CHAPTER-3

INDIA'S ENERGY SCENARIO

3.1 Introduction

This chapter is divided into two parts. A general review of the Indian energy scenario is given in the first part. The relationship between the energy situation and the GDP, population, and energy demand is demonstrated. Additionally, a few important energy-related metrics are emphasized, including GDP per capita, energy demand per capita, oil demand per capita, coal demand per capita, residential energy consumption, steel & cement use, car ownership, and CO2 emissions per capita. Furthermore, trends in energy consumption by fuel in a few different end-use industries are also shown. The availability of power, demand, reliance on outside sources, and sources of various energy have also been discussed. Moreover, it has been revealed how employment, energy, and GDP are related. Fuel usage in the industrial sector is noted. Specific to this study, the proportional percentage share of energy usage among the different industries is presented finally. Following that, the fuel share of each industry in total fuel consumption is marked.

In the second section, an exploratory and descriptive statistical analysis has been undertaken after conceptualizing the aforementioned themes. Variables like energy consumption, labor input, fixed capital, the fuel price index, and industrial gross value added were all the subjects of the statistical analysis. To learn the fundamentals about each variable in the data set, these variables under inquiry are checked. and to determine any potential connections between these variables. The goal of such an exercise is to comprehend mean central tendencies and dispersion measures.

Based on the aforementioned characteristics, the descriptive statistics are first calculated in level form for each industry, thereafter the growth rate of the variables within each industry is examined. All of these findings offer enough data for the chapters that follow to perform empirical research.

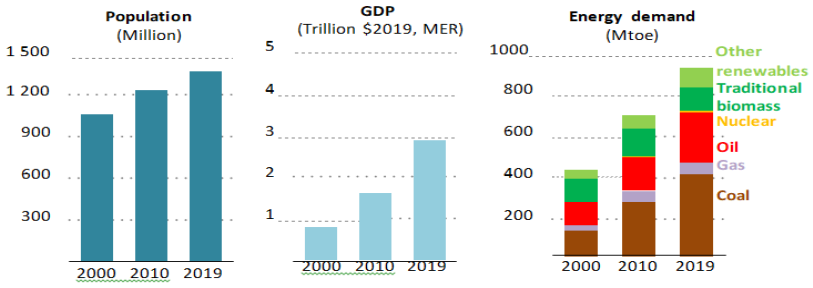
3.2 Section-I: Energy Scenario India

3.2.1 Energy sketch of India

Since 2000, India's energy consumption has increased many folds; this can be attributed to the rising population, massive industrialization, rapid urbanization, and the quest for economic proliferation (Figure 3.1), all of which have driven up energy demand. With an annual growth rate of the population of 1.18 percent, a further expansion of the population is

expected. Such expectations will posit India's energy consumption to be the fastest among major emerging economies by 2040.

Figure 3.1 Relationship between population, GDP & Energy demand

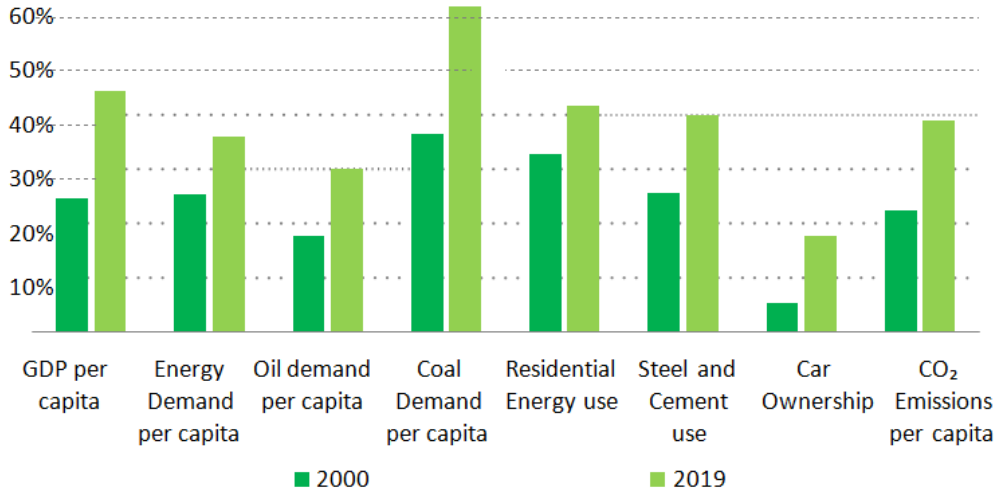


Source: Energy Outlook-2020-21

India's demand for energy is mainly met through three major fuels, coal, oil, and solid biomass, which together constitute more than 80% of total energy. Coal has been the major fuel for electricity generation and industry, and it continues to be the major fuel in the energy mix.

Since 2000 Indian economy is responsible for more than 10% of the rise in world energy demand. Energy demand in India has increased by more than 60% per capita. At present time, India has been outperforming the rest of the world in terms of economic and energy indices (Figure 3.2). The Per-capita Coal demand has soared from 25% of the world average in 1990 to 60% by 2019.

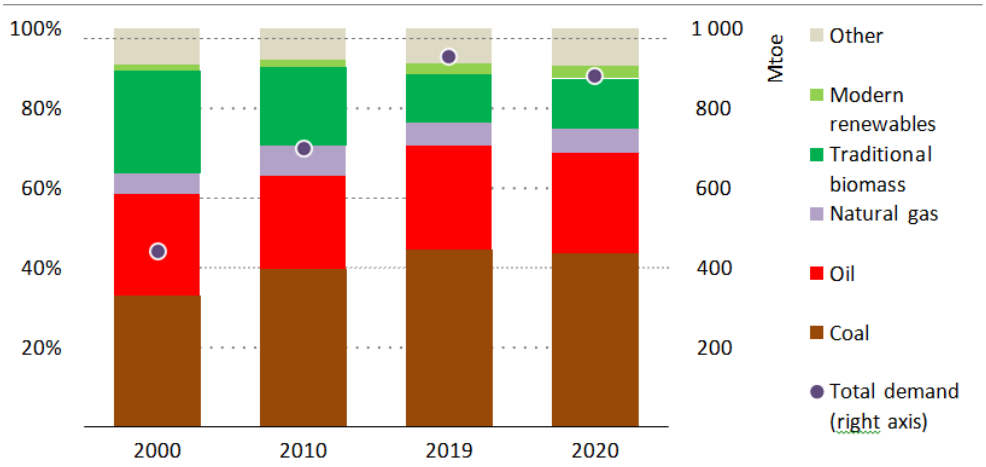
Figure 3.2 Key indicators in India as a percentage of global averages



Source: Energy Outlook-2020-21

However, India is still a resource-constrained country, except for solar, coal, and wind, among such scenario energy availability and affordability is a big challenge. Coal, oil, and biomass are the major source of energy demand for India. During the reform periods, these energy sources supplied over 80% of India's overall energy demand. Coal has gained its position as the leading energy source, holding its supremacy in power generation and serving as a main source of fuel for a variety of sectors (especially heavy industries such as iron and steel). Between 1998 and 2019, coal demand nearly tripled, accounting for fifty percent of all primary energy demand growth. Coal currently accounts for 44% of India's primary energy demand, up from 33% in 2000. Thus, Coal has fueled India's economic growth along with its negative externalities. (Figure 3.3.)

Figure 3.3 Total primary energy demand in India



Note: Mtoe = million tonnes of oil equivalent.

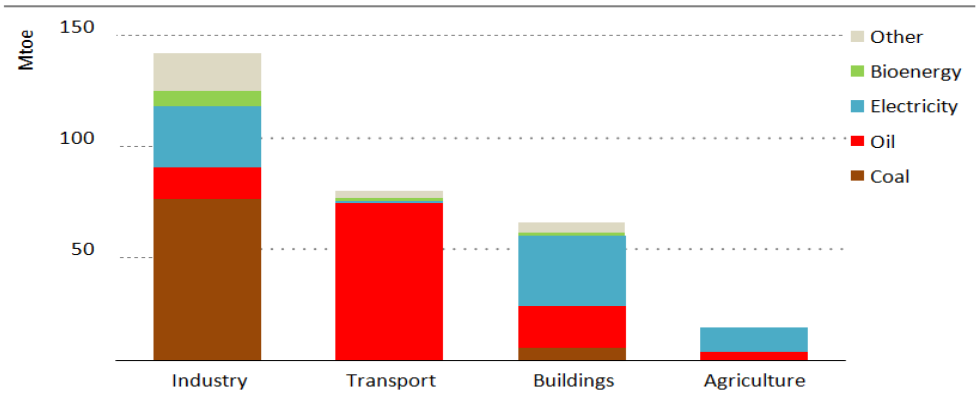
Source: Energy Outlook-2020-21

Since 2000, India's industrial sector has been the main consumer of energy, with coal accounting for over fifty percent. But, since 2000, transportation energy consumption rose by 3.5 times, while building energy usage has climbed by 40%, because of increasing electrical device ownership and people's access to contemporary cooking fuels. The agriculture sector has lacked energy use due to its decreasing share in the national output and prolonged use of conventional farming procedures.

As urbanization and rising factor income drive up the usage of domestic appliances, again that drives the production of such goods which are energy dependent, electricity consumption has nearly tripled in the last two decades, growing faster than total energy

demand. The increased usage of electrical motors and other machinery by industry has also been responsible for the rise in electricity demand (Figure, 3.4). On the supply side, coal continues to dominate the power sector, accounting for more than 70% of total generation in 2019. In 2019, solar PV and wind accounted for 18% of total capacity, while together their share was less than 10%. Because of disparities in economic and demographic trends, resource availability, and industrial structure, there is a difference in overall energy consumption across Indian states.

Figure 3.4 Change in energy demand by fuel in selected end-use Sectors from 2000- 2019



Source: Energy Outlook-2020-21

The gap between the demand and supply of power is expected to rise in the future. Table-3.1 shows the power supply status of the country from 2011 to 2018–2020. In 2019, the energy demand was 1,212, 134 GWh, and the availability was 1,203,567 GWh, i.e., a deficit of − 0.7%, although the demand and availability of energy had seen a downward movement during the covid years, the Central Electricity Authority of India (CEA) predicts that the electrical energy demand for 2021–2022 is estimated to be at least 1915 terawatt hours (TWh), with a peak electric demand of 298 GW. This is due to increasing urbanization and rising income levels, and the resultant increased demand for electrical appliances in the household sector. Higher energy demand is also influenced by increased demand for materials for buildings, transportation, capital goods, and infrastructure.

Table-3.1 Power availability status from 2011-2020

	Energy		Surplus (+)/Deficits (−)		Peak		Surplus (+)/Deficits (−)	
Year	Demand (GWh)	Availability (GWh)	(GWh)	%	Demanded (MW)	Supplied (MW)	(MW)	%
2011	830,594	746,644	− 83,950	− 10.11	119,166	104009	− 15,157	− 12.72
2012	861,591	788,355	− 73,236	− 8.50	122,287	110256	− 12,031	− 9.84
2013	937,199	857,886	− 79,313	− 8.46	130,006	116,191	− 13,815	− 10.63
2014	998,114	911,209	− 86,905	− 8.71	135,453	123,294	− 12,159	− 8.98
2015	1,002,257	959,829	− 42,428	− 4.23	135,918	129,815	− 6103	− 4.49
2016	1,067,085	1,028,955	− 38,130	− 3.60	148,166	141,160	− 7006	− 4.70
2017	1,114,408	1,090,850	− 23,558	− 2.10	153,366	148,463	− 4903	− 3.20
2018	1,142,928	1,135,332	− 7596	− 0.66	159,542	156,934	− 2608	− 1.63
2019	1,212,134	1,203,567	− 8.567	− 0.7	164,066	160,752	− 3314	− 2.0
2020	769,399	764,627	− 4773	− 0.6	177,022	175,528	− 1494	− 0.8

Source: Central Electricity Authority of India.

3.2.2 Energy Sources in India

Coal:

As mentioned earlier coal is the primary energy mix of India's energy economy, accounting for 44 percent, and the third largest among G20 countries. With huge domestic reserves, India ranks as the second-largest coal market. On average 700 million tonnes (Mt) of coal is mined in India each year, mining is largely done in the eastern states of Odisha, Chhattisgarh, Jharkhand, and Madhya Pradesh. The major coal production comes from the open pit. About 80% of the coal requirement for the nation is produced by Coal India which is one of the largest producers in the world.

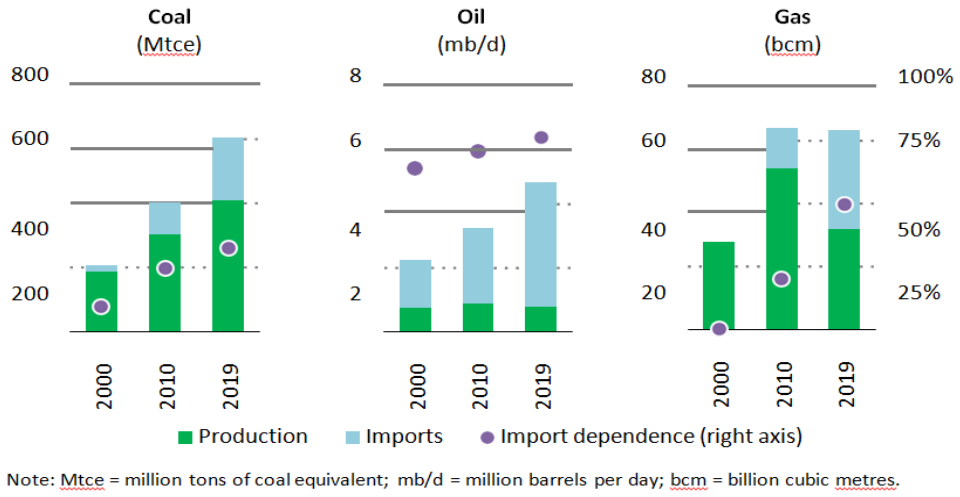
Despite Coal India having the fifth largest verified coal reserves in the world, local production has been unable to keep up with demand. This has resulted in a continuous increase in imports in recent years (Figure 3.5), albeit the growth of thermal coal import dependency has slowed since the mid-2010s due to increased domestic supply and decreased demand growth. The steel sector requires coking coal, which is significantly less abundant locally than thermal coal, which accounts for a portion of the import need.

Furthermore, around 18 GW of coal-fired power plants (or 8% of the entire fleet) are located along the coast and are built to utilize imported coal rather than lower-quality indigenous coal. Domestic coal also has high ash content and a poor calorific value, resulting in higher operating, transportation, and maintenance expenses. Despite these obstacles, the government has set a goal of eliminating coal imports by 2025 by promoting domestic coal production.

The government regulates coal supply to guarantee that coal reaches priority industries while keeping transportation and logistical costs low. To reach consumption centers in the north and west, most domestically mined coal in the east must travel long distances by rail. As a result, coal consumes about half of all railway capacity for bulk commodity transport, and freight costs account for a significant portion of the delivered cost of coal, especially as freight charges are used to cross-subsidize passenger rail rates.

Coal is generally provided by public-sector businesses at prices specified under fuel supply agreements (FSAs). And it is not related to the cost of manufacturing or market-determined, these prices are determined in such a way that is needed to maintain average profitability across supplier businesses.

Figure 3.5 India's production and trade of coal, crude oil, and natural gas



Note: Mtce = million tons of coal equivalent; mb/d = million barrels per day; bcm = billion cubic metres.

Source: Energy Outlook-2020-21

Oil:

In comparison to coal, India's domestic oil resources are limited, hence India relays heavily on imported crude oil to meet its demands. India currently has even surpassed China as the world's second-largest net oil importer. India's reliance on imported crude oil has risen steadily, and it now stands at roughly 75%.

The government has expanded its strategic petroleum reserve (SPR) to moderate the risks of growing heavy import dependence. India had roughly 40 million barrels of oil in the strategic petroleum reserve as of mid-2020, enough to cover about ten days of the country's net oil imports. Simultaneously Indian energy planning has worked in many ways to reduce its reliance on oil imports, by 10% by 2022. This was to be achieved by several policies, namely to increase the use of fuel substitution like bio-ethanol, bio-diesel, and compressed natural gas (CNG), as well as policies to increase domestic oil production. The government approved the Hydrocarbon Exploration and Licensing Policy (HELP) in 2016 to engage a level playing field for tapping fuel from all types of hydrocarbons under a revenue-sharing model, to boost domestic extraction and generation. However, not many of these efforts have so far helped to reduce India's reliance on imported oil. India, on the other hand, has intentionally grown its refining capacity during the last two decades, making it a net exporter of refined products. India's refining capacity is 250 Mt per year, making it the world's fourth largest. While public businesses dominate output, India's main refineries are owned by private players. Fuel retailers set the rates for transportation fuels, gasoline, and diesel as per the market conditions. During

periods of low crude oil prices, the government has slowly hiked excise rates on these fuels, removing administered prices and subsidies.

Natural gas:

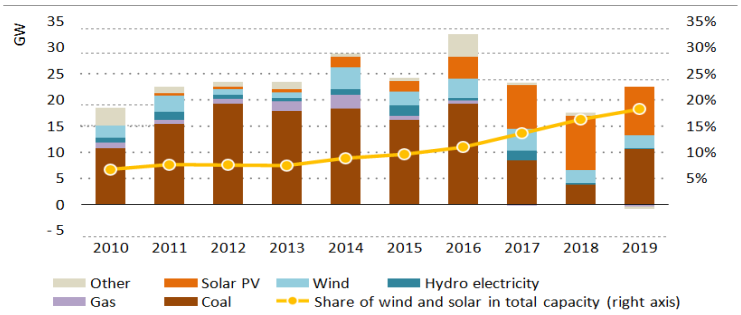
The share of natural gas in India's primary energy mix has remained relatively constant, at roughly 6%, however, the overall energy dependency has increased on natural gas. Since 2010, the demand for natural gas in industries has increased tenfold. India has committed to expanding natural gas's portion of its primary energy mix to 15% by 2030, up from 6% in 2019. The government has taken several steps to achieve this goal, including increasing domestic production, facilitating imports, and encouraging demand.

Indian demand for gas is more than its domestic production, making it rely on imported LNG. The imports of natural gases have increased from 20% of India's total gas demand in 2010 to 50% in 2020.

Solar and wind:

The most remarkable development in India's power sector has been the growth of renewable energy such as solar PV and wind; these sources of energy have increased rapidly. Their share of the overall energy mix in recent years increased. (Figure-3.6) In the last decade, solar PV capacity has grown at an average growth rate of around 60% and wind capacity of around 10%, outpacing the 7% growth in overall installed capacity. Such rapid growth can be attributed to constant government policy support and low raw materials costs.

Figure-3.6 Yearly power sector capacity additions



Source: Energy Outlook-2020-21

3.2.3 Energy and its relation to Macroeconomic variables

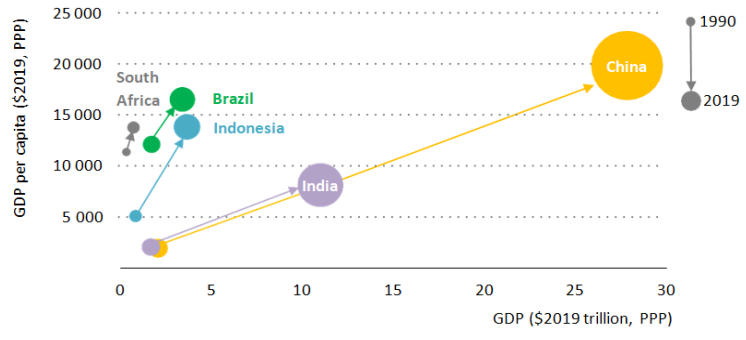
The year 1991 can be considered a year of milestone in Indian economic history. As India adopted a deliberate measure to liberalize its economy, opening up to a more market and service-based economy in that year. This put the Indian economy on a path of higher economic growth; the outcome was higher per capita income, increased private and international investment, increased competition, new manufacturing capacity, service sector enterprises, productivity gains, and a lower poverty rate. But at the same time, increased competition for land resources and rising demand for energy, rising levels of emissions, and pollutants accompanied increased economic activity, posing new issues for society as a whole.

Between 1991 and 2019, India's GDP increased at an annual average rate of 6.8%, exceeding the previous two decades' average annual growth rate of 4.2 percent. During these periods, India stood world's second-fastest-growing economy (Figure 3.7). India's GDP has nearly doubled in the last decade, making it the world's third-largest economy in PPP terms and fifth-largest in nominal ones.

India's annual per capita income has tripled since 1991, amounting to $8 100 (PPP) in 2019. The growth in per capita earnings has reduced the poverty rates, even though per capita income is significantly below the world average of $18 500 (PPP). India's Poverty Headcount Ratio dropped from 48% in 1993 to 13% in 2015. (World Bank, 2020). This has asserted an increase in living standards and development metrics. India's Human Development Index rose from 0.43 in 1990 to 0.65 in 2018, indicating an upgrade in life expectancy, access to education, and income (UNDP, 2019).

The growing demand for and supply of energy has fueled India's economic growth. Due to increased automobile ownership, demand for construction materials, and appliance ownership, Today India's energy consumption is twice as much as it did three decades ago.

Figure-3.7 GDP and GDP per capita for selected countries, 1990 and 2019

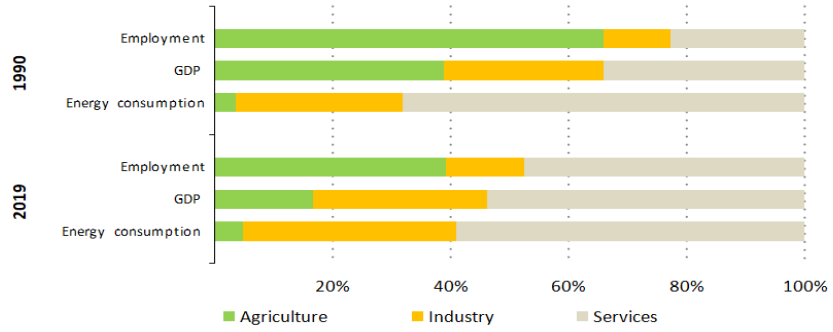


Note: Bubble size indicates GDP ($2019).

India’s workforce is engaged in three wide sectors: industry, which includes manufacturing; services, which includes transportation, utilities, information technology, and retail; and agriculture. As more labor force moved to the manufacturing and service sector there has been a decline in the labor force participation in agriculture. In the last three decades, employment in the manufacturing and service sectors has more than doubled, reflecting a similar raise in labour demand (MoSPI, 2019). Another driver is increasing urbanization, the share of the urban population increased from 26% in 1990 to 34% in 2019. In recent years India also proliferating as a manufacturing center for automobiles, electronics, and pharmaceuticals.

As a corollary to the above in the last three decades, the energy demand has been the highest, accounting for a 36 percent share of final consumption, which is higher than industrial output's share of GDP. The final fuel consumption of the services sector is considerably larger than its contribution to GDP: it accounts for 54 percent of GDP and 59 percent of total energy consumption. Agriculture, on the other hand, contributes 17% to GDP but utilizes only 5% of total energy usage. (Figure-3.8)

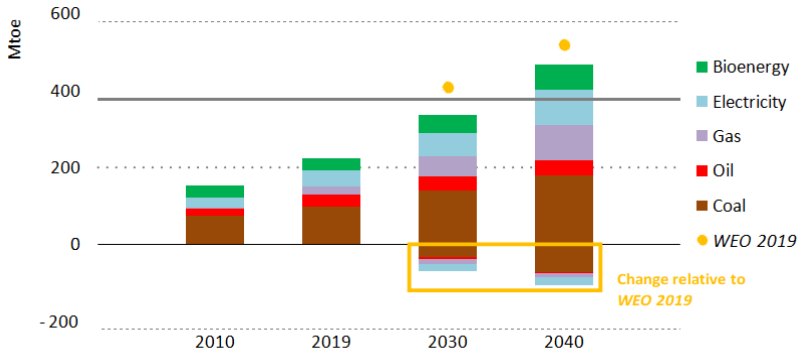
Figure 3.8 India’s sectoral shares in employment, GDP, and energy consumption



Source: IEA analysis based on MoSPI (2019); NSSO (2018).

Aligned with aforesaid changes, the share of industrial energy consumption increased from 28% to 36% between 1990 and 2019. This has made the industrial sector the largest end-use sector today. (Figure-3.9). The data trend shows that industrial energy consumption would increase to reach around 465 Mtoe by 2040. Subsequently, the industry’s share in total final consumption could increase from 36% in 2019 to 41% by 2040.

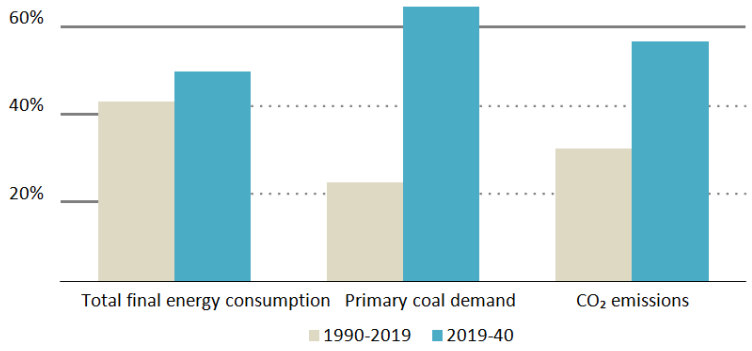
Figure:3.9 Industrial final consumption by fuel 2019



Source: Energy Outlook-2020-21

In addition to the final consumption of energy, the industrial sector is also responsible for the non-fossil energy use as industrial feedstocks, namely by industries such as petrochemical and fertilizer production. Feedstock consumption is expected to grow from 22 Mtoe in 2019 to 55 Mtoe by 2040, of which oil will be responsible for up to 40 Mtoe and gas up to 13 Mtoe (the remainder being hydrogen and biomass feedstocks). Further, in the last thirty years, almost three-quarters of the expansion in coal demand was used up by power generation. (Figure-3.10).

Figure-3.10 Industry share in total final energy consumption, coal demand, and CO_2 emissions growth in India



Source: Energy Outlook-2020-21

3.3 Energy share in each industry out of the total fuel consumption

The disaggregated energy share of each industry is shown in table- 3.2 below. Such a test reveals the degree to which each industry depends on a certain energy source. Additionally, it shows how each industry's energy sources have changed over time. Throughout the time

series, the basic metals (Iron) industry depends on its fuel mostly on electricity. It is also observed the industry is energy intensive. The second most fuel dependence is on coal. At some point in time, other fuels such as oil & gas have been substituted for electricity.

Similarly, the beverages industry is seemingly more dependent on electricity and less on coal energy sources for its energy inputs. At the same time, there happens to be an inter-substitution between three sources of energy - electricity, petroleum, and other fuels.

In contrast, the chemical and chemical products depended more on electricity for the period from 1998 to 2003. Thereafter, other fuels such as gas were substituted for electricity to take advantage of the lower price of gas. Thus, for this industry, coal, and petroleum have been the minimum sources of energy.

The coke and refinery product industries on the other hand initially utilized fuel such as gas, petroleum, and electricity but later zeroed down on the use of coal. However, since the year 2003 petroleum has been dominantly used by this industry.

Table-3.2, Energy share in each industry out of the total fuel consumption (%)

	BM					BV					CH					CRP					CEO					MP				
Year	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF
2001-02	23.5	57.6	8.8	10.1	100	9.4	46	20	24	100	9.7	50	17	24	100	0.8	40	19	41	100	0.0	68.2	21.8	10.0	100.0	4	60	25	11	100
2002-03	18.1	60.9	8.9	12.1	100	4.5	49	27	19	100	9.1	41	18	32	100	0.1	24	31	45	100	0.1	60.7	30.4	8.8	100.0	4	61	24	12	100
2003-04	21.8	56.8	12.2	9.2	100	4.5	45	31	19	100	8.4	32	31	29	100	0.1	25	30	45	100	0.1	60.1	29.5	10.3	100.0	4	54	33	9	100
2004-05	16.9	65.0	9.4	8.6	100	6.4	43	30	21	100	9.5	41	15	34	100	0.1	31	44	25	100	0.0	63.2	26.6	10.2	100.0	3	58	29	11	100
2005-06	15.6	59.8	7.2	17.4	100	6	44	27	23	100	11	31	17	41	100	0.1	51	26	23	100	0.1	52.7	36.7	10.5	100.0	2	56	24	17	100
2006-07	19.1	56.7	8.1	16.2	100	5.5	46	27	21	100	9.9	30	18	42	100	0.1	17	65	18	100	0.0	54.5	35.1	10.3	100.0	4	52	27	17	100
2007-08	16.9	56.7	9.6	16.8	100	4.7	42	31	22	100	9.9	29	17	44	100	0.1	15	56	28	100	0.1	53.2	29.1	17.6	100.0	3	52	31	15	100
2008-09	19.0	53.7	11.2	16.1	100	4.8	39	30	25	100	11	28	20	41	100	0	11	64	25	100	0.1	55.6	28.2	16.2	100.0	2	47	33	18	100
2009-10	18.8	54.5	11.7	15.0	100	4.3	34	26	36	100	10	25	19	45	100	0.1	9.8	59	31	100	0.2	58.1	23.2	18.5	100.0	3	44	30	23	100
2010-11	20.8	53.2	11.2	14.8	100	5.8	36	31	27	100	11	28	17	45	100	0.9	12	61	27	100	0.2	54.0	23.1	22.8	100.0	3	48	33	16	100
2011-12	16.0	47.6	9.9	26.5	100	7	38	30	25	100	12	27	15	46	100	0.4	10	57	32	100	0.0	47.4	35.3	17.2	100.0	6	49	31	15	100
2012-13	21.0	53.4	12.7	12.9	100	7.2	35	29	28	100	15	31	16	38	100	0	13	63	24	100	7.5	39.7	39.3	13.5	100.0	8	48	33	12	100
2013-14	21.3	54.1	15.8	8.8	100	9.2	39	31	20	100	14	35	16	35	100	0.3	18	56	25	100	0.1	61.5	27.1	11.3	100.0	6	56	28	10	100
2014-15	23.3	52.3	14.1	10.3	100	6.7	44	35	14	100	13	31	16	40	100	1.2	43	34	22	100	0.2	65.2	26.4	8.2	100.0	2	53	32	13	100
2015-16	26.1	53.4	11.5	9.1	100	11	47	26	16	100	12	33	17	37	100	3.1	30	42	24	100	0.1	61.6	31.7	6.6	100.0	2	59	26	12	100
2016-17	21.4	57.5	10.1	10.9	100	8	51	24	17	100	11	29	15	45	100	8.8	41	21	29	100	0.0	62.2	32.5	5.3	100.0	2	61	23	13	100
2017-18	22.0	60.1	8.6	9.3	100	8.3	50	22	19	100	12	36	10	42	100	7.6	34	19	40	100	0.0	65.4	29.1	5.5	100.0	2	64	23	11	100
2018-19	26.2	58.5	8.3	7.1	100	9.8	57	17	17	100	11	38	8.6	42	100	8.3	30	26	36	100	0.0	73.8	23.3	2.9	100.0	2	70	17	11	100
2019-20	27.0	57.5	7.1	8.4	100	12	56	17	15	100	11	43	8.4	37	100	0.4	16	52	32	100	0.0	79.4	18.2	2.4	100.0	1	68	21	9	100
2020-21	25.2	58.2	7.3	9.3	100	17	49	15	19	100	14	40	11	35	100	4.9	26	46	23	100	0.0	74.3	24.3	1.4	100.0	2	65	21	12	100

Note: MB=Basic Metal, BV=Beverages, CH=Chemical Products, CRP=Coke and Refinery Product, CEO= Computer Electronic & Optical, MP=Metal Product

C=Coal, E=Electricity, P=Petrol, OF=Other Fuel & TF= Total Fuel.

Table-3.2 (Continued), Energy share in each industry out of the total fuel consumption (%)

	FP					LRP					ME					OM					NMM					PPP				
Year	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF
2001-02	3.6	60.4	24.7	11.3	100.0	4.66	68.79	24.23	2.31	100.00	4.7	68.8	24.2	2.3	100.0	1.8	69.1	24.2	4.9	100.0	35.4	44.4	11.8	8.4	100.0	27.3	50.1	11.6	10.9	100.0
2002-03	3.7	60.8	23.8	11.8	100.0	3.63	65.40	26.61	4.36	100.00	3.6	65.4	26.6	4.4	100.0	1.4	67.3	26.7	4.6	100.0	30.5	42.3	16.9	10.3	100.0	30.3	44.3	14.1	11.4	100.0
2003-04	3.8	54.4	33.1	8.7	100.0	3.40	62.90	29.53	4.17	100.00	3.4	62.9	29.5	4.2	100.0	0.6	63.4	26.2	9.9	100.0	30.4	39.8	18.6	11.2	100.0	30.3	43.5	17.1	9.2	100.0
2004-05	2.5	57.7	29.2	10.6	100.0	3.72	56.79	31.60	7.89	100.00	3.7	56.8	31.6	7.9	100.0	0.2	67.5	24.4	7.9	100.0	33.1	39.8	17.2	10.0	100.0	32.8	41.7	15.4	10.0	100.0
2005-06	2.2	56.3	24.4	17.1	100.0	3.12	69.58	25.15	2.16	100.00	3.1	69.6	25.1	2.2	100.0	0.1	68.8	23.6	7.5	100.0	32.0	38.1	20.0	9.9	100.0	31.8	41.6	15.7	11.0	100.0
2006-07	3.6	52.5	27.3	16.6	100.0	2.96	66.27	28.76	2.01	100.00	3.0	66.3	28.8	2.0	100.0	0.8	69.4	24.9	4.9	100.0	33.2	36.9	17.4	12.6	100.0	30.4	41.4	17.8	10.5	100.0
2007-08	2.8	51.7	30.9	14.6	100.0	2.81	64.50	30.52	2.17	100.00	2.8	64.5	30.5	2.2	100.0	0.1	70.7	25.2	4.0	100.0	37.4	32.0	16.8	13.7	100.0	30.1	40.7	16.6	12.6	100.0
2008-09	2.4	47.3	32.8	17.5	100.0	3.14	62.24	32.42	2.19	100.00	3.1	62.2	32.4	2.2	100.0	0.5	70.6	24.1	4.8	100.0	36.9	31.9	14.7	16.5	100.0	32.2	38.6	13.1	16.1	100.0
2009-10	2.7	43.9	30.4	23.1	100.0	3.16	61.03	33.49	2.32	100.00	3.2	61.0	33.5	2.3	100.0	0.7	68.8	25.2	5.3	100.0	38.8	32.0	15.6	13.6	100.0	32.7	37.6	12.3	17.4	100.0
2010-11	2.8	48.0	33.4	15.7	100.0	3.29	64.58	29.15	2.98	100.00	3.3	64.6	29.1	3.0	100.0	0.3	69.9	26.3	3.5	100.0	43.3	30.1	13.9	12.6	100.0	29.6	37.1	14.2	19.1	100.0
2011-12	5.7	48.8	30.9	14.6	100.0	2.74	61.38	33.35	2.52	100.00	2.7	61.4	33.4	2.5	100.0	2.0	68.9	21.4	7.6	100.0	44.8	28.5	13.8	12.9	100.0	31.0	37.8	10.9	20.3	100.0
2012-13	8.0	47.7	32.5	11.7	100.0	5.00	64.35	29.08	1.56	100.00	5.0	64.3	29.1	1.6	100.0	0.3	70.7	22.4	6.5	100.0	46.5	28.9	11.8	12.8	100.0	33.1	38.7	11.6	16.5	100.0
2013-14	5.7	56.3	27.9	10.1	100.0	2.25	63.92	30.86	2.98	100.00	2.2	63.9	30.9	3.0	100.0	0.6	70.2	26.3	2.9	100.0	45.2	28.8	12.3	13.7	100.0	29.3	40.8	11.4	18.5	100.0
2014-15	2.0	53.1	32.2	12.7	100.0	3.17	63.86	30.21	2.75	100.00	3.2	63.9	30.2	2.8	100.0	0.2	68.8	23.2	7.8	100.0	44.1	27.5	14.7	13.6	100.0	28.0	43.5	10.1	18.3	100.0
2015-16	2.3	59.4	26.0	12.4	100.0	2.56	67.62	28.23	1.58	100.00	2.6	67.6	28.2	1.6	100.0	0.6	71.3	22.4	5.8	100.0	44.3	29.6	9.6	16.5	100.0	27.4	43.3	15.3	14.0	100.0
2016-17	2.4	61.3	23.1	13.3	100.0	2.70	68.01	27.06	2.23	100.00	2.7	68.0	27.1	2.2	100.0	0.2	70.5	18.4	10.9	100.0	44.4	29.9	9.6	16.2	100.0	34.1	41.7	9.8	14.3	100.0
2017-18	2.5	63.7	22.6	11.3	100.0	2.12	71.70	24.30	1.88	100.00	2.1	71.7	24.3	1.9	100.0	0.5	76.1	20.6	2.8	100.0	42.1	30.5	8.4	19.1	100.0	36.3	38.3	7.3	18.1	100.0
2018-19	1.5	70.1	17.2	11.2	100.0	2.26	75.10	20.55	2.10	100.00	2.3	75.1	20.5	2.1	100.0	2.3	83.2	12.9	1.6	100.0	38.8	37.1	8.7	15.4	100.0	35.0	42.7	9.1	13.2	100.0
2019-20	1.4	67.9	21.4	9.3	100.0	1.73	76.43	19.65	2.18	100.00	1.7	76.4	19.7	2.2	100.0	2.1	76.7	17.9	3.2	100.0	36.2	39.2	9.7	15.0	100.0	28.1	48.1	12.3	11.5	100.0
2020-21	1.6	65.1	20.9	12.4	100.0	1.75	78.17	17.64	2.45	100.00	1.7	78.2	17.6	2.4	100.0	0.3	76.7	18.7	4.4	100.0	38.2	36.1	9.5	16.2	100.0	32.3	46.2	10.1	11.3	100.0

ote:FP= Food Products, LRP= Leather and related product, ME= Machinery and Equipment, OM=Other Manufacutring, NMM=Non Metallic Minera, PP= Paper Product

C=Coal, E=Electricity, P=Petrol, OF=Other Fuel & TF= Total Fuel.

Table-3.2(Continued), Energy share in each industry out of the total fuel consumption (%)

	PMC					PR					RPP					TXT					TP					AI				
Year	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF	C	E	P	OF	TF
2001-02	5.3	63.6	19.5	11.7	100.0	0.07	73.96	25.20	0.78	100.01	4.32	65.71	22.88	7.09	100.00	4.86	64.04	23.31	7.79	100.00	13.59	42.15	34.57	9.70	100.01	14.9	55.3	16.9	12.9	100.0
2002-03	3.2	60.6	19.1	17.1	100.0	0.00	76.98	20.95	2.06	99.99	3.08	62.08	25.65	9.19	100.00	5.26	62.09	23.41	9.24	100.00	14.98	40.05	40.52	4.44	100.00	12.8	52.7	18.8	15.7	100.0
2003-04	3.7	53.1	33.9	9.4	100.0	0.00	69.37	27.85	2.78	100.00	2.53	59.43	33.13	4.92	100.00	7.17	58.41	25.58	8.85	100.00	12.52	38.86	44.74	3.89	100.00	13.3	48.7	23.8	14.2	100.0
2004-05	3.2	55.9	30.2	10.7	100.0	0.00	71.60	22.15	6.26	100.01	1.69	62.95	28.12	7.24	100.00	5.85	62.72	20.57	10.85	100.00	9.54	40.19	41.58	8.71	100.01	13.0	53.1	18.5	15.5	100.0
2005-06	4.5	57.0	27.1	11.4	100.0	0.02	70.77	26.84	2.38	100.01	3.15	61.96	26.40	8.49	100.00	6.46	59.35	21.04	13.16	100.00	11.22	39.95	39.77	9.06	99.99	13.0	49.9	18.4	18.7	100.0
2006-07	4.1	56.4	28.4	11.1	100.0	0.00	71.02	26.58	2.40	100.00	2.54	62.30	25.68	9.48	100.00	7.06	62.02	20.23	10.69	100.00	10.02	38.71	40.04	11.24	100.00	11.4	45.7	15.6	14.5	100.0
2007-08	5.2	58.3	26.7	9.9	100.0	0.21	66.61	31.61	1.56	99.99	2.44	63.73	25.52	8.32	100.00	8.49	59.69	18.49	13.33	100.00	11.58	37.94	37.37	13.10	99.99	15.2	46.6	19.2	19.0	100.0
2008-09	5.2	54.8	26.1	13.9	100.0	0.01	71.84	25.71	2.44	100.00	3.83	59.08	27.51	9.57	100.00	8.00	59.81	17.33	14.86	100.00	18.28	37.75	38.68	5.29	99.99	14.7	45.3	20.6	19.4	100.0
2009-10	5.7	54.6	28.7	11.0	100.0	0.12	71.77	26.51	1.59	100.00	3.10	63.44	20.86	12.60	100.00	7.86	62.67	15.33	14.14	100.00	12.69	42.09	35.66	9.56	100.00	14.4	46.6	20.2	18.8	100.0
2010-11	4.7	54.1	26.4	14.8	100.0	0.77	69.92	27.46	1.86	100.00	2.80	64.43	21.06	11.72	100.00	10.27	61.74	14.57	13.42	100.00	12.04	39.91	38.04	10.02	100.00	16.7	45.9	19.0	18.4	100.0
2011-12	5.8	54.1	26.9	13.3	100.0	0.17	72.91	24.10	2.81	100.00	2.73	61.45	23.33	12.49	100.00	13.00	58.58	13.52	14.90	100.00	11.90	43.63	32.41	12.06	100.00	16.9	42.2	18.1	22.9	100.0
2012-13	9.7	53.1	26.6	10.6	100.0	0.00	72.45	23.54	4.00	100.00	3.91	61.10	25.40	9.60	100.00	11.31	60.13	13.66	14.90	100.00	21.08	43.23	29.72	5.97	100.00	18.0	45.1	19.4	17.4	100.0
2013-14	7.5	57.8	25.9	8.9	100.0	0.00	74.21	24.15	1.64	100.00	4.48	63.11	25.97	6.44	100.00	13.12	61.17	13.92	11.80	100.00	13.78	44.68	36.84	4.71	100.00	18.0	47.1	19.3	15.6	100.0
2014-15	5.0	58.9	25.8	10.2	100.0	0.00	73.49	22.00	4.51	100.00	4.15	67.58	21.84	6.43	100.00	13.13	61.36	12.46	13.04	100.00	12.65	40.89	41.14	5.32	100.00	18.0	46.7	18.9	16.4	100.0
2015-16	5.3	58.9	24.7	11.1	100.0	0.00	75.24	21.93	2.83	100.00	3.23	67.01	21.80	7.97	100.00	11.37	63.60	13.26	11.77	100.00	10.84	45.86	31.86	11.44	100.00	19.4	47.4	17.8	15.3	100.0
2016-17	4.8	65.6	20.5	9.1	100.0	0.00	79.53	19.21	1.26	100.00	3.71	70.59	17.87	7.82	100.00	11.50	67.39	11.23	9.88	100.00	8.75	49.70	33.60	7.94	100.00	17.0	47.5	14.1	21.3	100.0
2017-18	5.0	64.2	21.5	9.3	100.0	0.35	76.59	21.74	1.32	100.00	3.42	73.58	14.49	8.51	100.00	12.59	70.07	9.70	7.64	100.00	9.62	52.73	29.44	8.21	100.00	17.7	52.1	12.8	17.3	100.0
2018-19	5.6	67.6	17.1	9.7	100.0	0.15	81.40	15.69	2.77	100.00	2.63	78.53	13.35	5.49	100.00	12.16	73.40	8.24	6.20	100.00	9.79	60.68	23.21	6.32	100.00	17.3	55.0	12.4	15.4	100.0
2019-20	6.0	69.4	15.6	9.0	100.0	0.22	81.04	17.68	1.06	100.00	3.69	79.13	13.23	3.94	100.00	13.07	72.82	8.65	5.46	100.00	11.25	60.34	23.00	5.41	100.00	16.8	55.3	13.3	14.7	100.0
2020-21	5.6	68.5	16.9	9.1	100.0	0.00	83.11	14.85	2.04	100.00	4.93	78.32	12.85	3.90	100.00	13.28	71.85	9.15	5.72	100.00	5.46	58.87	25.93	9.74	100.00	17.6	54.2	12.9	15.3	100.0

Note:PMC=Pharmaceuticals Medicinal Chemical, PR=Printing and Reproduction, RPP=Rubber Plastic Product, TXT=Textiles, TP=Tobacco Products & All Industries

C=Coal, E=Electricity, P=Petrol, OF=Other Fuel & TF= Total Fuel.

However, in the later year of 2011 onwards the industry used a different combination of fuels to minimize the cost of energy input. In the bargain, even coal usage has improved after 2013 in this industry.

Because of their inherent reliance on electricity and petroleum fuels, the computer, electronics, and optical products industries have never used coal, except for 2010 when it made up around 7.54 percent of total fuel use. The fabricated metal products, however, rely on all four energy sources. which has the most dependence on electricity. Petroleum products were the next major energy input. Gas usage has been done to some extent. Since it produces fabricated metals, the industry also uses a lot of coal. The food product industry, which also depends on all forms of energy, is in a similar situation. However, it consumes more power and a different proportion of coal, gas, and petroleum. The use of petroleum has decreased since 2010, while the use of gas and coal has increased. The pricing disparities could be the cause of the same.

About 66 percent of the energy used in the production of leather and associated products comes from electrical sources. Petroleum is the industry's second energy source. There is some use of coal and other fuels. In contrast, electricity and petroleum fuel are crucial for the production of machinery and equipment. However, during the period under study, there has been a very slight increase in dependence on coal and gas. The best source of raw materials for making products like cement, ceramics, glass, and lime is nonmetallic minerals. Additionally, the industry's applications are fairly varied and include everything from dinnerware and decorative items to sanitary and construction materials. Initially, electricity was required for the production of such a wide range of goods, but recently, coal consumption has assumed a key role. Further, gas has replaced a portion of the petroleum fuel that has been used less frequently.

India's need for paper has been steadily increasing despite the country's transition to a paperless economy and digitization. The market for paper and paper products is predicted to increase by 7.8% CAGR from $ 8.6 billion in 2018 to $ 13.4 billion in 2024. These industries have relied significantly on coal and power for their growth potential. This dependence is anticipated to grow even more as the demand for paper in the quality packaging sector rises. Similar to this, there is an increasing need for paper products in the upstream market, such as tissue paper, filter paper, tea bags, lightweight online coated paper, and medical grade coated paper.

Pharmaceutical, medicinal chemical, and botanical product manufacturing has relied mainly on electricity and petroleum energy sources over the years. On average, electricity provides 60% of the energy needed by these sectors. And nearly 30% rely on energy from petroleum. In a similar vein, the printing and recording industries are highly dependent on electricity and, to a lesser extent, on petroleum supplies. It has no reliance on coal.

The manufacturing of rubber and plastic products relies on electricity for about 65 percent of energy use, unlike the past when their reliance on coal, gas, and petroleum fuel has been maximum. In the recent past industries' energy dependence on petroleum, gas, and coal has been reduced and replaced with electricity use. The textile industry holds a record of the lowest efficiency in energy use and is also one of the major energy-consuming industries. Around 34% of energy is consumed in spinning, 23% in weaving, 38% in chemical processing, and 5% for miscellaneous purposes. Its energy source is mainly (70%) dependent on electricity. It is the manufacturing of tobacco products that have been using the best mixture of various energies. Of which petroleum and electricity have been utilized in an equal proportion. In recent years electricity usage is offsetting other fuels.

According to the information on industrial reliance on different energy sources provided above, electricity is used by the majority of industries to generate their goods. A small number of industries, including those that use non-metallic materials (such as cement, chemicals, and paper), are dependent on coal. In actuality, the non-metallic mineral sector relies on 60% of coal-based fuel on average. In contrast, the paper and pulp industry typically rely on 50% coal for energy.

3.4 Relative percentage of energy consumption across the industries.

The relative percentage of energy consumed by various industries is shown in the table below (3.3), where the basic metal industry ranks first with an average energy consumption of 26.03%. The next highest energy-consuming industry is chemical and chemical products at 13.7%, followed by other non-metallic at about 13.5%, then textiles at about 10.5, fabricated goods at about 6.9%, coke refinery products at about 4.0%, R & PP at 3.2%, paper & paper products at about 3.2%, and PMC at about 2.3%.

Table-3.3. Relative % of Energy Consumption Across Industries

year	BM	BV	Ch&Ch	CRP	CE&O	MPEM	FP	LRP	M&E	OM	ONM	PP	PMC	PRP	R&PP	TEX	TP	OI	ALL I
2001-02	22.0	0.7	16.3	3.3	0.9	1.8	7.4	0.4	2.1	0.3	13.0	4.2	1.8	0.2	3.1	13.1	0.2	9.1	100
2002-03	20.4	0.8	18.3	2.9	0.7	1.7	7.3	0.4	1.9	0.3	14.6	4.4	2.2	0.2	3.1	14.2	0.2	6.5	100
2003-04	21.0	0.9	19.6	2.4	0.8	2.0	7.0	0.5	1.9	0.3	12.6	4.3	2.2	0.2	3.0	14.6	0.2	6.4	100
2004-05	21.7	0.9	19.7	1.7	0.7	1.9	7.3	0.6	1.8	0.3	13.5	4.1	2.1	0.2	3.2	12.9	0.2	7.1	100
2005-06	24.2	0.9	18.5	1.0	0.8	1.9	7.1	0.5	1.8	0.3	12.9	4.2	2.0	0.2	3.1	13.0	0.2	7.4	100
2006-07	20.6	0.7	13.6	2.3	0.6	1.4	5.4	0.4	1.4	0.3	10.5	3.0	1.6	0.1	2.5	9.7	0.2	25.5	100
2007-08	26.5	0.8	15.7	3.5	0.7	1.7	6.6	0.5	1.8	0.3	13.2	3.4	1.9	0.2	3.2	11.5	0.2	8.3	100
2008-09	27.6	0.8	15.3	4.3	0.6	1.9	6.8	0.5	1.7	0.3	12.8	3.2	1.9	0.2	2.9	11.5	0.2	7.4	100
2009-10	28.3	0.8	13.7	4.0	0.5	2.3	6.4	0.4	1.7	0.3	12.4	2.7	2.0	0.2	2.7	11.7	0.2	9.8	100
2010-11	28.6	0.9	13.4	3.9	0.5	2.4	6.4	0.4	1.8	0.3	14.0	3.1	2.0	0.2	2.9	10.8	0.2	8.3	100
2011-12	29.0	0.9	13.9	4.0	0.6	2.1	6.3	0.4	1.5	0.4	14.7	3.0	2.1	0.3	2.9	9.9	0.1	7.8	100
2012-13	27.1	0.9	11.4	4.2	1.1	2.1	6.9	0.5	1.5	0.3	13.7	3.2	2.5	0.3	3.4	10.1	0.2	10.8	100
2013-14	27.7	0.9	11.4	3.5	0.7	2.2	7.1	0.4	1.6	0.3	14.3	3.3	2.3	0.3	3.3	10.1	0.1	10.5	100
2014-15	27.4	1.1	11.8	6.0	0.5	2.0	6.9	0.4	1.8	0.3	14.6	2.9	2.5	0.3	3.3	9.1	0.1	9.0	100
2015-16	27.2	0.9	12.7	5.4	0.5	1.9	6.7	0.3	1.5	0.3	14.2	3.0	2.4	0.3	3.4	9.6	0.1	9.8	100
2016-17	24.1	0.9	12.2	5.4	0.4	2.1	6.8	0.4	1.3	0.3	13.5	2.9	2.6	0.3	3.3	9.6	0.1	13.9	100
2017-18	25.9	1.3	12.5	4.8	0.5	1.8	7.4	0.4	1.5	0.3	14.8	3.2	2.4	0.4	3.5	9.9	0.1	9.2	100
2018-19	25.9	1.0	12.3	4.0	0.4	2.1	7.5	0.5	1.5	0.5	14.1	2.9	2.7	0.3	3.8	10.6	0.1	9.9	100
2019-20	27.4	0.9	11.7	5.9	0.3	2.2	7.6	0.4	1.5	0.4	12.9	2.8	2.8	0.3	3.7	9.7	0.1	9.1	100
2020-21	27.9	0.9	12.0	5.2	0.4	1.8	7.5	0.4	1.6	0.4	13.5	2.8	2.6	0.3	3.6	9.1	0.1	10.1	100
Average	25.5	0.9	14.3	3.9	0.6	2.0	6.9	0.4	1.7	0.3	13.5	3.3	2.2	0.3	3.2	11.0	0.2	9.8	100.0

After having examined the energy scenario in India, and the energy share of particular energy in each industry out of total fuel and each industry's fuel share out of total fuel, in the next section the summary statistics about various variables selected for studying the relationship between energy consumption and industrial value added are described to find out whether the data are normally distributed across industries and time series. Also, to calculate measures of the central tendency, and dispersion for a given variable, and to detect if there are any outliers in the reported variables understudy.

Five major industries have been considered based on their share in the gross industrial value added and consumption of fuel. These industries are Basic metal chemical, non-metallic, Paper, and textile industries. In addition to this, descriptive statistics are presented for all industries.

3.5 Section-II: Descriptive Statistics:

3.5.1 Descriptive Statistics on Selected Variables-Fuel price index, Fixed Capital, Total Fuel Consumed, labor employed, and Gross Industrial Value Added

Tables of four subdivided periods—2001–2006, 2006–11, 2011–2016, and 2016–2021—present the industry-wise interpretation of the important descriptive statistics data to give a comparison picture. Each referred industry in the study had 220 observations in the sample. It should be noted that the fuel price index has not been listed in a separate table because it is constant for all industries in the given year. However, when the trends in the chosen variables are graphically displayed, the fuel price index has been taken into account together with other parameters.

Table 3.4 Fixed Capital

		BM	*CH*	*Non-M*	*PP*	*TEX*	*ALL Ind*
2001-2006	Mean	50407.88	684156.2	322216.7	121626.2	410710.3	4138680
	Standard Error	4987.343	28908.8	15197.83	7802.995	14616.71	103565.9
	S. Deviation	11152.04	64642.04	33983.39	17448.03	32683.96	231580.3
	Sample Variance	1.24E+08	4.18E+09	1.15E+09	3.04E+08	1.07E+09	5.36E+10
	Kurtosis	1.179591	0.423997	-2.39216	0.95615	-2.15804	-2.14906
	Skewness	-1.34573	-1.05467	0.539853	0.32079	0.088658	0.639011
	Range	27009.3	161112.3	76430.6	47795.5	76692.3	536079.3
	Minimum	32507	584391.8	289827.8	98911.2	370726.1	3911515
	Maximum	59516.3	745504.1	366258.4	146706.7	447418.4	4447594

2006-11	Mean	84224.42	794723.8	426347.2	159778.6	610954.1	6307209
	S.Deviation	14215.99	123866.3	101535.5	38263.91	187158.2	1518850
	Sample Variance	2.02E+08	1.53E+10	1.03E+10	1.46E+09	3.5E+10	2.31E+12
	Kurtosis	1.450514	-3.01938	2.558581	0.384436	-2.94768	-1.02457
	Skewness	1.35313	-0.53697	1.491737	1.074851	0.305238	0.584792
	Range	35622.3	260146.3	263750.9	92797.9	400485.6	3718007
	Minimum	71541.2	646281.4	331127.8	126134.4	417380.2	4733314
	Maximum	107163.5	906427.7	594878.7	218932.3	817865.8	8451321
2011-16	Mean	190335.7	1278754	1194253	349918.4	1057586	16289935
	S.Deviation	48697.94	136095.6	502604.5	60023.9	139647.1	4505884
	Sample Variance	2.37E+09	1.85E+10	2.53E+11	3.6E+09	1.95E+10	2.03E+13
	Kurtosis	-1.85077	-0.48351	2.057631	0.5385	-1.27154	-1.43167
	Skewness	-0.08917	0.852535	1.406269	-0.26441	-0.63639	-0.0406
	Range	118465.5	327285.3	1268316	162378.7	326958.8	11242941
	Minimum	130324.9	1152955	749449.6	265095.8	860950.1	10559661
	Maximum	248790.4	1480241	2017766	427474.5	1187909	21802602
2016-21	Mean	310133.1	2313391	1769273	525971.6	1584308	28268193
	S. Deviation	33414.86	691407.5	197042.8	53079.57	269661.4	4100860
	Sample Variance	1.12E+09	4.78E+11	3.88E+10	2.82E+09	7.27E+10	1.68E+13
	Kurtosis	-2.51127	-2.31755	0.629546	-2.70486	0.596628	-2.72048
	Skewness	-0.49362	0.359049	-0.91609	0.251695	0.851185	0.048498
	Range	73585.4	1593941	499180.7	118723.6	699068.4	9121702
	Minimum	267524.7	1594251	1466597	467233	1295704	23737190
	Maximum	341110.1	3188192	1965778	585956.6	1994772	32858893

Source: Author's Calculation

Note: BM=Basic Metal, CH=Chemical, Non-M= Non-metallic, PP=Paper and Paper Product, TXE=Textiles.

From table 3.4 it is evident that the mean expenditure of fixed capital of basic metal factories which was 50407.88 for the period 2001-06 increased to 310133.1 during 2016-21. The average percentage change in the fixed capital expenditure between 2001-2006 and 2016-21 is 515%. Similar trends are evident for the chemical industry (238.138%), the non-metallic industry 449.094 %., the paper and paper product industry (332.449%), and the textile industry (285.748%)

Table-3.5. Total Fuel Consumed

		BM	*CH*	*Non-M*	*PP*	*TEX*	*All Ind*
2001-06	Mean	4819.06	106586.5	76262.16	24370.78	77628.18	573454.4
	S.Deviation	988.7208	19327.67	9883.684	3195.627	10502.97	74331.65
	Sample Variance	977568.8	3.74E+08	97687216	10212034	1.1E+08	5.53E+09
	Kurtosis	-1.5694	1.523405	2.072622	2.19361	2.051655	1.181455
	Skewness	-0.81861	-1.39092	-1.39975	-0.98088	-1.37952	-0.57641
	Range	2299.4	48064.1	25564.8	8783.2	25925.7	203163
	Minimum	3422.2	75268.2	60090.9	19307.5	60441.2	462595.2
	Maximum	5721.6	123332.3	85655.7	28090.7	86366.9	665758.2
2006-11	Mean	8771.16	149084.2	132754.1	31828.62	115885.4	1048189
	S.Deviation	2114.056	20043.87	32783.89	4996.962	23126.87	189488.2
	Sample Variance	4469232	4.02E+08	1.07E+09	24969626	5.35E+08	3.59E+10
	Kurtosis	-0.39081	-2.04241	-0.13604	2.653107	-2.70643	-2.28075
	Skewness	0.872712	0.073921	0.747424	1.530689	0.149641	0.563867
	Range	5197.6	48073.6	84024.6	12909.1	50524.1	437078.6
	Minimum	6713.2	125186.8	97024.6	27248.5	89625.3	858538.4
	Maximum	11910.8	173260.4	181049.2	40157.6	140149.4	1295617
2011-16	Mean	18945.38	248572.1	291664.9	62706.84	197268.9	2038339
	S. Deviation	5440.678	62571.95	72877.89	13706.75	42865.61	501842.9
	Sample Variance	29600977	3.92E+09	5.31E+09	1.88E+08	1.84E+09	2.52E+11
	Kurtosis	-2.20192	-0.85523	-2.72751	-2.09227	-1.21318	-2.28217
	Skewness	0.555301	0.76673	0.258122	-0.11943	0.346905	0.337104
	Range	12352.4	154680.2	156940.9	32723.7	105740.8	1153832
	Minimum	13773	184132.1	221714.2	46403.9	149986.3	1521620
	Maximum	26125.4	338812.3	378655.1	79127.6	255727.1	2675452
2016-21	Mean	30672.72	375963	424828.7	90686.18	301466.2	3092749
	S.Deviation	4692.941	25433.28	31230.83	6433.663	11592.38	234045
	Sample Variance	22023692	6.47E+08	9.75E+08	41392014	1.34E+08	5.48E+10
	Kurtosis	1.331908	3.812244	-0.86317	-2.63373	-0.12334	3.777043
	Skewness	1.322649	1.934969	0.945937	0.310615	0.07743	1.895962
	Range	11780.8	60507.9	72940.7	14554	30746.6	585628.2
	Minimum	26429.9	359614	397909.2	83482.5	286180.3	2912349
	Maximum	38210.7	420121.9	470849.9	98036.5	316926.9	3497977

Source: Author Calculation

Note: BM=Basic Metal, CH=Chemical, Non-M= Non-metallic, PP=Paper and Paper Product, TXE=Textiles.

From table 3.5 it is clear that the mean value of the fuel consumed by basic metal factories which were 4819.06 for the period 2001-06 increased to 8771.16, 18945.38, 30672.72 in the subsequent period of 2006-11,2011-16 and 2016-21. The average percentage change in fuel expenditure between 2001-2006 and 2016-21 is 536.48%. Similar trends are evident for the chemical industry (252.73%), the non-metallic industry (457.064%), the paper and paper product industry (272%), and the textile industry (288.346%)

Table-3.6. Labor employed

		BM	*CH*	*Non-M*	*PP*	*TEX*	*All Ind*
2001-06	Mean	79367.8	550568.2	478301.6	172620.6	1253416	8047282
	S.Deviation	4993.49	18688.87	68411.8	5807.182	69655.76	348864.4
	Sample Variance	24934943	3.49E+08	4.68E+09	33723365	4.85E+09	1.22E+11
	Kurtosis	-1.71373	-2.44014	4.271182	-1.49472	-2.53074	0.799264
	Skewness	-0.83715	0.343788	2.033035	-0.19183	-0.21929	1.040114
	Range	11181	42387	167681	14461	156049	901927
	Minimum	72335	531556	430707	165245	1178519	7686654
	Maximum	83516	573943	598388	179706	1334568	8588581
2006-11	Mean	100714.4	525671.2	576911.4	193621	1414345	9155911
	S.Deviation	10173.41	16300.49	88816.4	31467.72	237182.3	1115241
	Sample Variance	1.03E+08	2.66E+08	7.89E+09	9.9E+08	5.63E+10	1.24E+12
	Kurtosis	3.234608	0.877565	-1.50837	4.46065	2.192872	-2.32812
	Skewness	1.653163	-1.35291	-0.40961	2.099421	1.49352	-0.01458
	Range	26474	37996	209392	74288	595625	2575100
	Minimum	91474	499651	456095	174892	1210384	7803395
	Maximum	117948	537647	665487	249180	1806009	10378495
2011-16	Mean	134143.8	619193	850794.2	237971	1414573	12362537
	S.Deviation	9776.878	38353.65	68258.35	11432.14	31731.69	856475.1
	Sample Variance	95587352	1.47E+09	4.66E+09	1.31E+08	1.01E+09	7.34E+11
	Kurtosis	-1.87511	-0.94274	-2.53388	-2.57738	-2.75902	-1.74802
	Skewness	0.410945	0.344016	-0.34105	0.488421	0.265472	-0.35019
	Range	23525	94532	156876	25649	69225	2092923
	Minimum	123406	577937	769051	226707	1379264	11252793
	Maximum	146931	672469	925927	252356	1448489	13345716
2016-21	Mean	160298	753841.2	1014870	253142.6	1562540	14377032
	S. Deviation	2478.07	51945.56	53851.94	16823.61	68081.59	831424.3
	Sample Variance	6140833	2.7E+09	2.9E+09	2.83E+08	4.64E+09	6.91E+11

	Kurtosis	2.79528	-1.57078	-2.6954	3.845522	2.532536	-0.88263
	Skewness	1.413676	0.619204	0.380051	1.881602	1.280136	0.539935
	Range	6635	120503	121527	42812	183521	2084138
	Minimum	157766	705264	956613	239457	1490212	13462061
	Maximum	164401	825767	1078140	282269	1673733	15546199

Source: Author Calculation

Note: BM=Basic Metal, CH=Chemical, Non-M= Non-metallic, PP=Paper and Paper Product, TXE=Textiles.

Table 3.6 demonstrates how the mean value of labour employed in basic metal industries increased from 4819.06 in the 2001–2006 period to 8771.16, 18945.38, and 30672.72 in the following periods of 2006–11, 2011–16, and 2016–21. Between 2001–2006 and 2016–21, labour employed changed by an average of 101.969%. The chemical sector (36.92%), non-metallic industry (112.182%), paper and paper product industry (46.64%), and textile industry (24.66%) all exhibit similar patterns.

Table-3.7. Gross Value Added

		BM	*CH*	*Non-M*	*PP*	*TEX*	*All Ind*
2001-06	Mean	25132.56	297906.4	93357.88	35963.5	157735.7	1876511
	S. Deviation	3469.683	23593.1	14428.11	9274.844	10977.86	159294.7
	Sample Variance	12038702	5.57E+08	2.08E+08	86022722	1.21E+08	2.54E+10
	Kurtosis	3.574638	-0.00603	4.576195	-2.31036	-2.3025	2.784911
	Skewness	1.82358	0.068896	-2.10911	-0.21972	0.19807	1.59743
	Range	8612.1	62847.8	35275.5	21446.5	25519	406487
	Minimum	22488.6	266593.5	67838.5	24442.4	145768.1	1737269
	Maximum	31100.7	329441.3	103114	45888.9	171287.1	2143756
2006-11	Mean	59790.96	394336.4	206503.7	55420.24	242050.3	3870061
	S.Deviation	36847.05	63108.22	102272.8	13283.03	57481.47	1211389
	Sample Variance	1.36E+09	3.98E+09	1.05E+10	1.76E+08	3.3E+09	1.47E+12
	Kurtosis	-1.25534	-0.42875	0.266596	0.141838	-2.72553	-1.0616
	Skewness	0.872683	0.059974	1.057124	0.88327	0.006595	0.415345
	Range	86272.4	165143.1	256182.6	32610.1	124867	3049790
	Minimum	26608.1	313686	107375.3	42915.9	176085.8	2477773
	Maximum	112880.5	478829.1	363557.9	75526	300952.8	5527562
2011-16	Mean	112112.4	765823.6	472231.9	98747.02	422374.2	8092232
	S. Deviation	25372.51	185078.6	56580.07	16980.23	116622.6	1584415
	Sample Variance	6.44E+08	3.43E+10	3.2E+09	2.88E+08	1.36E+10	2.51E+12

	Kurtosis	-2.44136	-1.56408	-2.85388	-2.24145	-0.56106	-1.42378
	Skewness	0.431535	0.405871	0.24151	-0.70247	0.180506	-0.05249
	Range	57922.4	454216.8	123105.6	37258.8	302982	3959680
	Minimum	86210.4	558019.4	413577.6	75916.2	277070.1	6113115
	Maximum	144132.8	1012236	536683.2	113175	580052.1	10072795
2016-21	Mean	169954.8	1208510	622247.9	167321.7	635767.9	12676229
	S.Deviation	19738.56	245307.4	102994.8	29091.94	52977.53	1592644
	Sample Variance	3.9E+08	6.02E+10	1.06E+10	8.46E+08	2.81E+09	2.54E+12
	Kurtosis	-1.15632	-3.14931	-1.0526	3.03163	-0.63325	-1.24859
	Skewness	-0.2275	-0.52079	0.578821	1.69087	0.819195	-0.04748
	Range	50024.2	509454.2	257474.3	71912.2	128082.5	4018588
	Minimum	144140.1	932171.8	508603.6	144694.9	585444.4	10651116
	Maximum	194164.3	1441626	766077.9	216607.1	713526.9	14669704

Source: Author Calculation

Note: BM=Basic Metal, CH=Chemical, Non-M= Non-metallic, PP=Paper and Paper Product, TXE=Textiles.

Table 3.7 makes it clear that the mean gross value added of basic metal factories, which was 25132.56 for the years 2001 to 2006, climbed to 59790.96, 112112.4, and 169954.8 in the years 2006 to 11, 2011 to 16, and 2016 to 21. Between 2001-2006 and 2016–21, the gross value added of the basic metal industry changed on average by 576.234%. The chemical industry (305%), the non-metallic industry (566.51%), the paper and paper product sector (365.254%), and the textile industry (303.059%) all exhibit comparable trends.

From the aforesaid presentation, it is clear that there has been an upward trend in expenditure incurred on the fixed capital, total fuel consumed, and labor employed across different industries. Similarly, an upward swing in the income generated by industries is also witnessed. It is also noteworthy that there is a perfect relation among the variables. Particularly, as fixed capital increased it has led to higher demand for fuel consumption and moderate labor demand, whose impact has been noticed through expanding industrial income. Hence it is obvious that there are either unidirectional or bidirectional relations among the input and output variables.

3.6. Trends in the Growth rate of selected variables of different Industries:

The above exercise on descriptive statistics is restricted to only five major industries. This restriction was to hypothetically test the relationship among variables in different

industries. Five industries were chosen based on higher energy consumption and industrial output. However, the following narrative has been extended to many other industries with the purpose to capture the movement of indicators with their growth rate. The objective is to compare the growth rate of a variable at different periods in different industries. The growth rate of one variable is also compared with the growth rate of another related variable. Such an exercise will reveal the magnitude of association among variables in the respective industries.

From Table-3.8 the growth rate of selected variables explains their association with each other across industries. The Basic metal industry in 2002-03 with a feasible fuel price index of 3.27, decent fuel expenditure could be incurred to 10.36 percent growth rate. The industrial gross value added saw a growth rate of 10.41 percent in the same year. This cause could be associated with a positive growth rate of labor by 1.54 percent and a positive growth rate of fuel expenditure by 10.36 percent. However, a fall in the expenditure on fixed capital by -14.94 percent hampered the potential improvement in the growth rate of industrial gross value added. Whereas in 2003-04 the fuel price index increased to 7.16 in comparison to the previous year's price of 3.27. In this year the combined negative growth rate effects of fixed capital and labor -4.26 & -10.46 percent respectively affected adversely on the growth rate of industrial value-added, hence industrial gross value-added turned negative by -21.14.

The rise in the fuel price index put pressure on the spending on fuel consumption. The lower expenditure on fuel and negative growth rate of expenditure on fixed capital and labor collectively caused a decline in industrial gross value added of the basic metal industry in the particular year. In the year 2004-05, there was a low fuel price index of 3.60. But this low price did not reflect higher expenditure on fuel consumption. The fuel spending growth rate accounted for just 4.92 percent the lower growth rate expenditure on fuel along with negative fixed capital and labor growth rate pushed the industrial gross value-added growth rate to be negative. In the reference period 2005-06, the fuel price stood as low as 3.41. The industry took advantage of this and increased its spending on fuel; hence growth rate on fuel consumption expenditure stood at 24.28 percent.

An improvement in the growth rate of fixed capital spending and fuel expenditure represented an increase in the growth rate of industrial gross value added. Labor employed having a negative growth rate could not influence much on industrial gross value added. With a moderate fuel price index of 5.46 in 2006-07, the spending on fuel witnessed a growth rate of 17.41 percent. A combined positive growth rate of fixed capital, fuel consumption

expenditure, and labor, 16.31, 17.41 & 0.89 respectively pushed industrial gross value added to 37.49 percent. In the year 2008-09 the fuel price index recorded 4.74, despite a moderate level the spending on fuel remained at 9.22 percent. Hence mostly the amount of gross value-added 36.51 percent was caused by a 19.63 percent growth rate of fixed capital and a 5.26 percent growth rate of labor. In the year 2015-16 when the fuel price index was 6.90 above the moderate level, the spending on consumption was just with a growth rate of 9.54, much less than 23.03 in the year 2014-15. A negative downturn on the spending of labor (-6.41) and fixed capital growth rate being lower to 1.51 percent. These caused the industrial gross value added to be lower as much as on the negative side with -37.62 percent whereas in the year 2020-21 the fuel price index fell as much as 2.95 percent. It became advantageous to incur more expenditure on fuel, hence fuel expenditure growth rate improved to 15.53 percent.

Table- 3.8, Growth Rate of Selected Variables Under Different Industries																				
Year	BM					BV				CH				CRP				FMP			
	FPI	FC	GVA	FK	L	FC	GVA	L	FK	FC	GVA	L	FK	FC	GVA	L	FK	FC	GVA	L	FK
01-02																					
02-03	3.27	10.36	10.41	-14.94	1.54	21.03	35.73	-4.66	43.90	34.35	6.02	4.95	20.41	4.72	-6.56	3.84	-34.24	14.12	11.76	5.75	6.18
03-04	7.16	9.95	-21.14	-4.26	-10.46	30.46	-27.69	14.78	18.12	14.22	-11.25	-1.44	3.54	-11.23	34.81	-5.56	25.12	24.15	4.00	5.34	-1.72
04-05	3.60	4.92	-5.46	-0.08	-3.74	0.05	8.97	-1.12	4.95	1.90	-8.82	-5.45	2.33	-28.71	28.85	1.07	67.62	-2.95	-2.23	-9.61	7.71
05-06	3.41	24.28	45.18	9.33	-1.45	5.84	0.60	1.73	2.64	4.78	8.92	-0.61	-11.6	-35.83	93.81	1.95	9.33	13.10	8.48	6.27	8.75
06-07	5.46	17.41	37.49	16.31	0.89	17.33	44.00	9.53	20.20	1.50	8.03	-6.00	2.63	231.09	30.65	5.91	6.44	1.21	16.34	-0.23	0.92
07-08	7.27	20.11	66.41	8.18	7.12	8.32	-25.05	4.35	6.54	7.70	13.22	3.97	-4.40	37.48	21.24	7.29	0.63	12.62	17.14	12.83	5.90
08-09	4.47	17.43	-10.98	24.24	11.36	11.78	52.71	3.79	2.15	9.31	13.77	3.06	32.12	39.29	38.31	7.31	17.57	25.81	46.59	16.45	37.49
09-10	6.59	27.00	42.99	16.13	19.00	20.95	105.09	0.58	13.44	11.78	3.94	0.42	4.36	17.27	18.97	5.26	3.91	48.47	49.49	18.66	49.33
10-11	4.74	9.22	36.51	19.63	5.26	21.15	35.46	18.38	21.32	5.16	14.02	-0.28	1.73	3.54	25.05	21.26	6.57	13.01	26.13	17.06	49.09
11-12	8.05	19.08	-14.85	25.73	10.94	15.63	-7.48	4.63	21.61	22.44	16.54	7.80	29.03	21.90	7.46	3.44	7.27	0.79	2.96	-3.62	12.14
12-13	3.81	-0.65	6.51	34.86	-0.44	5.66	-17.45	6.55	18.31	-13.20	15.41	1.37	-1.42	9.87	-7.98	8.64	87.55	6.04	29.31	10.23	12.72
13-14	9.56	23.28	12.44	23.53	13.27	17.79	7.48	-3.03	25.93	20.79	12.00	7.22	7.95	0.87	24.99	-6.61	6.26	30.08	38.78	18.96	56.15
14-15	9.02	23.03	61.94	36.92	7.36	52.41	43.67	15.23	15.46	28.30	40.33	7.06	8.18	113.84	-26.2	-5.64	17.78	14.48	-3.85	0.63	5.02
15-16	6.90	9.54	-37.62	1.51	-6.41	-11.45	8.27	-3.77	10.97	18.73	-11.7	-6.08	9.94	-0.68	94.65	-7.61	-11.1	3.17	7.18	-5.53	-0.84
16-17	5.20	-1.36	37.37	11.54	-4.05	14.25	0.01	11.59	7.53	7.92	4.33	11.67	7.70	11.00	-9.31	10.01	19.82	20.28	-5.12	7.33	12.75
17-18	1.26	7.59	-10.96	4.10	2.91	44.57	8.65	1.27	27.51	2.46	2.23	0.64	10.17	-10.54	30.82	11.77	22.03	-10.2	4.22	-7.61	-6.79
18-19	-3.65	-2.49	-24.45	1.86	-5.63	-25.48	15.10	2.89	-17.17	-4.01	42.15	4.36	23.45	-19.15	8.72	16.75	43.57	10.35	9.68	5.33	23.96
19-20	1.73	11.97	17.09	14.38	4.14	-1.16	-3.13	-3.12	13.56	0.05	0.50	6.34	31.89	57.24	8.11	7.85	21.42	10.87	4.40	7.39	14.24
20-21	2.95	15.53	31.02	2.87	4.61	14.07	11.20	0.62	5.56	16.77	5.90	4.84	11.49	-0.51	-9.66	-4.91	4.95	-7.34	5.76	-2.38	-19.2

Source: Author's Calculation

Note: WPI=wholesale fuel price index, FC=Fuel Consumption, GVA=Gross Value Added, L=Labour, FK=Fixed Capital

Growth Rate of Selected Variables Under Different Industries (Table-3.8, Continued)												
Year	FP				M&E				Non-Met			
	FC	GVA	L	FK	FC	GVA	L	FK	FC	GVA	L	FK
2001-02												
2002-03	16.57	2.85	1.52	17.47	10.97	6.11	-37.1	-4.05	33.72	43.19	4.76	24.04
2003-04	3.54	0.24	-2.0	-2.24	6.83	-1.83	-9.12	-6.22	-7.42	1.98	-1.60	-20.8
2004-05	4.43	4.20	-2.0	6.63	-3.57	0.88	-3.95	6.06	8.64	4.09	5.24	20.66
2005-06	9.33	1.68	0.02	12.69	6.26	-4.65	-0.92	11.94	5.99	-3.37	28.07	-11.3
2006-07	5.69	-7.84	-1.5	-4.48	10.10	18.22	-2.03	-1.96	13.27	7.77	-23.7	6.81
2007-08	13.13	20.67	3.47	11.59	17.17	23.23	10.28	10.40	17.23	40.91	15.18	12.62
2008-09	16.86	21.29	3.61	11.27	9.87	28.61	6.48	26.36	8.64	4.96	10.49	6.58
2009-10	15.45	32.80	5.19	29.43	21.14	25.58	11.27	8.91	20.08	58.37	13.21	9.52
2010-11	7.88	-6.64	0.79	18.49	15.33	26.97	7.68	27.00	22.01	44.56	1.27	36.65
2011-12	16.42	26.50	3.84	18.23	1.34	33.92	28.19	24.74	23.20	13.76	15.56	25.98
2012-13	15.45	16.62	2.55	23.40	2.69	4.52	-21.4	14.36	-0.60	11.50	2.60	13.25
2013-14	25.05	28.48	4.29	20.49	30.68	13.47	20.99	32.21	26.47	-7.94	13.31	28.72
2014-15	20.17	22.74	6.14	21.06	38.85	22.02	1.70	6.58	26.43	23.73	3.56	15.59
2015-16	8.30	-2.68	-5.0	9.27	-11.2	8.28	-2.7	12.57	6.81	2.18	-5.41	59.78
2016-17	12.01	7.82	2.19	5.72	-0.19	-17.1	-3.74	4.17	6.19	-5.23	9.22	-27.3
2017-18	9.46	6.25	1.99	11.46	18.57	20.20	10.08	17.81	10.17	15.52	2.79	20.87
2018-19	-0.77	12.95	-0.8	12.80	-2.85	9.34	2.12	-3.94	-7.39	-4.20	0.72	-2.91
2019-20	6.48	21.06	5.93	8.91	6.53	8.00	7.25	21.31	-3.01	21.92	7.63	14.21
2020-21	12.53	7.02	4.70	8.88	16.47	18.65	8.92	-0.83	18.33	11.64	1.15	-2.32

Source: Author's Calculation

Note: WPI=wholesale fuel price index, FC=Fuel Consumption, GVA=Gross Value Added, L=Labour, FK=Fixed Capital

Growth Rate of Selected Variables Under Different Industries (Table-3.8, Continued)												
Year	PP				TEX				All Industries			
	FC	GVA	L	FK	FC	GVA	L	FK	FC	GVA	L	FK
2001-02												
2002-03	25.94	18.12	6.37	28.98	29.34	7.55	-3.85	20.69	19.32	8.55	-4.84	2.74
2003-04	4.92	58.94	2.24	-7.02	9.93	9.25	0.42	-1.40	6.83	-5.42	-3.12	-0.56
2004-05	-3.47	-19.84	-6.33	-1.96	-10.1	-13.22	-8.27	-10.88	1.29	2.74	-2.92	8.10
2005-06	14.07	19.16	3.39	26.14	11.84	11.81	-0.30	2.03	11.47	17.00	2.39	2.96
2006-07	-3.00	-2.09	0.48	-14.0	3.77	5.95	2.70	4.06	38.16	15.58	-0.85	6.42
2007-08	6.69	3.62	1.84	3.03	10.56	11.19	4.46	10.92	-6.66	24.96	7.43	8.40
2008-09	4.87	21.33	-0.23	14.77	12.11	21.77	5.74	20.57	12.55	17.79	7.82	18.30
2009-10	5.55	11.63	5.93	17.14	26.15	26.23	35.08	46.53	24.25	26.18	12.58	17.83
2010-11	24.79	25.39	32.38	25.31	-0.49	-0.65	-19.5	-2.38	7.91	20.12	1.99	18.18
2011-12	15.55	13.19	-7.99	21.09	7.54	-7.33	-4.14	7.83	17.44	10.59	8.42	24.95
2012-13	10.34	-11.19	-1.12	23.52	8.66	26.76	-1.04	13.20	6.20	14.05	4.18	28.05
2013-14	27.60	49.08	9.28	7.97	21.24	36.77	4.95	11.40	20.93	18.35	7.64	18.85
2014-15	9.39	-0.90	1.86	6.38	11.38	-11.91	0.07	8.57	24.06	9.70	5.77	21.32
2015-16	10.72	-4.60	-7.37	13.67	16.20	37.08	-3.08	0.78	10.36	11.28	-3.54	11.83
2016-17	11.05	35.23	5.36	9.30	11.91	0.93	6.15	67.92	11.57	5.74	4.57	8.87
2017-18	10.31	1.89	-2.77	4.57	3.80	1.60	2.85	-35.05	0.17	9.35	2.57	4.24
2018-19	-13.8	8.78	2.87	4.61	3.63	4.51	1.83	8.57	-2.60	9.32	3.04	13.55
2019-20	4.35	4.46	2.04	12.89	-2.78	6.74	-0.35	10.72	5.70	7.44	4.31	13.55
2020-21	12.54	29.31	12.29	1.56	5.89	7.54	7.62	7.03	13.63	7.23	4.75	2.99

Source: Author's Calculation

Note: WPI=wholesale fuel price index, FC=Fuel Consumption, GVA=Gross Value Added, L=Labour, FK=Fixed Capital

Fuel consumption growth rate along with the positive growth rate of labor and fixed capital collectively improved the industrial gross value-added growth rate to 31.02.

In the year 2002-03 beverage industry faced a low-price index of 3.27. This led to positive spending on fuel consumption to have a 21.3 percent growth rate. On the other hand, the growth rate of fixed capital by 43.90 percent together with the growth rate of fuel consumption impacted the industrial gross value added to attain a growth rate of 35.73 percent. In 2006-07 the fuel price index moderated to 5.64, this accommodated a growth rate of fuel consumption expenditure to 17.33 percent. The rising growth rate of Industrial gross value added to 44.00 percent was purely

due to the growth rate of fixed capital expenditure and cost of labor. The increased investment growth rate in fixed capital and labor were 9.53 percent and 20.20 percent respectively. In the year 2011-12 industrial gross value-added saw a negative -7.48 despite a positive growth rate in fuel consumption expenditure to 15.63 percent, the growth rate of labor spending to 4.63 percent, and the growth rate of fixed capital spending to 21.61 percent hence the cause of negative growth rate on industrial value added, might have been variables other than labor and fixed capital. In the year 2020-21 fuel price index is at its minimum of 2.95 the spending growth rate on fuel consumption touched 14.07 percent. The growth rate of outlay on 0.62 labor and 5.56 of cost on fixed capital together pushed the growth rate of industrial gross value added to 11.20 percent.

Coke and refinery product industry is an energy-intensive industry. In the year 2002-2003 with a moderate fuel price, it improved its expenditure on fuel consumption, as a result, the growth rate of fuel consumption struck 4.72 percent. However, the great fall in the growth rate of fixed capital by -34.24 percent and a marginal fall in the growth rate of labor employed by 3.84 percent, together affected gross value added negatively. In the year 2011-12, the fuel inflation was 8.05. In such high fuel inflation situation too, the coke & refinery product positively influenced the fuel consumption expenditure growth rate to 21.90 percent. In the reference period 2016-17, the moderating fuel inflation figure was 5.20. The positive growth rate of fixed capital 19.82 percent, 11.00 percent of fuel consumption expenditure, and growth of labor employed could not positively influence the industrial gross value added. Hence the negative growth rate of industrial gross value-added -9.31 percent is affected by variables other than fuel consumption, fixed capital, and labor in this particular year. In the year 2020-21 despite a very low 2.95, the spending on fuel recorded a negative growth rate of -0.51. The growth rate of labor and fixed capital, together with fuel consumption could bring a negative growth rate on industrial gross value added.

Fabricated metal products are another energy-intensive industry. In the year 2002-03 the fuel price index accounts for 3.27. The growth rate of fuel consumption is 14.12 percent. The growth rate of labor employed 5.75 along with fixed capital at 6.18 impacted the growth rate in industrial gross value added to 11.76 percent. In the year 2006-07 with a moderate fuel price index of 5.46, the expenditure on fuel consumption was low. This gave a fuel growth rate of 1.21 percent. The growth rate of labor faced a negative percentage of -0.23. So it is identified that the entire growth rate of industrial gross value added (16.34 percent) is due to the growth rate of fixed capital

0.92 percent and fuel consumption growth rate. Similarly in the year, 2011-12 the fuel price index was as high as 8.05, which caused the fuel expenditure to be as low as 0.79 percent. Then, the growth rate of industrial gross value added could reach only 2.96 percent. This was purely the effect of the growth rate on fixed capital 12.14 percent and fuel expenditure. In 2011-12 the moderate fuel inflation enabled a leaping growth rate in the fuel consumption expenditure by 20.28 percent. In the same year, there was a considerable growth rate in labor employed and fixed capital yet these three factors could not influence the industrial gross value added. Finally, the industrial gross value added is fixed at -5.12 percent. In the year 2020-21 with as much as low fuel price index of 2.95 did not much influence the spending on fuel consumption. As a result, fuel consumption faced a negative growth rate of -7.34 percent. Even though labor and fixed capital growth rates indexed negative growth rates yet the industrial gross value added stood with its growth rate of 5.76 percent.

The food product industry consumes a large amount of fuel consumption. In the year 2002-2003 with a tolerable figure of fuel inflation fuel spending faced a growth rate of 16.57 percent. the positive growth rate of labor employed 1.52 percent along with the fixed capital growth rate of 17.47 percent could influence the gross value-added growth rate to only an amount of 2.85 percent. In the year 2007-08 with high fuel inflation, an indispensable growth rate of spending on fuel consumption of 13.13 percent. The growth rate of fuel consumption along with the growth rate of fixed capital (11.59) and labor (3.47) influenced substantially attaining an industrial gross value-added growth rate of 20.57 percent. Higher fuel inflation of 8.05 in the year 2011-12 kept fuel consumption spending at a growth rate of 16.42 percent. This spending along with the growth rate of the number of laborers employed and the growth rate of the amount spent on fixed capital influenced the gross value added to attain a growth rate of 26.50 percent. Whereas in the year 2016-17 with moderate inflation of 5.20. The growth rate of expenditure incurred on fuel consumption amounted to 12.01 percent, such improvement along with the growth rate of labor at 2.19 percent and fixed capital at 5.72 percent putting the industrial gross value added to 7.82 percent. Similarly, the year 2020-21 with a much lower fuel inflation index of 2.95, could enable spending on the growth rate of fuel to reach 12.53 percent. Such an amount of spending on fuel together with the growth rate of labor and fixed capital brought the industrial gross value added to 7.02 percent.

Machine and equipment production is also to an extent energy dependent. In 2002-2003 with a lower fuel price index of 3.27. The lower fuel price index enabled the industry to spend more on fuel consumption, whose growth rate accounted for 10.97 percent. although the growth rate of labor employed and fixed capital turned negative with -37.15 and -4.05 percent respectively, the positive growth rate of 6.11 percent industrial gross value added can be attributed fuel consumption growth rate. In the year 2005-06 a moderate fuel inflation of 4.74, drove the industry to meet a fuel consumption expenditure growth rate of 15.33 percent. In this particular year, the growth rate of labor was 7.68 percent and the growth rate of fixed capital was 27.00 percent together positively impacted the industrial gross value added to achieve a growth rate of 26.97 percent. In the year 2015-16 the high fuel inflation of 6.90, turned the fuel consumption expenditure growth rate negative -11.26 percent. In this particular year, although the growth rate of labor employed declined to a negative -2.78 percent, the growth rate of fixed capital 12.57 percent seems to have impacted a growth rate of 8.28 percent industrial gross value added. Whereas the year with very lower fuel inflation of 2.95, influenced the growth rate of fuel consumption expenditure by 16.47 percent, along with the growth rate of 8.92 percent of labor and a negative growth rate of -0.83 percent fixed capital spending affected the industrial gross value-added growth rate to be 18.65 percent.

The non-metallic mineral product industry has been using more energy in production. In the year 2002-2003 with a low fuel price index of 3.27, the industry incurred a substantial amount of expenditure on fuel consumption, whose growth rate reached 33.72 percent. Such an increase along with the growth rate of labor employed (4.76 percent) and fixed capital (24.04 percent) accounted for a growth rate of 43.19 percent in industrial gross value added. In the year 2008-09 a moderate fuel inflation of 4.74 led to a greater influence on the spending of fuel consumption by 22.01percent. The labor growth rate of 1.27 and fixed capital growth rate of 36.65 percent together impacted the industrial growth rate by 44.56 percent. whereas in the year 2016-17 with more than moderate fuel inflation of 5.20, the expenditure on fuel accounted for a small growth rate of 6.19 percent. but with a great fall in the growth rate of fixed capital by about a negative amount of -27.32 percent the industrial gross value-added growth rate fell to a negative amount of-5.47 percent. Still with a great fall in the fuel price index by 2.95, the expenditure on fuel improved by 18.33 percent. This growth rate, along with a growth rate of labor of 1.15 percent gave an industrial gross value-added growth rate of 11.64 percent.

The growth rate comparison for the paper industry in the year 2006-07 reveals that the growth rate of fixed capital expenditure (-14.02) and the growth rate of fuel consumption (-3.00) are having negative figures. The lower growth rate in labor employed 0.48 along with the negative growth of fixed capital and fuel consumption could not contribute to a positive growth rate on industrial gross value added. However, in the year 2008-09 with moderate inflation of 4.74, the industry spent more on fuel consumption, whose growth rate was 24.79 percent. A combined growth rate effect of labor 32.38 percent and fixed capital 25.31 percent boosted the industrial gross value added to 25.39 percent. Whereas in 2015-16 with a high fuel inflation index of 6.90, there was moderate spending on fuel consumption. Whose growth rate was 10.72 percent with a negative labor growth rate of -7.37 percent and a positive growth rate of fixed capital of 13.67, the gross value-added growth rate touched -4.60. In the year 2020-21 with low fuel inflation of 2.95, there was substantial spending on fuel consumption, whose growth rate was 12.54 percent. a high growth rate of labour12.29 and a lower growth rate of fixed capital 1.56 percent together positively impacted 29.31 percent.

The textile sector has been identified as one of the energy-intensive sectors in India. In the year 2002-2003 with a lower fuel price index of 3.27, the industry allocated substantial funds to fuel consumption, whose growth rate was 29.34 percent. Such a growth rate in fuel consumption along with the growth rate of fixed capital of 20.69 percent impacted the industrial gross value added to attain a growth rate of 7.55 percent. The growth rate of these variables changes in the year 2006-07. In this reference period, the fuel price index was 5.46. This moderate indication on the fuel price index drove very little expenditure on fuel consumption; the growth rate of fuel consumption was only 3.77 percent. The positive growth rate of labor employed and fixed capital incurred collectively sustained the industrial gross value added to 5.59 percent.

From the analysis above, it can be concluded that in most industries, the cost of energy input is higher than the cost of other inputs. Energy demand is low in many industries as a result of rising fuel costs and rising costs of energy input. However, the rise in fixed capital spending implies that some industries have embraced energy-saving practices in an effort to lower their energy costs.

3.7 Conclusion

The observation of the Indian energy profile gives a vivid understanding of energy and related variables. To summarize, energy had a nature of derived demand over the years. The driving forces were population growth, rapid industrialization, expansion of urbanization, positive change in per-capita income, good standard of living, and habit of mass consumption. The Indian energy demand mostly comes from three major fuels coal, oil, and solid biomass. Among these coal plays an important role in the energy mix. Coal demand nearly tripled between 2000 and 2020, and is responsible for 50% of primary energy demand growth. Since 2000 Indian energy demand accounts for about 10% of the world's energy demand. It is bound to increase energy demand further. About 74% of the required coal is produced in India. Crude oil dependency on external sources is about 87%. And natural gas dependency is about 56%.

It was also found that the has not been much change in sectoral dependency on a particular fuel. Manufacturing industries largely depend on coal, the transportation sector largely depends on oil, the building sector largely depends on electricity so also agriculture which heavily depends on the electricity sector. Further, the final energy consumption in the industrial sector is the second largest, amounting to 36 to 41%.

Further, in the year of the low fuel price index, the usage of fuel increased drastically. This had a subsequent effect on the Industrial gross value added. The presence of such linkages validated the existence of the economic theory of the law of demand. Later in some years, it has been observed that with a lower or constant fuel price index the improvement in the gross value added is minimum.

The above investigation reveals that by and large industries depend on electricity for their production. However, there are few coals-dependent industries such as non-metallic minerals (cement, chemical, etc.) and paper and paper products. The non-metallic mineral industry on average depends on 60 % coal-based fueling. Whereas the paper and paper industry depend on an average of 50% of coal energy. The tobacco industry in recent years has replaced oil with electricity. Similarly, the textile industry for a few years avoided the usage of gas and oil, and instead increased the usage of electricity. The Rubber producing industries over the recent years reduced the consumption of oil and gas and instead increased the usage of electricity. Hence it has

been noticed that industries over the decades transforming their infrastructure to be compatible with electricity rather than other sources of energy input.

The summary statistics presented in this chapter provided useful information on how the values of the variables are normally distributed, their changing trend, how they are related to one another, and if so, how strong these relationships are. Aside from that, the chapter detailed the fuel mix in each industry, as well as the trend and intensity of each.

With this context, the empirical relationship between industrial gross value added and fuel consumption will be discussed in the following chapter, both in an aggregate and disaggregated manner. The research was conducted using econometric methods like fixed and random effect models to discover the functional relationship between chosen variables.

3.8 References

- Agência Brasil, (2019). Agência Brasil. Retrieved 23 July 2020, from https://agenciabrasil.ebc.com.br/geral/noticia/2019-06/preco-do-gas-e-desemprego-elevam-uso-da-lenha-para-cozinhar-no-brasil

- CEA, (2019). Draft Report on Optimal Generation Capacity Mix for 2029-30. New Delhi: Central Electricity Authority.

- CEA, (2019). Growth of Electricity Sector in India from 1947-2019.New Delhi: CEA. Retrieved from www.cea.nic.in/reports/others/planning/pdm/growth_2019.pdf

- IEA, (2021). Special Report on World Energy Outlook India 2020-21. France: Directorate of Sustainability, Technology, and Outlooks.

- IEA,(2020).*India Energy Policy Review*. Paris: IEA. Retrieved from www.iea.org/reports/india-2020

- IEA, (2019). Material Efficiency in Clean Energy Transitions. Paris: IEA. Retrieved from www.iea.org/reports/material-efficiency-in-clean-energy-transitions

- IEA, (2020c). Iron and Steel Technology Roadmap: Towards more sustainable steel making. Paris: IEA. Retrieved from www.iea.org/reports/iron-and-steel-technology-roadmap

- Inaki Arto, (2016). The energy requirements of a developed world. Energy for Sustainable Development.

- MoSPI, (2019). Annual Survey of Industries 2017-18. Delhi: Ministry of Statistics and Programme Implementation.

- OEA DPIIT, (2020). Index of Core Industries. New Delhi: Office of the Economic Advisor, Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India.

- Power sector at a glance all India, (2019). Ministry of Power, Government of India. Available at https://powermin.nic.in/en/content/power-sector-glanceall-India.

- Vikas Khare, (2013). Status of solar wind renewable energy in India Renewable and Sustainable Energy Reviews.

****