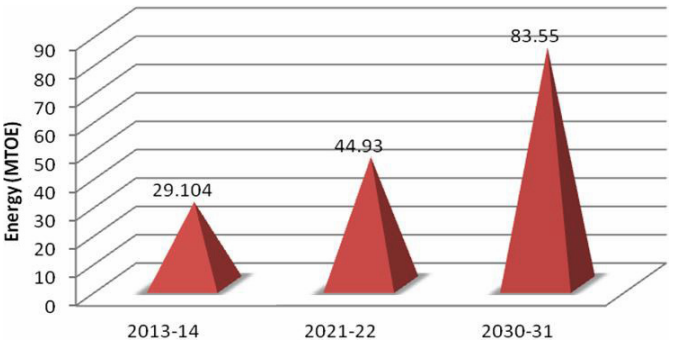

Fig. 5. Trends in energy demand for transport [10]

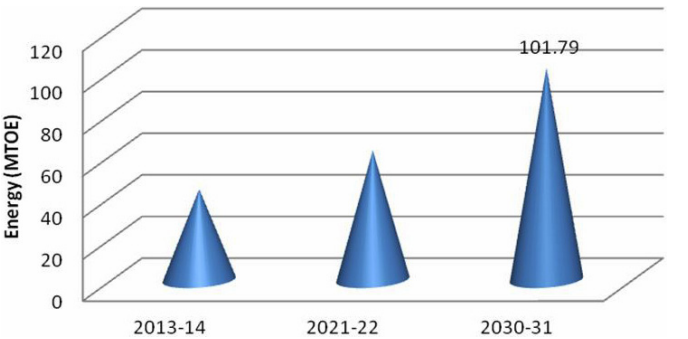

Fig. 6. Trends in energy demand for domestic sector [10]

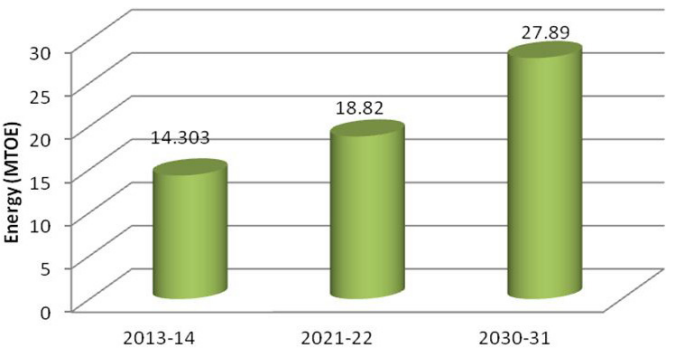

Fig. 7. Trends in energy demand for agriculture sector [11]

- **Industrial sector:** Projected energy consumption of Indian industry as per International energy agency, France is 600-634 MTOE by year 2050[9] which reflects average 3% annual growth in Industrial energy consumption. The last 7-8 years have seen the Industrial energy consumption growth at the average annual rate of 5.8%. [7-8, 12, 13]. Backed up by strong policies of Indian government for Indian industry boost further, we can assume the same progress up to next 15 years and the energy demand has been predicted as shown in Fig. 4.
- **Transportation sector:** The total number of vehicles in India have increased at the average rate of approximately 10.5% per annum [12]. India has the largest consumer of two wheelers in the world. The two wheelers have around 72% of the

share in the number of vehicles present in India at present (Fig. 8). Trends further indicate that India's energy consumption in the transportation sector is expected to grow at the highest rate globally, averaging 5.5% annually, significantly outpacing the global average of 1.4% per year. Additionally, overall energy demand in India is projected to rise at an average rate of 6.4% per year. [10].

- **Domestic sector:** India is the third largest producer of electricity in the world with production of 1208400 GWh in year 2014 [2]. India is presently the fourth-largest electricity consuming country and accounts for about 5% of the world's total annual electricity consumption. India's demand for electricity is rising at a remarkable pace. Over the past decade, the country's annual electricity generation and consumption have grown by approximately 64%. Looking ahead, India's electricity consumption is expected to grow at one of the fastest rates globally, with overall energy consumption projected to increase by an average of 5.2% annually [10]. Figure 6 shows the trend in demand up to 2030.
- **Agriculture sector:** The trends of energy consumption in agriculture sector are represented in Fig. 7. The use of technology and fertilizers enhance the energy consumption. It has been estimated in various energy reviews that the energy consumption will increase at an average rate of 4% per annum. Therefore, India would be requiring approximately 28 MTOE of energy during this year for agriculture sector.

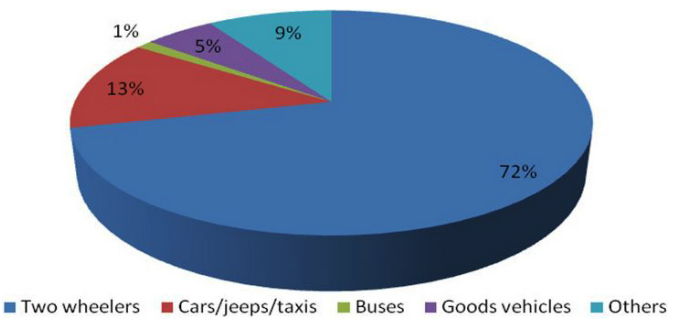

Fig. 8. The vehicle population shares in India

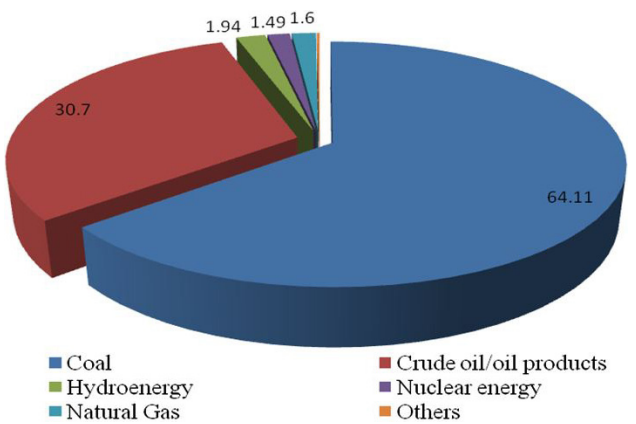

Fig. 9. Percentage share of each resource in TPES [8]

From the trends of energy demand discussed above, It can be concluded that:

(a) The demand for energy continues to increase in all the sectors with industry sector having the largest share.

(b) The energy resources need to be developed in India to make up for the increased energy demand.

(c) The strategies need to be developed and analysed so that the import of various energy resources can be reduced.

(d) The consumption in energy also leads to increased CO_2 and other emissions which is of prime concern to the World and India today.

THE ENERGY RESOURCES OF INDIA

Currently, fossil fuels such as petroleum, coal, and natural gas serve as the primary sources of energy. Although these fuels continue to form under the earth's heat and pressure, their consumption far exceeds the rate at which they are replenished. This imbalance classifies fossil fuels as non-renewable resources, as they cannot be replaced quickly enough to match their usage. In India, the major burden for the supply of energy is on coal as there is increase in the electric energy demand as well as materials in which coal is a key component of production such as steel and cement. The crude oil is another major energy resource. India, not having much of the reserves, has to import around 80% of its crude oil demand. The renewable has lesser shares in energy supply at present though the share of hydro energy is significant among the renewables

Table 2. Primary energy supply from various resource

Resource	*Share (MTOE)*	*Percentage Share*
Coal	382.355	64.11
Crude oil/oil products	183.120	30.7
Hydro energy	11.587	1.94
Natural Gas	9.896	1.6
Nuclear energy	8.913	1.49
Others	0.954	0.08

(around 1.9%). Nuclear energy is another significant resources and is currently being developed to large extent.

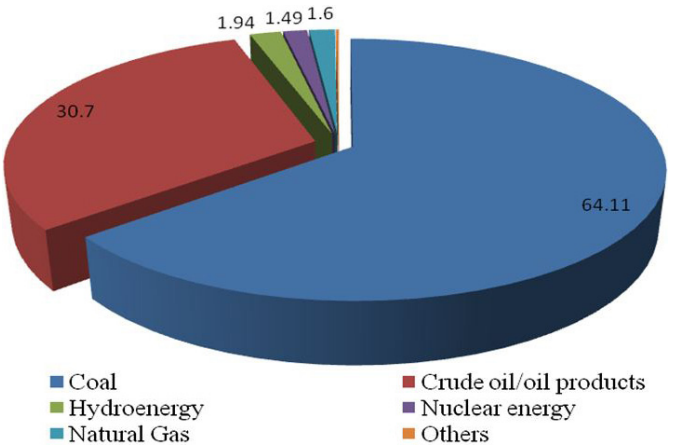

Fig. 10. Share of each resource in total primary energy supply

Coal

Coal is the most abundant fossil fuel on earth, with confirmed reserves of approximately 1,000 billion tonnes. [14] and its consumption is next only to oil. Coal contributes to about 26% of the world's primary energy consumption and approximately 40% of the global energy used for electricity generation. [15]. Bituminous coal is the most abundant type of coal, serving as the primary source of coke for smelting, coal tar, and various chemically modified fuels. At existing production rates, current coal reserves are expected to meet demand for nearly 150 years. The remaining recoverable resources are even greater, making a shortage of coal unlikely to limit production. Additionally, coal is the most widely distributed fossil fuel, with 43% of proven reserves located in OECD countries, compared to 10% for natural gas and 16% for oil. [15]

The rise in global coal consumption is mainly due to the growing demand for electricity in China, India, and other non-OECD countries, where total power generation has more than doubled since 2000. More than half of this increased electricity generation has been fuelled by coal.

Coal accounts for approximate 26% of the world's primary energy consumption and around 40% of the energy consumed worldwide for electricity generation. At present coal production levels, the world reserves would meet demand for almost 110 years. India has proven coal reserves of 344.05 billion tons which is 6.8% of the world reserves. India was 3rd largest in the world producer of coal after China and USA with production equal to 565.77 million tons in 2014 (MTs).

- Reserve/Production (R/P) Ratio = No. of years the reserve can last = 223 years
- Net coal imports = 166 million tons
- Import burden approximately 22 lakh USD/year

Crude Oil

India is the fourth largest consumer of crude oil in the world. The present proven reserves of oil in India are 800 million tons against the 240,000 million tons with R/P 52.5. The Demand for diesel in India is about 8 times that of petrol. India imports about 80% of its crude oil demand at present.

Table 3. Imports of crude oil (value) in 2005-06 and 2013-14

Year	*Imports (MMT)*	*Value (Thousand Crore Rs)*
2005-06	100	249546
2013-14	190	864875

Natural Gas

The Natural Gas reserves in the world are 187 trillion cubic meters R/P is 54. India's present share in world production of Natural Gas is a less than 1%. The proven reserves in India are 1.4 trillion cubic meters R/P 45.

Nuclear Energy

There are 7 nuclear plants across India with 21 Nuclear reactors at present. Further 8 sites have been proposed to be set up. The present Capacity is 5780 MW. But the potential of nuclear power generation is 43644 MW.

Renewable Energy

The total potential for renewable power potential generation in the country estimated at 531414 GWh [17]. That means we are utilizing just 1/3 of the Renewable resources Share of Renewable energy can be 46 MTOE, i.e. around 11%.

Table 4. Use of renewable energy country-wise

Country	*Hydropower*	*Wind Power*	*Biomass and Waste*	*Solar Power*	*Geothermal*	*Total*
China	1,070,000	160,000	4,2000	2,8200	-	1300,000
USA	260,000	180,000	64,000	18,300	16,600	540,000
Brazil	510,00	7,000	42,300	–	–	559,300
Canada	395,700	12,000	9,400	800	–	417900
Russia	176400	-	3,400	–	–	179800
India	135000	30,000	5,000	3,000	–	178000

Units: GWh Data for 2013-14; *Source:* [2, 8, 15, 16, 18, 19]

Table 5. Per capita energy consumption for various countries/regions

Country/Region	*CO_2 Emissions/Capita (Gt) [2,4]*
World	31.734
OECD countries	12.341
Africa	0.968
Middle East	1.607
USA	5.2
China	8.7
India	1.8

ENERGY ISSUES

There are many issues pertaining to the energy consumption that arise concerns. The foremost issue due to which the whole world is concerned is global warming. With development and the energy consumption, CO_2 consumption is increasingly rejected into the environment. Table 5 shows the CO_2 emissions per capita for various countries and regions of the world.

The other energy challenges that are bothering the leaders of the world are:

- Energy Poverty – in 2009–2010, an estimated 29.8% of India's population—350 million people—lived below the poverty line [20]
- Energy efficiency
- Energy Intensity
- Energy Subsidies
- Pollution
- Import Burden

ENERGY BALANCE 2030

As per the trends of energy demand from all the sectors, the energy 1500 MTOE considering 6% AGR. Then the trends of energy production from various resources are indicated in Table 6. The Total Primary energy supply From conventional resources is predicted to be 1018 MTOE and from the Non conventional Energy resources is 216 MTOE which is assumed on the basis that it will have 20% share in the total energy production. Therefore there will be still an energy deficit of 280 MTOE by 2030.

Table 6. Trends of energy production from various resources

Resource	*CAGR (Last 8 years)*
Coal and Lignite	3.85%
Crude petroleum	1.79%
Natural Gas	1.06%
Nuclear	7.2%
Hydro	3.8%

CONCLUSION

- China and India are projected to dominate in global energy demand.
- The present energy scenario in India is not satisfactory.
- Energy demand is expected to increase at an annual rate of 6-7% with final energy demand of 1700 MTOE by 2030
- Maximum demand for Energy by will be form the Industry sector.
- Coal will continue to have the largest share in Total Primary energy supply.
- There is tremendous scope in the potential of Nuclear energy consumption and Renewable energy.

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