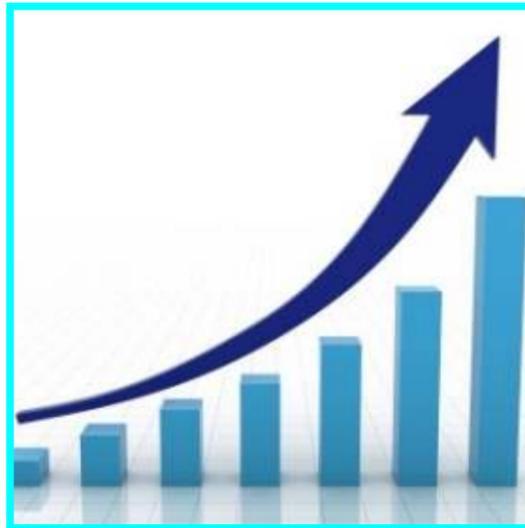


## CONVENTIONAL ENERGY SOURCES AND ECONOMIC DEVELOPMENT IN INDIA; BASIC ISSUES, PROBLEMS AND POLICY SUGGESTIONS



**S. R. Keshava**

Associate Professor ,  
Post Graduate Department of Economics , Bangalore University, Bangalore.

**Abstract:** Energy plays a vital role in economic development. Economic growth and demand for energy is positively correlated. The demand for energy increases with the increase in the standard of living and economic growth. It is vital input for industry, agriculture and service sectors as electricity is needed for their common needs of water supply, transport, communication and domestic lighting.

India at present is predominantly dependent on fossil fuel based energy namely thermal, oil, natural gas followed by hydro, nuclear, and other renewable source for its energy like wind, solar etc.

The government of India since independence did realize the role of energy in empowering its masses and economic development, but unfortunately it did not do much to generate the power at the rate it was supposed to do. Hence the ambitious 'power to all' deadlines put for themselves, kept on repeating since the last decade of 20th century, the latest of them being in 2012.

India should increase its installed capacity to at least three times of the present at the earliest. At the same time India should also be sensitive to the issues of climate change and sustainable development. The power generation in India should not only aim at sufficient power generation, but also towards the clean source of power generation. There should be a proper energy mix of conventional and renewable energy sources to produce electricity in India. If a proper plan is done and implemented for green power generation, it will lead us to meaningful sustainable inclusive economic development in India.

**Keywords:** Conventional Energy, Economic development, Energy Crisis, Natural gas, Planning, Nuclear Energy, Electricity, Energy Intensity, Per capita energy consumption, Climate change.

**INTRODUCTION**

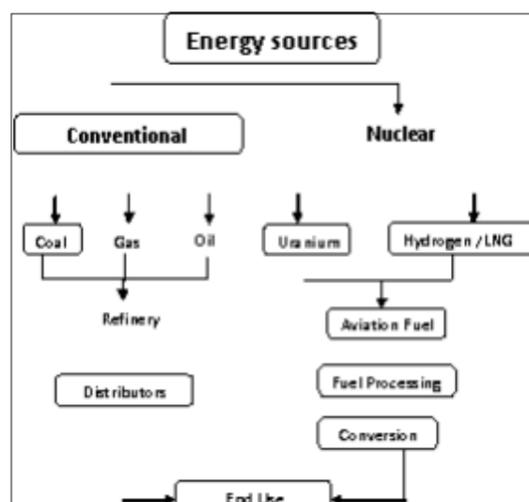
Energy plays a vital role in economic development. Economic growth and demand for energy is positively correlated. The demand for energy increases with the increase in the standard of living and economic growth. The draft of fifth five year plan (1974) states 'electricity is the most versatile form of energy and provides an important infrastructure for economic development. It is vital input for industry and agriculture and is particular importance to a developing rural sector which needs more power for its agriculture operations, for its small scale and agro industries. All sectors of the economy need electricity for their common needs of water supply, transport, communication and domestic lighting. Given the large scale dependence on lift irrigation for food production, food processing and preservation industries, the increase in the power intensive industries such as aluminum, fertilizer, petro chemicals etc, and the increasing dependence on electric traction for transport, there is hardly any community or sector which is not affected by power shortage today. The future development of the country therefore will depend upon the rate of growth of power generation capacity.

The government of India since independence did realize the role of energy in empowering its masses and economic development, but unfortunately it did not do much to generate the power at the rate it was supposed to do. Hence the ambitious 'power to all' deadlines put for themselves by Ministry of power, government of India, kept on repeating since the last decade of 20th century, the latest of them being in 2012, where 'power to all by 2012' failed miserably once again. It is the result of lack of appropriate planning.

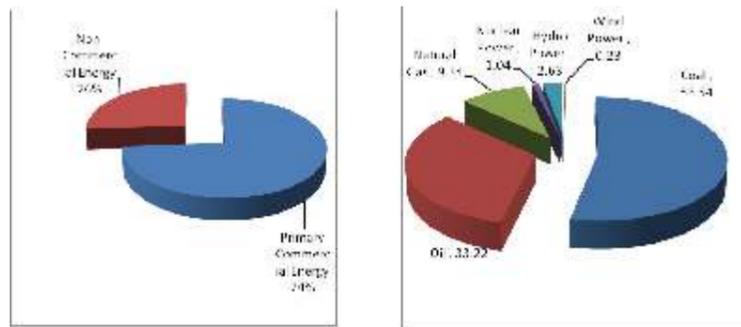
By observing the facts, it is clear that, there was no clear road map or long term energy policy to generate adequate power, keeping in mind the growth of population, economic growth and increase in the demand for power in India. Today 85 percent of villages in India are electrified, but still 15 percent of villages and 30 % of households do not have access to electricity. Even in the houses which are electrified, there is no continuous quality power to the households in India. This is truer in case of rural India, where 68.84 % live in rural areas.

**Energy crisis in India**

Historically, the world energy crisis began in 1973 when the organization of petroleum exporting countries (OPEC) increased the oil price from \$2.09 per barrel to \$8.06 per barrel. After then the crude oil prices was raised by OPEC at regular intervals making the energy shock the regular phenomena to be forced by the economies. Oil price reached \$27.30 per barrel in 1980. India recognized the fact, "Apart from the heavy strain this will cast on the country's balance of payments, even the physical availability of oil in the international markets will pose a problem in the years to come. This means that if India's plans of economic growth are not to be hampered by inadequacies of energy supply, reduced dependence on imported oil has to be a key element in our development strategy" (Planning commission, 1981)



India at present is predominantly dependent on fossil fuel based energy namely thermal, oil, natural gas followed by hydro, nuclear, and other renewable source for its energy like wind, solar etc. The primary commercial energy constitutes 73.78 percent and non commercial energy constitutes 26.22 percent share in the total primary energy consumption. In case of primary commercial energy coal constitutes 39.5 percent, oil 24.51 percent, natural gas 6.87 percent, Nuclear power 0.77 percent, Hydro 1.94 percent and wind constituted 0.17 percent.



Percentage share in total Primary Energy Consumption      %Share in primary Commercial Energy  
 Source: Derived from the data in energy statistics 2012

**FOSSIL FUEL BASED ENERGY**

Fossil fuels are formed inside the earth crust. They are formed through heat and compression of forests, waste and other organic matter over millions of years. They are buried in the earth due to earth quake, landslide etc. Fossil fuels are of three types 1) Solid (Coal) 2) Liquid (Petroleum) and 3) Gaseous (Natural Gas)

Coal is abundantly found fossil fuel. It contains Water, Sulphur, Nitrogen and Carbon. Coal meets 40 percent of global electricity, whereas in India coal contributes 53.54 percent of electricity in total utility generated in India and 39.05 percent of total primary energy consumption. India has 285.86 billion tons of coal reserves in the country.

**Table No. 1: Estimated Reserves of coal and Lignite in India (In billion tones)**

	Proved		Indicated		Inferred		Total	
	2010	2011	2010	2011	2010	2011	2010	2011
Coal	109.80	114.00	130.65	137.47	36.36	34.39	246.81	285.86
Distribution (%)	39.67	39.88	47.20	48.09	13.13	12.03	100.00	100.00
Lignite	6.15	6.15	25.34	25.79	8.41	8.97	39.90	40.90
Distribution (%)	15.40	15.02	63.52	63.02	21.07	21.92	100.00	100.00

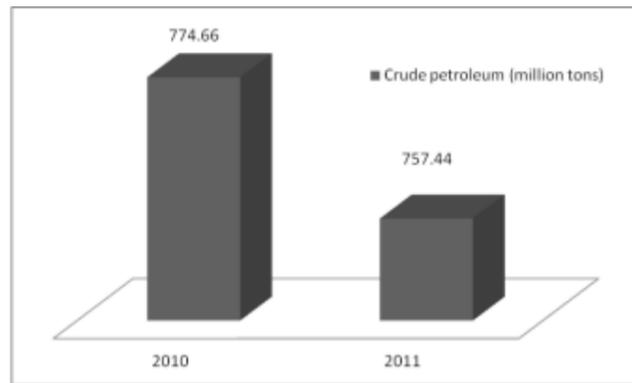
Source: Energy Statistics (2012), Central Statistics Office, National Statistical Organization, Ministry of Statistics and Programme implementation, Government of India.

In India the total availability of raw coal in India during 2010-11 stood at 589.87 metric tons and that of lignite at 37.73 metric tons. The availability of coal has increased at CAGR of 5.3 percent from 1970-71 to 2010-11. The increase is attributed increase in quality mining techniques due to research and development in the field. The raw coal in India is used mainly for producing electricity (70.33 %) steel and washery (7.4%), cement (2.6%), paper (0.4%), cotton (0.04%), others (19.11%) in 2010-11. The major advantages and disadvantages are discussed in the following table.

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1) Coal is cheapest form of energy</li> <li>2) Coal stock exists in more than seventy countries in the world, India also have abundant coal resources</li> <li>3) Easily convertible into energy source and easy to store</li> <li>4) Reliable and continuous supply</li> <li>5) Economies of scale can be seen as large units are produced using mature technology</li> </ol>	<ol style="list-style-type: none"> <li>1) The major problem about the availability of Indian coal is that the average quality of Indian coal is not high. Hence good quality coal is imported to facilitate the requirement of steel plants.</li> <li>2) The other major issue about coal is that when it is burnt to derive energy it emits carbon dioxide and contributes to climate change.</li> </ol>

### Crude petroleum and Natural Gas in India

Crude petroleum and natural gas are the important source of fossil fuel. Crude petroleum is formed due to decomposition of micro plankton, deposited by the action of bacteria and catalytic cracking upon the sea beds, lakes and rivers for millions of years.

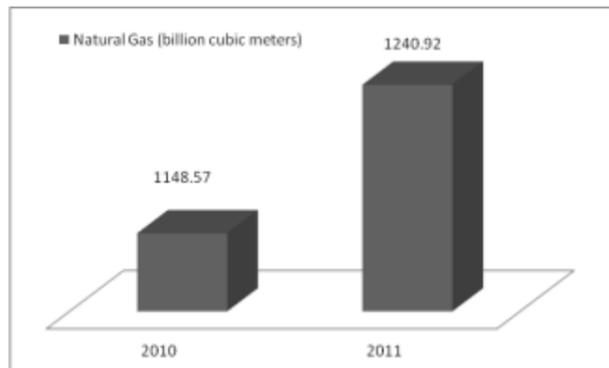


Source: Derived from the data obtained from Energy Statistics (2012),

The oil reserves in India is too less. It is just 0.43 percent of the world's proven oil reserves. The estimated reserve of crude petroleum in India is 757.44 million tons in India. The production of crude oil was 0.25 million tons in 1950-51 which has increased to 37.7 million tons in 2010-11.

Advantages	Disadvantages
<ol style="list-style-type: none"> <li>1) Liquid fuel is relatively cleaner and easy to transport</li> <li>2) It is less capital intensive than coal</li> </ol>	<ol style="list-style-type: none"> <li>1) The major disadvantage is the combustion process which produce the pollutants like NO, SO<sub>2</sub>, CO, CO<sub>2</sub>, smog etc and contributes to climate change.</li> <li>2) It also contributes and aggregates the urban pollution, acid rain and water contamination.</li> </ol>

Natural Gas is the mixture of hydrocarbons gases trapped inside the earth. It consists of methane (CH<sub>4</sub>), Propane (C<sub>3</sub>H<sub>8</sub>) and butane (C<sub>4</sub>H<sub>10</sub>), after processing it can be used in two different forms namely 1) Liquefied petroleum Gas (LPG) and 2) Compressed Natural Gas (CNG).



Source: Derived from the data obtained from Energy Statistics (2012)

The estimated natural gas has increased from 1148.57 billion cubic meters in 2010 to 1240.92 billion cubic meters in 2011. The increase is attributed to use of modern technology and exploration. But still the proportion of India's gas reserves to the world gas reserves is only 0.5 percent.

Advantages	Disadvantages of natural gas
<ol style="list-style-type: none"> <li>1) Gas is emerging as cleanest source of energy</li> <li>2) It plays an important role in reduction of carbon emissions as it is eco-friendly.</li> </ol>	<ol style="list-style-type: none"> <li>1) The major disadvantage is when burnt for energy it release methane which adds to GHGs</li> <li>2) It requires high pressure as well as low temperature for compression</li> <li>3) Storage of gases requires specially designed tanks as it is stored at high pressure.</li> </ol>

### Nuclear Energy

Nuclear energy is derived by splitting of uranium atoms through the process fusion. In the power generating station the fusion process is used for generating heat that produces steam, which is used by a turbine to produce electricity.

Advantages of Nuclear Energy	Disadvantages of Nuclear Energy
<ol style="list-style-type: none"> <li>1. It is considered as reliable source of energy with no carbon emissions to atmosphere.</li> <li>2. It requires smaller amount of raw material and relatively cheapest among conventional source of energy.</li> </ol>	<ol style="list-style-type: none"> <li>1) The threat of exposure to radioactivity is present despite the safety installations.</li> <li>2) The waste disposal from nuclear plant is the major cause of worry. At present it is dumped in a specially designed steel container and buried into earth. The cost is high and the safety concerns remain!</li> </ol>

### Trends in Gross Generation of Electricity

As already pointed out, India also tried to fulfill its energy needs from the existing conventional resources. Thermal sources led the energy generation in India. The details of the trends in gross generation of electricity in utilities and non utilities in India are given in table No 2.

**Table No. 2: Trends in Gross Generation of Electricity in Utilities and Non Utilities in India**  
(Giga Watt hour) = (106 X Kilo Watt hour)

	Utilities				Non utilities			Grand total
	Thermal	Hydro	Nuclear	Total	Railways	Others	Total	
1970-71	28162	25248	2418	55828	37	5347	5384	61212
1975-76	43303	33302	2626	79231	38	6657	6695	85926
1980-81	61301	46542	3001	110844	42	8374	8416	119260
1985-86	114347	51021	4982	170350	43	12997	13040	183390
1990-91	186547	71641	6141	264329	29	25082	25111	289440
1995-96	299316	72579	7982	379877	24	38142	38166	418043
2000-01	409940	74362	16902	501204	-	59638	59638	560842
2005-06	505001	101494	17324	623819	-	73640	73640	697459
2006-07	538350	113502	18802	670654	-	81800	81800	752454
2007-08	585282	120387	16957	722626	-	90477	90477	813102
2008-09	617832	113081	14713	745626	-	95905	95905	842531
2009-10	670965	106680	18636	796281	-	109693	109693	905974
2010-11	704323	114257	26266	844846	-	114224	114224	959070
<b>Growth rate of 2010-11 over 2009-10 (%)</b>	<b>4.97</b>	<b>7.10</b>	<b>40.94</b>	<b>6.10</b>	<b>-</b>	<b>4.13</b>	<b>4.13</b>	<b>5.86</b>
<b>CAGR 1970-71 to 2010-11 (%)</b>	<b>8.17</b>	<b>3.75</b>	<b>5.99</b>	<b>6.85</b>	<b>-</b>	<b>7.75</b>	<b>7.74</b>	<b>6.94</b>

Source: Energy Statistics (2012), Central Statistics Office, National Statistical Organization, Ministry of Statistics and Programme implementation, Government of India

In 1950-51, India was generating 5106 GWH of electricity, considering both utilities and non utilities that increased to 959070 GWH in 2010-11. Out of this 7, 04,323 GWH was generated from thermal and 1, 14,257 GWH was generated from hydro and 26, 266 GWH was generated from Nuclear sources. Hence the utilities contributed for the generation of 8, 44,846 KWH, whereas the total electricity generated from non utilities was 1, 14,224 GWH. The highest growth was accorded in thermal, during 1970-71 to 2010-11 the compound average growth rates (CAGR) of 8.17 percent in Gross electricity generation followed by nuclear sector with CAGR of 5.99 percent and hydro with CAGR with 3.75 percent, whereas the non utilities had the CAGR of 7.74 percent during the 1970-71 to 2010-11.

The government of India did not do much to correct the negative balance for decades. The eleventh five year targeted the capacity addition of 62374 MW, where as the China added more than 60,000 MW during the period every year. In absolute terms the gross generation of electricity has definitely increased but not in tune with the growth of population and economic growth. Hence let us now see the per capita energy consumption and energy intensity in India.

#### Per capita Energy Consumption and Energy intensity in India

Per capita Energy consumption (PEC) during a year is computed as the ratio of the estimate of total energy consumption during the mid year population of the considered year. Energy intensity is referred as the amount of energy consumed for generating one unit of GDP at constant prices.

**Table No.3: Trends in Per capita Energy Consumption and Energy intensity in India**

Year	Energy consumption in billion KWH	Midyear population in '000 numbers	GDP (Rs. Crore) 1999-2000 prices	Per capita energy consumption (KWH)	Energy intensity (KWH) per rupee
1970-71	663.99	551311	517148	1204.39	0.1284
1975-76	840.53	617248	596428	1361.74	0.1409
1980-81	1012.58	688320	695361	1471.09	0.1456
1985-86	1477.50	766135	894041	1928.51	0.1653
1990-91	1902.75	852297	1193650	2232.50	0.1594
1995-96	2436.77	939540	1529453	2593.58	0.1593
2000-01	3154.28	1034931	2030710	3047.81	0.1553
2005-06	3909.37	1117734	2844942	3497.59	0.1374
2006-07	4226.78	1134023	3120029	3727.24	0.1355
2007-08	4508.26	1147677	3402716	3928.16	0.1325
2008-09	4845.25	1161495	4154973	4171.56	0.1166
2009-10	5462.31	1175480	4464081	4646.87	0.1224
2010-11	5693.54	1182105	4877842	4816.44	0.1167
<b>Growth rate of 2010-11 over 2009-10 (%)</b>	<b>4.23</b>	<b>0.56</b>	<b>9.27</b>	<b>3.65</b>	<b>-4.61</b>
<b>CAGR 1970-71 to 2010-11 (%)</b>	<b>5.38</b>	<b>1.88</b>	<b>5.63</b>	<b>3.44</b>	<b>-0.23</b>

Source: Compiled from Energy Statistics (2012),

The estimated PEC has increased from 1204 KWH in 1970-71 to 481644 KWH in 2010-11, where in CAGR growth for the period was 3.44 percent. The annual increase in PEC during 2010-11 over 2009-10 was 3.65, which is marginally better than CAGR of 40 years. Energy intensity was 0.1284 KWH in 1970-71 which increased to 0.1653 KWH in 1985-86, from there on, it kept on decreasing and reached 0.1167 KWH by 2010-11. The most important aspect is although PEC is increasing, it is not in tune with either population growth nor with GDP growth. It is unfortunate that despite having high economic growth during post reform period, especially after 2000, the energy generation in India did not gain momentum as expected.

### Basic Issues and problems

In India, the basic energy problem is that demand and supply imbalance is widening with each passing year for all the commercial fuels. The important issues are

- 1) The growth of Indian Economy is a positive sign. But the government did not come out with a longer concrete energy policy with a clear vision and foresight
- 2) The government did not make efforts to develop the need based and resource based industrial and transport system. They are dependent on petroleum products, which India lack significantly. The heavy dependence on import of petroleum, oil, lubricants is touching 80 percent of the total imports. Hence any hike in international prices of petroleum oil lubricants will have negative impact on Indian Economy.
- 3) India's import of natural gas was 21 percent in 2011-12. It is estimated to reach 28.4 percent by the end of the twelfth five year plan. Heavy dependence on the natural gas which is not found to that extent drains the treasury and strains the economy.
- 4) The inordinate delay in initiating, installing and commissioning of the power projects in India is the main reason for energy crisis. Energy crisis can be attributed to lack of government's strong will to initiate, install and commission the projects.
- 5) The poor transmission and distribution of power due to managerial inefficiencies and corruption is causing the loss to the range of 35-45 percent which is highest in the world is aggravating the problem. The following table gives the comparative picture of the same.
- 6) The targeted power generation was never met in five year plans. For example the ninth plan had the target of adding 40,243 MW of installed generating capacity. But the actual achievement was just 19015 MW (47%). Similarly the tenth plan targeted 41,110 MW and actual achievement was just 21,080 MW (51%). The eleventh five year plan targeted 62,374 MW, but the actual achievement was only 48,000 MW (76%). The carryover of deficiency and lack of attaining the fixed targets in every five year plan is aggravating the situation.

The existing basic problem has become more serious after the issue of climate change has come to the forefront. The international Energy Agency reveals that the power sector is responsible for 37 percent of all manmade carbon dioxide (CO<sub>2</sub>) emissions. Coal being the source of energy that generates 40 percent of

global electricity is the major culprit. Energy sector creates about 23 billion tons of CO<sub>2</sub> emissions every year, which is in excess of whopping 700 tons a second. Hence the energy policy in India should not only aim at adequate, sufficient and quality power, but also from the clean and green source.

### **Policy Suggestions**

#### **At Government level**

- 1)The government should draw a well designed appropriate long term energy strategy. Which would address the issues of climate change and sustainable development
- 2)Industry and transport sector should be encouraged to use the alternative and clean source of energy. Industry can use the Biogas and energy from Waste. Similarly transport can use Biofuel, Solar and Electricity.
- 3)The renewable source of energy is abundantly available in India. It is also clean and green. Hence it should be optimally used to address the energy deficits and issues of climate change and sustainable development.
- 4)The optimal fuel mix between conventional sources and renewable energy sources should be properly managed.

#### **At individual level**

- 1)Individuals at their level should not waste energy. They should switch off the lights, TV, Computer and other electronic gadgets when not in use.
- 2)Individuals should use solar water heaters, solar lamps and cookers.
- 3)While constructing the house the individuals should build a green house utilizing nature friendly tools and allowing adequate the natural light and air to flow in the light.
- 4)Use energy saving CFL bulbs, and other energy saving electronic consumer goods.
- 5)Use public transport, instead of private vehicles.
- 6)Avoid using car when moving alone, may go in for car pooling,
- 7)Instead of using vehicles to travel short distances i.e., to go to nearby office or market place, one can either walk, which is healthy habit or may use cycle which is eco-friendly and healthy.

### **CONCLUSION**

Indian economic development is hampered by energy deficit. The government though realized the importance of energy did not do much for self reliance in energy sector. The lack of vision and foresightedness aggravated the negative balance in energy sector. As a result the energy crisis has become one of the stumbling blocks for the economic development. Hence, India has to solve the energy deficit issue at the earliest.

At the same time India should also be sensitive to the issues of climate change and sustainable development. The power generation in India should not only aim at sufficient power generation, but also towards the clean source of power generation. Fortunately 12.2 percent of total installed capacity comes from renewable energy sources as on March 2012 (India Wind Energy outlook, 2012). If a proper plan is done and implemented for green power generation, it will lead us to meaningful sustainable inclusive economic development in India.

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