CHAPTER II

ENERGY AND INDUSTRY: AN OVERVIEW

Introduction

Energy, one of the major inputs for economic activities of any country, is considered as an engine for development. In the case of developed countries, energy resources are still in demand to retain economic growth. The large-scale utilization of energy resources in such countries has resulted in associated environmental problems. In the case of the developing countries, the energy sector assumes a critical importance in view of the spiraling energy needs to service the rising economy. This demands huge investments in the energy sector. Moreover, energy utilization and its conversion in developing countries are less efficient.

Energy can be broadly classified into Primary and Secondary energy; Commercial and Non-commercial energy; and Renewable and Non-Renewable energy. Primary energy sources are those that are either found or stored in nature. Common primary energy sources are the fossil fuel reserves like coal, oil, natural gas, and biomass such as wood. Other primary energy sources found on earth include nuclear energy from radioactive substances, thermal energy stored in earth’s interior (geo thermal energy), and potential energy due to earth’s gravity. Primary energy sources are mostly converted in industrial utilities into secondary energy sources. For example coal, oil or gas gets converted into steam and electricity. They can at times be used directly as well. Some energy sources have non-energy uses. For instance, coal or natural gas can be used as feedstock in fertiliser plants.

The global coal reserve is estimated to be 9,84,453 million tonnes by the end of 2002. The USA has the largest share of the global reserve (25.4%) followed by Russia (15.9%) and China (11.6%). India is fourth in the list with 8.6%. Global proven oil reserves by the end of 2002 are estimated to be 1047.7 thousand million barrels. Saudi Arabia has the largest share with almost 25%. The global proven gas reserves are estimated to be 155.78 trillion cubic metres at the end of 2002. The Russian Federation (erstwhile) has the largest share of the reserve with almost 30.5%. The global primary energy consumption at the end of 2002 was equivalent to 9405 million tonnes of oil equivalent (MTOE). It may be seen that India’s absolute primary energy
consumption is only 1/29th of the world, 1/7th of USA, 1/1.6th time of Japan but 1.1, 2.9, 1.3, 1.5 times of Canada, Australia, France and U.K respectively.

The Energy sources that are available in the market for a definite price are known as commercial energy. By far the most important forms of commercial energy are electricity, coal and refined petroleum products. Biomass fuels like firewood, rice husk, cashew shells, etc., also can be now classified under the category of commercial energy in many places. Commercial energy forms the basis of industrial, agricultural, transport and commercial development in the modern world. In the industrialised and many developing countries, commercialised fuels are the predominant source not only for economic production but also for many household tasks of general population. The energy sources that are not available in the commercial market for a price are classified as non-commercial energy. Non-commercial energy sources include fuels such as firewood, cattle dung and agricultural wastes, which are traditionally gathered, not bought. These are also called traditional fuels. Non-commercial energy is often ignored in energy accounting.

The energy sources that are not depleted or inexhaustible after harnessing them for energy services, like the solar, wind, ocean tide, ocean waves, etc., fall in this category. Hydro power - the potential energy stored in water at a height - is considered a renewable energy source as water is not depleted after harnessing the energy, though the same water after having been used for energy service cannot be reused for similar energy extraction at the same place without additional energy input. Similarly sustainably harvested biomass can be classified under this category as the biomass can be grown again. In other words, all energy sources which are carbon neutral - that which doesn’t contribute to the increase of carbon dioxide content in the atmosphere - can be considered renewables. Energy sources that will get depleted once used -- those which gets converted into different forms or constituents -- are termed non-renewable energy sources. Fossil fuels like coal, lignite, oil and gas are examples of non-renewable energy sources.

Although 80% of the world’s population lies in the developing countries, despite a fourfold increase in the past 25 years, their energy consumption amounts to only 40% of the world total energy consumption. The high standards of living in the developed countries are responsible for their high energy consumption levels. Also, the population growth in the developing countries has kept the per capita
energy consumption low compared with that of industrialised countries. The world average energy consumption per person is equivalent to 2.2 tonnes of coal. In industrialized countries people use four to five times more than the world average and nine times more than the average for the developing countries. An American uses 32 times more commercial energy than an Indian.

Indian Energy Scenario

Coal dominates the energy mix in India, contributing to 54% of the total primary energy production. Over the years there has been a marked increase in the share of natural gas in primary energy production, from 10% in 1994 to 13% in 1999. There has been a decline in the share of oil in primary energy production, from 20% to 17% in the same period. In 2003, India’s per capita consumption of primary energy (Table 2.1) was a mere 0.44 TOE (tonnes of oil equivalent) as compared to 1.09 TOE in China, 7.84 TOE in the US, and the world average of 1.69 (Planning Commission 2006). It is anticipated that the demand for coal will increase to 670 MT (million tonnes) in 2011/12 (Planning Commission 2006) from 502 MT in 2007/08 (MoC 2008). Similarly, it is expected that the demand for petroleum products and natural gas would rise to 135 MT and 61 BCM (billion cubic metres), respectively, in 2011/12 (Planning Commission 2006), from 118 MT and 34 BCM, respectively, in 2007/08 (MoPNG 2008).

Table 2.1

<table>
<thead>
<tr>
<th>Per Capita Energy Requirements in Selected Countries*</th>
</tr>
</thead>
<tbody>
<tr>
<td>j TPES</td>
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<tr>
<td>(kgoe)</td>
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<tr>
<td>India 2003-04</td>
</tr>
<tr>
<td>India 2031-32 (projected® 8% GDP growth)</td>
</tr>
<tr>
<td>World Average (2003)</td>
</tr>
<tr>
<td>OECD (2003)</td>
</tr>
<tr>
<td>U.S.A. (2003)</td>
</tr>
<tr>
<td>China (2003)</td>
</tr>
<tr>
<td>South Korea (2003)</td>
</tr>
<tr>
<td>Japan (2003)</td>
</tr>
</tbody>
</table>

*For 2003
**per capita coal consumption of India has been estimated based on the calorific value of hard coal used internationally (6000 kcal/kg) to maintain uniformity. The figures in brackets are the actual per capita consumption based on Indian coal with a calorific value of 4000 kcal/kg.
India has huge coal reserves, with at least 84,396 Million tonnes of proven recoverable reserves (at the end of 2002), that contribute to about 8.6% of the world reserves and it may last for about 235 years at the current Reserve to Production (R/P) ratio. In contrast, the world's proven coal reserves are expected to last only for 204 years at the current R/P ratio. [If the reserves remaining at the end of the year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that level]. The country is the fourth largest producer of coal and lignite in the world. Coal production is concentrated in states like Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, Orissa, Jharkhand and West Bengal. In 2007/08, India produced 35 MT of coking coal, 422 MT of non-coking coal, and 34 MT of lignite. In 2007/08, India imported 21.5 MT of coking coal and 28.5 MT of non-coking coal.

![Figure 2.1](http://planningcommission.nic.in/sectors/energy.html)

Oil accounts for about 33% of India's total energy consumption (Figure 2.1). While India has invested considerable resources in this sector, the crude oil production has stagnated around 32-33 million metric tonnes per year over the past decade. The majority of India's roughly 5.4 thousand million barrels in oil reserves are located in the Bombay High, Upper Assam, Cambay, Krishna-Godavari, and Cauvery basins. India's average oil production level for 2002 was 793,000 barrels per day. But the consumption continues to outstrip production. About 70% of the total petroleum product demand is met by imports imposing a heavy burden on foreign exchange. In terms of sector wise petroleum product consumption, transport accounts for 53% followed by domestic and industry with 18% and 17% respectively. The domestic production of crude oil was 34.12 MT in 2007/08, which is barely 0.4%
higher than the figure of 33.99 MT in 2006/07. The total crude throughput in the 17 public sector refineries and two private sector refineries was to the tune of 156 MT in 2007/08. This necessitated an import of 122 MT of crude during this period, which accounted for 6.3% of GDP and 23.4% of total import bill. The refineries operated at an average capacity of 105% during the year, resulting in a net export of 16.6 MT of petroleum products (MoPNG 2008). Natural gas accounts for about 9 per cent of energy consumption in the country. Natural gas reserves are placed at 660 billion cubic meters. The country produced 32.27 BCM of natural gas in 2007/08, registering an increase of 2.2% over the previous year. Though the MoPNG does not report any import of natural gas in its annual statistical publication, India imported nearly 9.98 BCM of LNG in 2007 through Dahej and Hazira terminals (Teddy 2009), which is around one-third of the domestic production.

The total installed electricity generation capacity in India was 1,67,480 MW as on 31 March 2008. Of this, 1,44,130 MW capacity was accounted for by utilities (Figure 2.2) and 23,350 MW capacity by captive power plants. Amongst utilities, 91,907 MW capacity was accounted for by thermal power plants (Figure 2.3); 35,909 MW capacity by hydro; 4,120 MW capacity by nuclear; and 12,195 MW capacity was accounted for by renewable energy source based power plants. Total electricity generated in India amounted to 798 TWh (terawatt-hours) in 2007/08, accounting for 6% increase from 752 TWh in 2006/07 (CEA 2008).
Nuclear Power provides about 3% of electricity generated in India. India has ten nuclear power reactors at five nuclear power stations producing electricity. More nuclear reactors have also been approved for construction. India is endowed with a vast and viable hydro potential for power generation of which only 15% has been harnessed so far. The share of hydropower in the country’s total generated unit has steadily decreased and it presently stands at 25% as on 31st March 2008. It is assessed that exploitable potential at 60% load factor is 84,000 MW, which could yield 442 billion units of ‘firm’ generation annually and further 150 billion units of ‘infirm’ seasonal electricity. Out of the total potential available, nearly one-fifth has either been developed or is being developed.

India is richly endowed with renewable sources of energy such as sunlight, wind, and biomass. These sources have started contributing to the national electricity mix. The share of renewables in total electricity generation in India increased from 0.15% in 2001/02 to 0.54% in 2006/07 (CEA 2003, 2008). As on 31 December 2007, the cumulative grid-interactive power-generating capacity due to renewable energy sources was 11,272 MW (an increase of 20% since 31 January 2007) (MNRE 2008). Besides electricity generation, application of RETs (renewable energy technologies) has benefits in terms of meeting cooking and other energy requirements in an environmentally benign manner, so as to improve health conditions, reduce deforestation, increase employment opportunities, and improve the standard of living, particularly in rural areas. With an installed capacity of 7,844 MW for wind power at the end of 2007, India is ranked fourth in the world. India also exports indigenously produced wind turbines and turbine blades to the USA, Europe, Australia, China, and Brazil (MNRE 2008). The Government of India initiated its renewable energy programme in the late 1970s, much before there was a global surge for renewables. The Department of Non-conventional Energy Sources was established in 1982 and subsequently upgraded to a full-fledged Ministry of Non-conventional Energy Sources in 1992, which has now been renamed MNRE.

Final energy consumption is the actual energy consumed at the user end. This is the difference between primary energy consumption and the losses that take place in transport, transmission and distribution and refinement. The actual final energy consumption (past and projected) is given in Table 2.2.
Table 2.2

Demand for Commercial Energy for final consumption

<table>
<thead>
<tr>
<th>Source</th>
<th>Units</th>
<th>1994-95</th>
<th>2001-02;</th>
<th>2006-07;</th>
<th>2011-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>BU</td>
<td>289.36</td>
<td>480.08</td>
<td>712.67</td>
<td>1067.88</td>
</tr>
<tr>
<td>Coal</td>
<td>MT</td>
<td>76.67</td>
<td>109.01</td>
<td>134.99</td>
<td>173.47</td>
</tr>
<tr>
<td>Lignite</td>
<td>MT</td>
<td>4.85</td>
<td>11.69</td>
<td>16.02</td>
<td>19.70</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>MCM</td>
<td>9880.00</td>
<td>15730.00</td>
<td>18291.00</td>
<td>20853.00</td>
</tr>
<tr>
<td>Oil products</td>
<td>MT</td>
<td>63.55</td>
<td>99.89</td>
<td>139.95</td>
<td>196.47</td>
</tr>
</tbody>
</table>

Source: - Planning Commission, New Delhi; Business as Usual

With enhanced economic activity (GDP and per capita income), the demand for commercial energy has been increasing over a period of time in India. Table 2.3 depicts the commercial energy consumption in the country, by sector, for the past two and a half decades. The commercial energy consumption has increased 3.2 times during this period, with 6.2% increase during 2006/07. While the industrial sector continues to be the largest consumer of commercial energy, its share declined from 54% in 1980/81 to 46% in 2006/07. The share of the transport sector also declined from 25% to 18% during the same period. On the other hand, the share of agriculture increased from 2% to 7% and that of residential and commercial sectors, from 8% to 15% during the same period.

Table 2.3

Final commercial energy consumption (in MTOE) in India, by sector

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>1.6</td>
<td>2.4</td>
<td>4.9</td>
<td>8.4</td>
<td>15.2</td>
<td>15.1</td>
<td>16.8</td>
</tr>
<tr>
<td>Industry</td>
<td>36.9</td>
<td>49.2</td>
<td>62.9</td>
<td>77.5</td>
<td>77.4</td>
<td>96.2</td>
<td>102.9</td>
</tr>
<tr>
<td>Transport</td>
<td>17.4</td>
<td>21.7</td>
<td>28.0</td>
<td>37.2</td>
<td>33.5</td>
<td>36.5</td>
<td>40.3</td>
</tr>
<tr>
<td>Residential &amp; Commercial</td>
<td>5.6</td>
<td>8.9</td>
<td>12.6</td>
<td>15.3</td>
<td>24.1</td>
<td>32.6</td>
<td>35.0</td>
</tr>
<tr>
<td>Other energy uses</td>
<td>1.9</td>
<td>2.7</td>
<td>3.9</td>
<td>6.8</td>
<td>13.4</td>
<td>18.7</td>
<td>16.5</td>
</tr>
<tr>
<td>Non-energy uses</td>
<td>5.3</td>
<td>7.9</td>
<td>12.6</td>
<td>14.1</td>
<td>28.0</td>
<td>17.5</td>
<td>18.4</td>
</tr>
<tr>
<td>Total</td>
<td>68.7</td>
<td>92.8</td>
<td>124.9</td>
<td>159.3</td>
<td>191.6</td>
<td>216.6</td>
<td>229.9</td>
</tr>
</tbody>
</table>

Sources: - various editions of TEDDY, All India Electricity Statistics General Review 2008, Indian Petroleum and Natural Gas Statistics 2006/07, Coal Directory 2006/07, New Delhi

The Indian industry sector registered a growth rate of 9.2% in 2007/08 (April-November) as compared to 11.6% in 2006/07. The Indian industrial sector consumes (as fuel and feedstock) about 44.8% of the total commercial energy produced (2006/07). Coal and lignite account for 58.6% of the industrial commercial
energy consumption. The energy saving potential in Indian energy-intensive sectors is in the range of 10%-25%.

Energy and Industrial sector in India
- India is the fifth largest crude steel producing country in the world and is the largest producer of sponge iron. Its per capita consumption of steel is only 46 kg as compared to the global average of 150 kg.
- India is the second largest producer of cement in the world (about 5% of world’s production).
- India has the fifth largest reserves of bauxite, with deposits of about 3.29 billion tonnes (5% of the world deposits). Total installed capacity of aluminium is about 3% of the global capacity.
- India ranks third in the world in terms of production and consumption of fertilizers. The average specific energy consumption in urea production is 6.49 Gcal/tonne. 66% of urea production is based on natural gas as feedstock and 30% is based on naphtha as the feedstock.
- Average capacity of Indian paper mill is about 35 TPD (tonnes per day), which is very less as compared to the average of 260 TPD for Asia and 900 TPD for developed countries. The total specific energy consumption of Indian paper industry ranges from 31 GJ to 51 GJ per tonne of product, which is almost double of that of North America and Scandinavian countries. Energy cost constitutes about 25% of the total manufacturing cost.
- Cotton textile/man-made fibre industry is the single largest organized industry in the country and the second largest provider of employment after agriculture; contributes about 14% to total industrial production, 4% to the GDP, and 17% to the country’s export earnings.
- The overall capacity and production of chlor-alkali industry have increased by 3.15% and 3.95%, respectively, annually over 2001/02. Energy cost accounts for 60%-70% of the total production cost, and the energy saving potential in this sector is about 15%.

Out of the total oil and oil products consumed in the country in 2006/07, the transport sector consumed 51% in the form of petrol, diesel, compressed natural gas, and aviation fuel. Transport plays a significant role in the overall development of a nation’s economy. India has an extensive and diversified transportation system, which caters to the needs of about 1.03 billion people. The transport infrastructure in the country comprises 3.314 million km of roads, 63 465 km of rail tracks, 12 major and 200 minor ports, 11 international airports, 89 domestic airports, and 14 500 km of navigable inland waterways. The sector's contribution to India's GDP (gross domestic product) was 6.4% in 2004/05.

Energy and Transport sector in India
- Share of road in the total traffic grew from 13.8% of freight traffic and 15.4% of passenger traffic in 1950/51 to an estimated 65% and 86.7% respectively by the end of 2004/05.
- From 1999/2000 to 2003/04, total number of vehicles increased at an average rate of 10.10% per annum.
- Total length of national highways increased from 65,569 km in 2003/04 to 66,754 km in 2006/07. The length of rural roads increased at the rate of 150%, from 1.1 million km in 2001/02 to 2.7 million km in 2006/07.
- Railways sector registered an increase in the passenger traffic, from 5725 million passengers to 6219 million passengers, an increase of 8.6%. Passenger kilometres increased from 616 billion to 695 billion (an increase of 12.8%). Passenger earnings also increased from Rs 150.81 billion to 171.76 billion (an increase of 13.9%).
- Total freight carried by the Indian Railways registered a growth of 9.2% (from 66.51 MT [million tonnes] to 72.77 MT) during 2005/06 to 2006/07.
- In the ports and shipping sector, the freight traffic handled by major ports decreased from 463.84 MT in 2006/07 to 423.99 MT in 2007/08. During 2006/07, the aggregate capacity of major ports was enhanced by 48.55 MT; aggregate capacity as on 31 March '07 was 504.75 MT.
- The passenger traffic declined to 3.04 million in July 2008 (down by 12.65% from July 2007).

Source: TEDDY 2009
Traditionally, India has been predominantly an agricultural economy. The share of agriculture in total GDP (gross domestic product) has fallen over a period of time, from 55% in 1950/51 to 18.5% in 2006/07. However, the agricultural sector accounted for 12.5% of total exports in 2007/08. It provides employment to about 52% of the workforce. It is also an important source of raw material and fulfils the demand for many industrial products, particularly fertilizers, pesticides, agricultural implements, and a variety of consumer goods. Electricity consumption in agriculture increased from about 90,292 GWh (gigawatt-hours) in 2005/06 to 99,023 GWh in 2006/07. Tractors per 1000 ha of area harvested of cereals have increased from 11.94 in 1994 to 16.39 in 2002.

Energy and Agricultural sector in India
- The gross cropped area and the gross irrigated area in India stood at 192.80 Mha (million hectares) and 82.63 Mha, respectively, in 2005/06
- The production of fruits and vegetables stood at 62.86 MT (million tonnes) and 122.26 MT, respectively, in 2007/08
- Fertilizer consumption, which was 21.6 MT in 2006/07, increased by 6% in 2007/08
- Pesticide consumption declined from 61,260 MT during 1995/96 to 41,350.4 MT during 2004/05
- Consumption of biopesticides increased from 219 MT in 1996/97 to 683 MT in 2000/01

Source: TEDDY 2009

The domestic sector in India comprises 154.29 million rural households and 54.44 million urban households. The urban and rural households together consume 159.39 MTOE (million tonnes of oil equivalent) of energy, primarily for lighting, cooking, and space heating applications, of which 78% is supplied by solid biomass. A total of 65.6% and 32.9% of households use electricity and kerosene, respectively, as main sources for lighting. Average electricity consumption per urban household stands at 1332 units/year, which is 4.4 times greater than the average electricity consumption per rural household. In India, 60.2%, 21.8%, and 7.1% of households use firewood and chips, LPG (liquefied petroleum gas), and dung cake, respectively, as main sources for lighting. Biomass (59%) will dominate India’s energy basket in 2030, followed by electricity (21%) and LPG (13%).

Energy Needs of Growing Economy

Economic growth is desirable for developing countries, and energy is essential for economic growth. However, the relationship between economic growth and increased energy demand is not always a straightforward linear one. For example, under present conditions, a 6% increase in India’s Gross Domestic Product (GDP) would impose an increased demand of 9% on its energy sector. In this context,
the ratio of energy demand to GDP is a useful indicator. A high ratio reflects energy dependence and a strong influence of energy on GDP growth. Due to increase in energy demand vis-a-vis slow pace in supply side augmentation, the energy deficit in the country is rising (Figure 2.4). The plan outlay vis-a-vis share of energy is given in Figure 2.5. It is worth noting that developed countries, by focusing on energy efficiency and lower energy-intensive routes, maintain their energy to GDP ratios at values of less than 1. The ratios for developing countries tend to be much higher.

Figure 2.4
Rising energy deficit in the country

![Graph showing rising energy deficit](image)

Source: CEA 2008, New Delhi

Figure 2.5
Expenditure towards energy sector

![Graph showing expenditure towards energy sector](image)

Source: TEDDY 2009
The per capita energy consumption, as shown in Figure 2.6, is too low for India as compared to developed countries. It is just 4% of USA’s and 20% of the world average. The per capita consumption is likely to grow in India with growth in economy thus increasing the energy demand. India’s energy intensity is 3.7 times of Japan’s, 1.55 times of USA’s, 1.47 times of Asia’s and 1.5 times of world average. High-energy intensity points towards energy wastages in the economy, which can be minimised through efficient use of energy. However, the structure of the economy also determines the energy intensity. Energy intensity is energy consumption per unit of GDP.

**Figure 2.6**

Consumption per capita in 2008 (tonnes of oil equivalent)

![Consumption per capita in 2008](image)

Source: BP Statistical Review 2009

**Long Term Energy Scenario**

India’s demand for petroleum products is likely to rise from 97.7 million metric tonnes in 2001-02 to around 139.95 million metric tonnes in 2006-07, according to projections of the Tenth Five-Year Plan. The plan document put compound annual growth rate (CAGR) at 3.6% during the plan period. Domestic crude oil production is likely to rise marginally from 32.03 million tonnes in 2001-02 to 33.97 million tonnes by the end of the 10th plan period (2006-07). India’s natural gas production, on the other hand, will rise from 86.56 million cubic metres per day (mcmd) in 2002-03 to 103.08 mcmd in 2006-07, mainly on the strength of a more
than doubling of production by private operators to 38.25 mcmpd, the plan document estimated. It further estimated that India would muster around 0.4% of the world's proven reserves of crude oil. As against this amount of reserves, domestic crude consumption is estimated to be 2.8% of the world's consumption. The balance of recoverable reserves, as estimated in the beginning of 2001, is placed at 733.70 mm tonnes of crude and 749.65 billion cubic metre of natural gas. India's oil balance is illustrated in Figure 2.7.

[Figure 2.7: India's oil balance]

Coal is the primary energy source for power production in India, generating approximately 70% of total domestic electricity. Energy demand in India is expected to soar over the next 10-15 years. Although new oil and gas plants are planned, coal is expected to remain the dominant fuel for power generation. Despite significant increases in total installed capacity during the last decade, the gap between electricity supply and demand continues to increase. The resulting shortfall has had a negative impact on industrial output and economic growth. Indian coal is of poor quality with high level of ash content. However, to meet expected future demand, indigenous coal production will need to be greatly expanded. Production currently stands at around 290 Million tonnes per year, but coal demand is expected to more than double by 2010. Coal imports will also need to increase dramatically to satisfy industrial and power generation requirements.
India currently has a peak demand shortage of around 14% and an energy deficit of 8.4%. Keeping this in view and to maintain a GDP growth of 8% to 10%, the Government of India has very prudently set a target of 215,804 MW power generation capacity by March 2012 from the level of 100,010 MW as on March 2001, that is a capacity addition of 115,794 MW in the next 11 years (Table 2.4). In the area of nuclear power the objective is to achieve 20,000 MWe of nuclear generation capacity by the year 2020.

Table 2.4
India’s perspective plan for power for zero deficit power by 2011/12

<table>
<thead>
<tr>
<th>Thermal - Coal (MW)</th>
<th>Gas/ LNG/ Diesel (MW)</th>
<th>Nuclear (MW)</th>
<th>Hydro (MW)</th>
<th>Total (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity as on March 2001 61,157</td>
<td>Gas: 10,153 Diesel: 864</td>
<td>2720</td>
<td>25,116</td>
<td>100,010</td>
</tr>
<tr>
<td>Additional capacity (2001-2012) 53,333</td>
<td>20,408</td>
<td>9380</td>
<td>32,673</td>
<td>115,794</td>
</tr>
<tr>
<td>Total capacity as on March 2012 114,490 (53.0%)</td>
<td>31,425 (14.6%)</td>
<td>12,100 (5.6%)</td>
<td>57,789 (26.8%)</td>
<td>215,804</td>
</tr>
</tbody>
</table>

Source: Government of India (2007), Tenth and Eleventh Five-Year Plan projections, Planning Commission, New Delhi

Energy vs. Development

Energy consumption has been considered directly proportional to the economic indicators like the Net State Domestic Product (NSDP). However, in a large country like India, where the Urban-Rural divide and the rich-poor divide still exist, in terms of their economic prosperity or purchasing power or life styles, the per-capita energy consumption does not strictly reflect their economic well-being and to a greater extent doesn’t have any correlation with the other human development indices (Table 2.5) as analysed in Table 2.6. While there is good correlation between per capita energy consumption and % of population covered by sewerage, as per the above table, for all other HDI parameters, the correlation is not very good. But conventional wisdom demands a good correlation with atleast the majority of HDIs, if not all. This argument (the poor correlation between per capita energy use and HDIs) tends to lead to the conclusion that energy (particularly in the developing world) is still treated as a market commodity, not really linked to the improvement of HDIs, if not treated entirely as a development tool, by the policy makers.
### Table 2.5
State-wise data on energy use per capita, NSDP & Human Development Indicators

<table>
<thead>
<tr>
<th>State</th>
<th>KW per capita (1998-99)</th>
<th>NSDP Per-capita (Rupees)</th>
<th>Literacy rates (%)</th>
<th>Life expectancy at birth (Male)</th>
<th>Life expectancy at birth (Female)</th>
<th>Infant mortality rates (per 1000 live births)</th>
<th>Birth rate (per 1000)</th>
<th>Death rate (per 1000)</th>
<th>per capita water supply (litres)</th>
<th>% population coverage by sewerage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A &amp; N Island</td>
<td>210</td>
<td>21017</td>
<td>81.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>332</td>
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### Table 2.6
Correlation between per capita energy consumption and NSDP and other HDIs

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<th>Remarks on the extent of correlation</th>
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<td>NSDP Per-capita (Rupees)</td>
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<td>Good</td>
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<tr>
<td>2</td>
<td>Literacy rates (%)</td>
<td>0.27</td>
<td>Poor</td>
</tr>
<tr>
<td>3</td>
<td>Life expectancy at birth (Male)</td>
<td>0.26</td>
<td>Poor</td>
</tr>
<tr>
<td>4</td>
<td>Life expectancy at birth (Female)</td>
<td>0.26</td>
<td>Poor</td>
</tr>
<tr>
<td>5</td>
<td>Infant mortality rates (per 1000 live births)</td>
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<td>Very Poor</td>
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<tr>
<td>6</td>
<td>Birth rate (per 1000)</td>
<td>-0.32</td>
<td>Medium, but negative</td>
</tr>
<tr>
<td>7</td>
<td>Death rate (per 1000)</td>
<td>-0.30</td>
<td>Medium, but negative</td>
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<td>8</td>
<td>per capita water supply (litres)</td>
<td>0.24</td>
<td>Poor</td>
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<tr>
<td>9</td>
<td>% population coverage by sewerage</td>
<td>0.70</td>
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Source: computed from table 2.5

25
Energy and Environment

The burning of energy resources in industry leads to environmental damage by polluting the atmosphere. Examples of air pollution are $\text{SO}_2$, $\text{NO}_x$ and $\text{CO}_2$ released from boilers and furnaces, CFC releases from refrigerants use, etc. In the case of chemical and fertilizers, toxic gases are released. Cement plants and power plants spew out particulate matter. Climate change, also called global warming, refers to the long-term fluctuations in temperature, precipitation, wind and other elements of the earth’s climate system. The energy use which attracts such huge attention now-a-days is more importantly due to the associated global climatic impacts. Increasing fossil fuel use has led to increasing carbon dioxide emissions leading to greenhouse effect and global warming. The heating up of the earth’s atmosphere due to trapping of long wavelength infrared rays (reflected from the earth’s surface) by the carbon dioxide layer in the atmosphere is called the greenhouse effect. The name greenhouse effect comes from the fact that this effect is used in horticulture for growing green plants in an enclosure made of glass or some other transparent material to act as a heat trap. Scientists generally believe that the combustion of fossil fuels and other human activities are the primary reason for the increased concentration of carbon dioxide. Plant respiration and the decomposition of organic matter release more than 10 times the $\text{CO}_2$ released by human activities; but these releases have generally been in balance during the centuries with carbon dioxide being absorbed by terrestrial vegetation and the oceans. Carbon dioxide, whose increase is largely produced by the burning of fossil fuels, is the primary global warming gas. CFCs, even though they exist in very small quantities, are significant contributors to global warming. And per fluorocarbons (PFCs), sulphur hexafluoride ($\text{SF}_6$) and hydro fluorocarbons (HFCs) are growing contributors.

Carbon dioxide, one of the most prevalent greenhouse gases in the atmosphere, has two major anthropogenic (human-caused) sources: the combustion of fossil fuels and changes in land use. Net releases of carbon dioxide from these two sources are believed to be contributing to the rapid rise in atmospheric concentrations since pre-industrial times. Because estimates indicate that approximately 80% of all anthropogenic carbon dioxide emissions currently come from fossil fuel combustion, world energy use has emerged at the center of the climate change debate. International accords began in Rio de Janeiro in 1992 (Rio
Earth Summit), wherein developed nations were asked to reduce GHG emission to 1990 levels by the year 2000. New levels of commitment were taken in the third Conference of Parties (COP) on The Framework Convention on Climate Change, held at Kyoto in 1997 (Kyoto Protocol), which made GHG reductions mandatory for 38 developed nations with average reduction of 5.2% below 1990 levels by 2012. The emergence of the Clean Development Mechanism (CDM) as a framework for the involvement of industrialized countries in the developing world may lead to financing opportunities for energy efficiency projects. The Kyoto protocol came into force on February 16, 2005.

**Energy Pricing**

The price of energy rarely reflects true cost to society and consumers are not fully informed. The basic assumption underlying efficiency of market place does not hold in our economy, since energy prices are undervalued and energy efficiency is undervalued and wastage is not discouraged. Pricing practices in India, as in many other developing countries, are influenced by political, social and economic compulsions at the state and central level. More often than not, this has been the foundation for energy sector policies in India. The Indian energy sector offers many examples of cross subsidies e.g., LPG and kerosene being subsidised by petrol, petroleum products for industrial usage and industrial and commercial consumers of electricity subsidising the agricultural and domestic consumers. As part of the energy sector reforms, the government has attempted to bring prices for many of the petroleum products (naphtha, furnace oil, LSHS, LDO and bitumen) in line with international prices. The most important achievement has been the linking of diesel prices to international prices and elimination of subsidy. However, LPG and kerosene, consumed mainly by domestic sector, continue to be heavily subsidised. Subsidies and cross-subsidies have resulted in serious distortions in prices, as they do not reflect economic costs at all in many cases. Grade wise basic price of coal at the pithead excluding statutory levies for run-of-mine (ROM) are fixed by Coal India Ltd from time to time. The pithead price of coal in India compares favourably with the price of imported coal. In spite of this, industries still import coal due its higher calorific value and low ash content. The government has been the sole authority for fixing the price of natural gas in the country. It has also been taking decisions on the allocation of gas to various competing consumers.
Electricity tariffs in India are structured in a relatively simple manner. While high tension consumers are charged based on both demand (kVA) and energy (kWh), the low-tension (LT) consumer pays only for the energy consumed (kWh) as per the tariff system in most of the electricity boards or utilities. The price per kWh varies significantly across states as well as customer segments within a state. Tariffs in India have been modified to consider the time of usage and voltage level of supply. In addition to the base tariffs, some of the State Electricity Boards have additional recovery from customers in the form of fuel surcharges and electricity duties. For example, for an industrial consumer the demand charges may vary from Rs. 150/kVA to Rs. 300/kVA whereas the energy charges may vary anywhere between Rs. 3/- to Rs. 5/-. As for the tariff adjustment mechanism, even when some of the states have regulatory commissions for tariff review, the decisions to effect changes are still political and there is no automatic adjustment mechanism, which can ensure recovery of costs for the electricity boards.

Energy Sector Reforms

Since the initiation of economic reforms in India in 1991 there has been a growing acceptance of the need for deepening these reforms in several sectors of the economy, which were essentially in the hands of the government for several decades. It is also now realized that if substance has to be provided to macroeconomic policy reform then it must be based on reforms that concern the functioning of several critical sectors of the economy, among which the infrastructure sectors in general and the energy sector in particular are paramount. The government has recognized the need for new coal policy initiatives and for rationalization of the legal and regulatory framework that would govern the future development of this industry. One of the key reforms is that the government has allowed importing of coal to meet our requirements. The private sector can now participate in the extraction and marketing of coal. The ultimate objective of some of the ongoing measures and others under consideration is to see that a competitive environment is created for the functioning of various entities in this industry. This will not only bring about gains in efficiency but also effect cost reduction, which will consequently ensure supply of coal on a larger scale at lower prices. Competition will also have the desirable effect of bringing in new technology, for which there is an urgent and overdue need since the coal industry has suffered a prolonged period of stagnation in technological innovation.
Since 1993, private investors have been allowed to import and market LPG and kerosene freely; private investment is also allowed in lubricants, which are not subject to price controls. Prices for naphtha and some other fuels have been liberalized. In 1997 the government introduced the New Exploration Licensing Policy (NELP) in an effort to promote investment in the exploration and production of domestic oil and gas. In addition, the refining sector has been opened to private and foreign investors in order to reduce imports of refined products, and investment in downstream pipelines is being encouraged. Attractive terms are being offered to investors for the construction of LNG import terminals.

Following the enactment of the Electricity Regulatory Commission Legislation, the Central Electricity Regulatory Commission (CERC) was set up, with the main objective of regulating the Central power generation utilities. State level regulatory bodies have also been set up to set tariffs and promote competition. Private investments in power generation were allowed. The SEBs were asked to switch over to separate Generation, Transmission and Distribution corporations. While India currently does not have a unified national power grid, the country plans to link the SEB grids eventually, and has set up a state company, Powergrid, to oversee the unification. The government has enacted Electricity Act, 2003 which seeks to bring about a qualitative transformation of the electricity sector through a new paradigm. The Act seeks to create a liberal framework of development for the power sector by distancing Government from regulation. It replaces the three existing legislations, namely, Indian Electricity Act, 1910, the Electricity (Supply) Act, 1948 and the Electricity Regulatory Commissions Act, 1998. The objectives of the Act are “to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity and generally for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalization of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority, Regulatory Commissions and establishment of Appellate Tribunal and for matters connected therewith or incidental thereto.” The Act strikes a balance, which takes into account the complex ground realities of the power sector in India with its intractable problems.
All the states except Nagaland and Arunachal Pradesh have either constituted or notified SERCs (State Electricity Regulatory Commissions). A joint electricity regulatory commission was constituted for Manipur and Mizoram in January 2005 (MoP 2008). Fourteen states have unbundled their SEBs (state electricity boards). These are Andhra Pradesh, Assam, Delhi, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tripura, Uttar Pradesh, Uttarakhand, and West Bengal (MoP 2008), while eight states, that is, Bihar, Chhattisgarh, Himachal Pradesh, Jharkhand, Kerala, Meghalaya, Punjab, and Tamil Nadu, are in the process of formulating schemes for the reorganization and unbundling of their SEBs. However, the restructuring and reorganizing of power utilities in the above eight states are still pending. The MoP launched the Accelerated Power Development, and Reforms Programme, or APDRP, in 2002/03. The APDRP had two components, namely, investment-based and incentive-based assistance, wherein, under the investment component, the central government provided assistance in the form of grants to the tune of 25% of the project cost to general category states and grants worth 90% of the project cost to special category states, and, under the incentive component, the government gave incentives in the form of fund releases to states that achieve reduction in cash losses of SEBs.

Energy Security

The energy security of a nation is to reduce its dependency on imported energy sources for its economic growth. India will continue to experience an energy supply shortfall throughout the forecast period. This gap has been exacerbated since 1985, when the country became a net importer of coal. India has been unable to raise its oil production substantially in the 1990s. Rising oil demand of close to 10% per year has led to sizable oil import bills. In addition, the government subsidizes refined oil product prices, thus compounding the overall monetary loss to the government. India’s rapidly growing economy will drive energy demand growth at a projected annual rate of 4.6% through 2010. This is the highest incremental energy demand rate of any major country. Imports of oil and coal have been increasing at rates of 7% and 16% per annum, respectively, during the period 1991-99. This dependence on energy imports is projected to increase in the future. Estimates indicate that oil imports will meet 75% of total oil consumption requirements and coal imports will meet 22% of total coal consumption requirements in 2006. At present, India does not import any natural gas but demand is supply constrained and
imports of gas and LNG are likely to arise in the conning years. This energy import dependence implies vulnerability to external price shocks and supply fluctuations, which threaten the energy security of the country.

Increasing dependence on oil imports means dependence on imports from the Middle East, a region susceptible to disturbances and consequent disruptions of oil supplies. This calls for diversification of sources of oil imports. The need to deal with oil price fluctuations also necessitates measures to be taken to reduce the oil dependence of the economy, possibly through fiscal measures to reduce demand and by developing alternatives to oil, such as natural gas and renewable energy. Some of the strategies that can be adopted by India to meet future challenges to energy security are building stockpiles (including joint stockpiles), diversification of energy supply sources, increased capacity of fuel switching, demand restraint, and development of renewable energy sources. However, though all these options are feasible, their implementation will take time. Also, for countries like India, reliance on stock-building will tend to be slow because of resource constraints. Nor is the market sophisticated enough or the monitoring agencies experienced enough to predict the supply situation in time to take necessary action. Insufficient storage capacity is another cause for worry and needs to be augmented if India has to increase its energy stock-build. But of all these options the simplest and easily attainable is by reducing demand through persistent energy conservation efforts. Increasing pressure of population and increasing use of energy in agriculture, industry and the domestic and public sectors is an area of concern. At the same time, the need to meet energy demand has created huge capital requirements needed for setting up power plants, pipelines, ports, terminals, railway tracks to move fuel etc. As India continues to grow at the rate of 7% to 8%, energy security has become a core focus. To alleviate concerns over energy security, the Government of India has taken multiple steps in recent years which include encouraging private sector participation, a more holistic approach towards broad basing its supply base, and improving efficiency in the sector as a whole.

**Energy Conservation and its Importance**

Coal and other fossil fuels, which have taken three million years to form are likely to deplete soon. In the last two hundred years, we have consumed 60% of all resources. For sustainable development, we need to adopt energy efficiency
measures. Today, 85% of raw energy comes from non-renewable, fossil sources (coal, oil, etc.). The reserves are continually diminishing and will not exist for future generations. Energy conservation and energy efficiency are separate but related concepts. Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress. On the other hand energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore regularly an integral part of energy conservation promotional policies.

Energy efficiency is often viewed as a resource option like coal, oil or natural gas. It provides additional economic value by preserving the resource base and reducing pollution. For example, replacing traditional light bulbs with Compact Fluorescent Lamps (CFLs) means consuming only 1/5th of the energy to light a room. Pollution levels also decrease by the same amount. Nature sets some basic limits on how efficiently energy can be used, but in most cases our products and manufacturing processes are still a long way from operating at this theoretical limit. Very simply, energy efficiency means using less energy to perform the same function. Though energy efficiency has been in practice ever since the first oil crisis in 1973, it has today assumed even more importance because of being the most cost-effective and reliable means of mitigating the global climatic change. Recognition of that potential has led to high expectations for the control of future CO$_2$ emissions through even more energy efficiency improvements than have occurred in the past. The industrial sector accounts for some 41% of global primary energy demand and approximately the same share of CO$_2$ emissions.

In order to institutionalize energy conservation efforts in the country, the Energy Conservation Act was passed in 2001, which established the BEE which launched a number of initiatives (BEE, 2007), including the launch of the ECBC (Energy Conservation Building Code) for large and new commercial buildings; the launch of energy labelling scheme for appliances; the initiation of a process for the development of energy consumption norms for industrial subsectors; and an annual examination to certify energy auditors and energy managers (MoP 2008). The BEE
developed an Action Plan for Energy Efficiency in the power sector. Various schemes launched by the BEE under the action plan are as follows.

- The BLY (Bachat Lamp Yojana) scheme was launched as a step towards energy conservation, on 28 May 2007. It aims at replacing about 400 million incandescent bulbs in use in the country with energy-efficient CFLs (compact fluorescent lamps). The scheme will provide high-quality CFLs to domestic consumers for about Rs 15 per lamp, that is, at a rate comparable to that of incandescent bulbs. This would lead to a possible reduction of 6000-10,000 MW of electricity demand, along with a reduction of about 24 million tonnes of CO₂ emissions every year. Total expenditure under the scheme approved during the Eleventh Plan is Rs 480 million.

- The standards and labelling scheme was launched in May 2006 with the basic objective to help consumers in making informed decisions about energy saving and, thereby, the cost saving potential of the marketed household and other equipment. Initially, the labelling scheme was applicable to frost-free refrigerator and TFL (tubular fluorescent lamps), but gradually it has been expanded to include air conditioners and distribution transformers on a voluntary basis. Thus, air conditioners (70%), tube lights (90%), and refrigerators (70%) have been added to the scheme. The scheme, with an expenditure of Rs 477.5 million, has been approved in the Eleventh Plan period. It targets an avoided capacity of 3000 MW during the Plan period.

- The ECBC was launched in May 2007. It sets minimum energy performance standards for commercial buildings. The Code has been prepared pursuant to Section 14 (p) of the Energy Conservation Act, 2001, which empowers the central government to recommend the ECBC for commercial buildings and building complexes for efficient use and conservation of energy. State governments have the flexibility to amend the ECBC to suit local or regional needs.

- Other measures include promoting DSM (Demand Side Management) in agriculture and municipal areas and energy efficiency measures in small and medium enterprises; contributing to State Energy Conservation Fund Scheme; and strengthening capabilities of SDAs (State Designated Agencies) and the BEE for promoting energy efficiency.
Another objective is to revise obsolete policies that are in conflict with the Energy Conservation Act because they reward energy inefficiency. Dialogues with other national entities, in particular power tariff-setting authorities, planning commissions and ministries in charge of energy-intensive industries, are part of an overall strategy to further improve the impact of the Energy Conservation Act and avoid future conflicts among diverging policies of different ministries. Policy changes in the energy field are never neutral, but may have negative as well as positive consequences of national importance which need to be weighted against each other.

An Internet-based reporting and analysis system to assess the positive and negative impacts of energy conservation measures implemented by industry as mandated by the Energy Conservation Act is under testing. Transparent monitoring is particularly important in the world’s largest democracy where ministries are responsible to parliamentary committees for their actions and where the general public commonly believe that the Government is already interfering too much in their private business and look at any new law with a deep sense of mistrust. One objective of this Web-based analysis system is to prove to the public and to legislators that the Energy Conservation Act is a law that forces affected energy consumers to make more profit.

Setting standards and codes for energy consumption in energy-intensive sectors, for energy-intensive industrial equipment and for energy-intensive household appliances is another ongoing task that will take several years to complete. This may seem long at first sight, but only extensive public consultations will assure public acceptance and the durability of the results. Setting energy consumption performance norms for industry, and in particular for the power industry, is a highly complex and conflict prone process. Initial trials have started to colour-code firms and assign bar labels to individual firms with respect to their manufacturing set-up and technology, taking into account other salient features to judge their performance. Giving public support to the few “gold” standard firms while the majority of firms remain in the silver, bronze and tin brackets will only increase the performance bandwidth. Instead, using public support to promote chameleon-like changes from bronze to gold is the better strategy to widen the market for energy efficiency measures and services.
A detailed annual survey of firms conducted by the Ministry of Power to identify and evaluate the benefits and impacts shows that at least 200 firms invested over US $200 million in energy efficiency measures with first year savings of US $140 million and fast payback periods below two years. Energy efficiency measures are excellent business for those who recognise it. Figure 2.8 illustrates the potential opportunity for energy savings by sector.

Figure 2.8
Potential opportunity for energy savings in India
- by sector (2001) - billion kWh and %

Agriculture, 60, 33%
Lighting, 70, 38%
Municipal, 3.7, 2%
Commercial, 0.8, 0%
Industrial, 49, 27%

Source: World Resource Institute, USA

The new national Energy Conservation Act requires detailed rules and regulations to support notifications and directives. Over 30 rules and regulations are presently being framed, publicly discussed and revised by stakeholders, the Ministry of Power and the Ministry of Law. Ultimately, they will form a complex mechanism to increase the present investment level in energy efficiency measures from an estimated US $250 million to at least US $1 billion per year. The Government of India is planning to evolve a mechanism for renewable energy certificate. This mechanism will designate ‘green power’ as a tradeable commodity and will provide a platform for carrying out trading between renewable energy surplus and deficit states. This initiative will supplement RPO commitment of the states. It will also facilitate inter-state trading in renewable power, which is otherwise difficult due to unscheduling, grid interchange, intermittent supply, and so on. It will encourage uniform growth in renewable resources across India.
Energy and industrial development

The interdependence between energy and industrial growth is crucial in formulating policies for sustainable development. Industry is a major market for energy, and the pricing and the availability of energy closely affect industrial growth. Conservation of energy is possible through short-term measures in the industrial sector, but major changes in the structure and mode of transportation also become necessary if significant gains are to be made. The major technical measures for energy conservation in industry include the recovery of heat from exhaust gases, the introduction of integrated energy systems, the recycling and re-use of materials, and automatic control, as well as the search for more advanced equipment and processes. Energy conservation in industry has led to improvements in overall energy efficiency in many countries over the last 15 years. In the United States, for instance, industrial energy use declined by 17% between 1973 and 1986. This occurred in spite of a 17% increase in industrial production during the same period. Structural changes and the replacement of open-hearth furnaces by more efficient basic oxygen furnaces has cut energy needs by half in the steel industries of most industrialized nations. Seen globally, these gains from decreased energy and materials intensity in the industrialized world may well be offset by the growing industrialization in developing countries. It is therefore imperative that the frontiers of technology shift along with the movement of many energy-intensive operations in the developing countries.

Energy use in Indian industry

An examination of trends in energy use in India may typify the trends in "industrial metabolism" in developing countries. When looking at structural change in industry, India differs markedly from countries like Austria, Belgium, Denmark, France, Germany, Finland, Norway, Sweden, the United Kingdom and Japan. In these countries, economic growth after 1970 has, in absolute or relative terms, been progressively delinked from the use of natural resources. This process of delinking has been associated with:

- a decrease in resource depletion and environmental pollution;
- the use of ex ante environmental protection measures; and
- the adoption of less polluting (cleaner) technologies in industry.
Structural change in India was different: The growing consumption of primary energy has led to an increase in pollution. The increase in the production of steel and cement also represents an increase in pollution. The increase in the weight of freight transport indicates that material demands have increased.

The growth in factors with negative environmental effects in India occurred faster than the growth in GNP. This trend is without doubt contrary to recent experience in the more highly industrialized countries. In India, the annual average growth rate for energy production has exceeded 7.5% since 1983, increasing to about 10% in 1985. Gross domestic consumption has grown at a fluctuating rate, varying from 6% to 6.5%. The higher growth rate of energy production suggests structural changes, with a build-up in energy-intensive sectors. This is a process which could continue into the next century, as per capita energy consumption in general is still rather low (9.8 TJ in 1989). For the Indian economy as a whole, energy demand has increased because of the increasing energy-intensity of production in both agriculture and industry. The industrial sector in India witnessed a moderate slowdown in 2007/08. It registered an overall growth rate of 9.2% in GDP during 2007/08 (April-November) (at a factor cost of constant 1993/94 prices), as against the growth rate of 11.6% in 2006/07. The decrease in the growth rate during this period is attributed to the slowdown in the manufacturing sector.

The industrial sector in India is the major consumer of energy, accounting for about 44.8% of total commercial energy consumption during 2005/06 (102.94 million tonnes of oil equivalent), with coal and lignite meeting 58.6% of total commercial energy consumption. The energy intensity (energy use per unit GDP) of India’s industrial output (6416 kcal [kilocalories]/dollar) is more than three times that of the US (2400 kcal/dollar) and four times that of the UK (1574 kcal/dollar) but appreciably less than that of China (8360 kcal/dollar) (Rao, 2006). The high energy intensity in the Indian industry may be attributed partly to investments made in basic and energy intensive industries, with emphasis on developmental plans and achieving self-reliance.

Studies conducted by a number of agencies in different energy-intensive sectors indicate significant energy saving potential, up to 25%. The Interministerial Working Group on Energy has calculated that with the installation of new equipment the savings from coal-based, oil-based, and electric power-generation machines are approximately 20%, 20%, and 15%, respectively. For identifying these energy
conservation potentials and implementing various energy conservation measures, the BEE has brought a number of energy-intensive sectors under the Energy Conservation Act, 2001 as designated consumers. These include iron and steel, cement, aluminium, fertilizer, pulp and paper, textile, and chlor-alkali. In producing about a fifth of India's GDP, the manufacturing sector consumes about half the commercial energy available in the country. Five major energy-intensive industries - aluminium, iron and steel, cement, pulp and paper, and ammonia - account for over 60% of the energy consumed within this sector. While absolute use in these industries grew at 4.1% per annum between 1990 and 2005, the specific energy consumption decreased significantly (Table 2.7).

Table 2.7

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron and Steel</td>
<td>41.9</td>
<td>37.6</td>
<td>33.3</td>
<td>29.1</td>
<td>-2.41%</td>
</tr>
<tr>
<td>Cement</td>
<td>3.6</td>
<td>3.4</td>
<td>3.3</td>
<td>3.1</td>
<td>-1.10%</td>
</tr>
<tr>
<td>Ammonia</td>
<td>55.3</td>
<td>60.4</td>
<td>51.9</td>
<td>42.9</td>
<td>-1.67%</td>
</tr>
<tr>
<td>Aluminium</td>
<td>399.0</td>
<td>393.8</td>
<td>380.5</td>
<td>364.9</td>
<td>-0.59%</td>
</tr>
<tr>
<td>Pulp and Paper</td>
<td>35.0</td>
<td>31.3</td>
<td>27.6</td>
<td>24.0</td>
<td>-2.48%</td>
</tr>
</tbody>
</table>

Source: Lawrence Berkeley National Laboratory (2009), USA

Role of industries in Indian economy with special reference to small scale sector

Industrialisation has a major role to play in economic development. The gap in per capita incomes between developed and developing countries is largely reflected in the disparity in the structure of their economies: the former are largely industrial and services economies. Table 2.8 clearly reveals this positive relationship.

Table 2.8

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>U.S.A*</td>
<td>34,260</td>
<td>2</td>
<td>26</td>
<td>72</td>
</tr>
<tr>
<td>Belgium</td>
<td>24,630</td>
<td>1</td>
<td>25</td>
<td>73</td>
</tr>
<tr>
<td>U.K*</td>
<td>24,500</td>
<td>1</td>
<td>25</td>
<td>74</td>
</tr>
<tr>
<td>Japan</td>
<td>34,210</td>
<td>2</td>
<td>36</td>
<td>62</td>
</tr>
<tr>
<td>China</td>
<td>840</td>
<td>16</td>
<td>49</td>
<td>34</td>
</tr>
<tr>
<td>India</td>
<td>460</td>
<td>27</td>
<td>27</td>
<td>46</td>
</tr>
</tbody>
</table>

*Figures for GDP distribution are for 1985
The progress of industrialization during the last 50 years since 1951 has been a striking feature of Indian economic development. The process of industrialization launched as a conscious and deliberate policy under the Industrial Policy Resolution of 1956 and vigorously implemented under the five year plans, involved heavy investments in building up capacity over a wide spectrum of industries. Industrial growth, however, has not been uniform since 1951. After a steady growth rate of about 8% during the initial period of 14 years (1951 to 1965), there was a fluctuating trend since then — near stagnancy during 1966-68, a high level of 9.5% during 1976-77, a minus 1.4% in 1979-80 (Ruddar Datt, 2009). During the seventh plan (1985-90), the growth rate picked up to an average of over 8% per annum and in the eighth plan, it declined to 7.3% per annum. During the ninth plan, the growth slumped to 4.6% per annum, but during the tenth plan (period from 2002 to 2008), it picked up significantly to 8.9% per annum.

SSI and the Indian Industrial Policy

To build the nation’s economy following the socialist path of development, an overwhelming importance was attached to the public sector units, which the first Prime Minister of India called “Modern Temples of India”. The Industrial Policy Resolution of 1948, which marked the evolution of Indian Industrial Policy, outlined the broad contours of the policy and defined the role of the state in industrial development both as an entrepreneur and a regulatory authority. In order to optimize the utilization of scarce resources and reduce the threat of re-colonization by the multinationals, centralized planning was adopted with wide ranging controls on private trade, investment, land ownership and foreign exchange. The foundations of the policy for the small scale industry were laid in the Second Five Year Plan. In 1956, the government announced its second industrial policy which unambiguously chose equity as the guiding principle for small industry development. The operative statement says: “small scale industries provide immediate large scale employment, offer a method of ensuing a more equitable distribution of national income and facilitate an effective mobilization of resources of capital and skill which might otherwise remain unutilised”.

A high watermark in the evolution of the policy for small industry was the ‘Industrial Policy Statement’ of 1977. It was then that the protection of small industry touched its acme; the guarded initiatives of earlier years were cast aside by
a heightened zeal for an expanded role for this sector, in particular, the reservation of products for exclusive manufacturing by the small industry, begun in 1967, was greatly extended to many more products. The important planks of the 1977 industrial policy statement were:

- Whatever can be produced by small, cottage industries must only be so produced;
- The number of products reserved for SSI was increased from 180 to 504 and further to 836 items in 1996;
- Special attention to be given to the 'Tiny Sector' defined as enterprises with investment in plant and machinery of upto Rs. 1 lakh and situated in towns and in villages with population less than 50,000;
- Special Legislation will be introduced to give due recognition and adequate protection to the self-employed in cottage and household industries;
- The focal point of development for small sector and cottage industries will be taken away from big cities and state capitals to the district headquarters. In each district, there will be one agency to deal with all requirements of small and village industries. This will be called “District Industries Center”;
- Special arrangements for marketing of the products of Small Scale Sector will be made by providing services such as product standardization, quality control, marketing surveys, etc.

The recognition of the importance of ancillary industry found expression in the policy statement of 1980 which laid emphasis on ancillaries. Moreover, the program for the development of rural and backward areas was accelerated. The Industrial Policy Statement of 1985 made incremental changes and took into account the impact of inflation. The investment ceiling for SSI was raised to Rs. 35 lakh and for ancillaries to Rs. 45 lakh.

The Industrial Policy of July 1991 marks a conscious shift from the regulated and controlled policy to a liberal one. Most of the medium and large industrial units, with a few exceptions, would no longer need licenses. Full foreign ownership will henceforth be possible in export-oriented enterprises. Import of capital goods has been significantly made free from restrictions. Foreign equity participation is also encouraged. With the lifting of several trade and investment related restrictions, India is witnessing a mini-revolution in its economic growth faced with the challenges of global market and competitiveness. The Government
established the Ministry of Small Scale Industries and Agro and Rural Industries (SSI & ARI) in October, 1999 as the nodal Ministry for formulation of policies and Central sector programmes/schemes, their implementation and related co-ordination, to supplement the efforts of the States for promotion and development of these industries in India. The Ministry of SSI & ARI was bifurcated into two separate Ministries, namely, Ministry of Small Scale Industries and Ministry of Agro and Rural Industries in September, 2001.

The role of the Ministry of Small Scale Industries is to mainly assist the States in their efforts to promote growth and development of the SSI, enhance their competitiveness in an increasingly market-led economy and generate additional employment opportunities. In addition, the Ministry attempts to address issues of country-wide common concern of this segment and also undertake advocacy on behalf of the SSI for this purpose. With effect from October 2, 2006, a comprehensive act called the Micro, Small and Medium Enterprises Act 2006 came into force. Micro will cover all enterprises with investment in plant and machinery of less than Rs 25 lakhs; Small enterprises with investment between Rs 25 lakhs and Rs 5 crores and medium enterprises with investment between Rs 5 crores and Rs 10 crores. The small scale industries sector plays a vital role in the growth of the country (Planning Commission, 2001). It contributes almost 40% of the gross industrial value added in the Indian economy. It has been estimated that a million rupees of investment in fixed assets in the small scale sector produces 4.62 million worth of goods or services with an approximate value addition of ten percentage points. The small scale sector has grown rapidly over the years. The growth rates during the various plan periods have been very impressive. The number of small-scale units has increased from an estimated 0.87 million units in the year 1980-81 to over 3 million in the year 2000. When the performance of this sector is viewed against the growth in the manufacturing and the industry sector as a whole, it instills confidence in the resilience of the small scale sector.

The SSI sector in India creates the largest employment opportunities for the Indian populace, next only to Agriculture. It has been estimated that Rs 1,00,000 of investment in fixed assets in the small scale sector generates employment for four persons. Food products industry ranked first in generating employment, providing employment to 0.48 million persons (13.1%). The next two industry groups were Non-metallic mineral products with employment of 0.45 million persons (12.2%) and
Metal products with 0.37 million persons (10.2%). In Chemicals and chemical products, Machinery parts except Electrical parts, Wood products, Basic Metal Industries, Paper products and printing, Hosiery and garments, Repair services and Rubber and plastic products, the contribution ranged from 9% to 5%, the total contribution by these eight industry groups being 49%. In all other industries the contribution was less than 5%.

Per unit employment was the highest (20) in units engaged in beverages, tobacco and tobacco products mainly due to the high employment potential of this industry, particularly in Maharashtra, Andhra Pradesh, Rajasthan, Assam and Tamil Nadu. Next came Cotton textile products (17), Non-metallic mineral products (14.1), Basic metal industries (13.6) and Electrical machinery and parts (11.2.) The lowest figure of 2.4 was in Repair services line. Per unit employment was the highest (10) in metropolitan areas and lowest (5) in rural areas. However, in Chemicals and chemical products, Non-metallic mineral products and Basic metal industries per unit employment was higher in rural areas as compared to metropolitan areas/urban areas. In urban areas highest employment per unit was in Beverages, tobacco products (31 persons) followed by Cotton textile products (18), Basic metal industries (13) and Non-metallic mineral products (12).

Non-metallic products contributed 22.7% to employment generated in rural areas. Food Products accounted for 21.1%, Wood Products and Chemicals and chemical products shared between them 17.5%. As for urban areas, Food Products and Metal Products almost equally shared 22.8% of employment. Machinery parts except electrical, Non-metallic mineral products, and Chemicals and chemical products between them accounted for 26.2% of employment. In metropolitan areas the leading industries were Metal products, Machinery and parts except electrical and Paper products and printing (total share being 33.6%). Tamil Nadu (14.5%) made the maximum contribution to employment. This was followed by Maharashtra (9.7%), Uttar Pradesh (9.5%) and West Bengal (8.5%) the total share being 27.7%. Gujarat (7.6%), Andhra Pradesh (7.5%), Karnataka (6.7%) and Punjab (5.6%) together accounted for another 27.4%. Per unit employment was high - 17, 16 and 14 respectively - in Nagaland, Sikkim and Dadra and Nagar Haveli. It was 12 in Maharashtra, Tripura and Delhi. Madhya Pradesh had the lowest figure of 2. In all other cases it was around the average of 6.
The SSI sector plays a major role in India’s present export performance. 45%-50% of the Indian Exports is contributed by the SSI Sector. Direct exports from the SSI sector account for nearly 35% of total exports. Besides direct exports, it is estimated that small scale industrial units contribute around 15% to exports indirectly. This takes place through merchant exporters, trading houses and export houses. They may also be in the form of export orders from large units or the production of parts and components for use for finished exportable goods. It would surprise many to know that non-traditional products account for more than 95% of the SSI exports. The exports from the SSI sector have been clocking excellent growth rates in this decade. It has been mostly fuelled by the performance of garments, leather and gems and jewellery units from this sector. The product groups where the SSI sector dominates in exports are sports goods, readymade garments, woollen garments and knitwear, plastic products, processed food and leather products. The SSI sector is reorienting its export strategy towards the new trade regime being ushered in by the WTO.

An evaluation study has been done by M/s A.C. Nielsen on behalf of the Ministry of SSI. As per the findings and recommendations of the said study the major export markets identified having potential to enhance SSIs exports are US, EU and Japan. The potential items of SSIs have been categorised into three broad categories. The Export Destinations of SSI products have been identified for 16 product groups. The opportunities in the small scale sector are enormous due to the following factors:

- Less Capital Intensive;
- Extensive Promotion and Support by Government;
- Reservation for Exclusive Manufacture by small scale sector;
- Project Profiles;
- Funding - Finance and Subsidies;
- Machinery Procurement;
- Raw Material Procurement;
- Manpower Training;
- Technical and Managerial skills;
- Tooling and Testing support;
- Reservation for Exclusive Purchase by Government;
- Export Promotion;
• Growth in demand in the domestic market size due to overall economic growth;
• Increasing Export Potential for Indian products; and
• Growth in Requirements for ancillary units due to the increase in number of greenfield units coming up in the large scale sector.

The small industry sector has performed exceedingly well and enabled our country to achieve a wide measure of industrial growth and diversification. By its less capital intensive and high labour absorption nature, the SSI sector has made significant contributions to employment generation and also to rural industrialisation. This sector is ideally suited to build on the strengths of our traditional skills and knowledge, by infusion of technologies, capital and innovative marketing practices. This is the opportune time to set up projects in the small-scale sector. It may be said that the outlook is positive, indeed promising, given some safeguards. This expectation is based on an essential feature of the Indian industry and the demand structures. The diversity in production systems and demand structures will ensure long term co-existence of many layers of demand for consumer products / technologies / processes. There will be flourishing and well grounded markets for the same product/process, differentiated by quality, value added and sophistication. This characteristic of the Indian economy will allow complementary existence for various diverse types of units. The promotional and protective policies of the Govt, have ensured the presence of this sector in an astonishing range of products, particularly in consumer goods. However, the bugbear / worry of the sector has been the inadequacies in capital, technology and marketing. The process of liberalisation coupled with government support will, therefore, attract the infusion of just these things in the sector.

SME Promotional Framework

The central and state governments in India have together set up an elaborate 3 tier structure for promoting the small scale sector. At national level, in pursuance of the recommendations of International Perspective Planning team (1953-54), several institutions have been set up. There is ‘Central Small Industries Organization’ (CSIO) which has been renamed as ‘Small Industries Development Organization’ (SIDO). During the last three and a half decades, this institution has
emerged as the core promotional agency at the central level with a professional staff of more than 13,000 in the year 1993. It consists of 28 Small Industries Service Institutes (SISIs), 30 branch SISIs, 37 extension centers in specific products and 74 workshops as in the year 1993. However subsequently, some of these have been wound up due to their financial non-sustainability. These institutions provide technical and management consultancy, organize training programs, conduct techno-economic surveys, prepare project profiles and help prepare unit specific project reports. Besides, there are four regional testing laboratories with state of the art equipment and 19 field testing stations which are meant to promote awareness on quality control and standardization, provide testing facilities, provide pre-shipment inspection as required by the 'Export Promotion Councils' and organize related training programs. In addition, there are two 'Prototype Development and Training Centers' (PDTC) to develop new technologies and upgrade the existing ones. There are a number of other technical institutions that are working closely with SIDO, which are more specialized in the fields of Tool designing, Electronics and Measuring instruments, Prototype development and Hand tools etc. Four ‘Central Tool Rooms’ in Delhi, Calcutta, Bangalore and Ludhiana, have been set up under bilateral assistance programs.

**Table 2.9**  
Industrial Administrative Set-up in India

<table>
<thead>
<tr>
<th>Industry</th>
<th>Agency</th>
<th>Administrative Department/ Ministry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large/ Medium Industries</td>
<td>Dept of Industrial Policy and Promotion and Dept, of Industrial Development, Ministry of Industry</td>
<td></td>
</tr>
<tr>
<td>Small Scale Industries</td>
<td>Small Industries Development Organisation</td>
<td>Dept, of Small Scale, Agro &amp; Rural Industries, Ministry of Industry</td>
</tr>
<tr>
<td>Powerlooms</td>
<td>Textile Commissioner</td>
<td>Ministry of Textiles</td>
</tr>
<tr>
<td><strong>Traditional Industries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Khadi and Village Industries (KVI)</td>
<td>Khadi and Village Industries Commission</td>
<td>Dept, of Small Scale, Agro &amp; Rural Industries, Ministry of Industry</td>
</tr>
<tr>
<td>Handlooms</td>
<td>Development Commissioner (Handlooms)</td>
<td>Ministry of Textiles</td>
</tr>
<tr>
<td>Sericulture</td>
<td>Central Silk Board</td>
<td>Ministry of Textiles</td>
</tr>
<tr>
<td>Handicrafts</td>
<td>Development Commissioner (Handicrafts)</td>
<td>Ministry of Textiles</td>
</tr>
<tr>
<td>Coir Fibre</td>
<td>Coir Board</td>
<td>Dept, of Small Scale, Agro &amp; Rural Industries, Ministry of Industry</td>
</tr>
</tbody>
</table>

Source: Compiled from different sources
In practice, the small scale industry sector serves as a residuary sector in the sense that all units that fall within a prescribed investment limit and are not recognized in a particular sub sector are included in the small scale industries sector. 'National Small Industries Corporation' (NSIC) is another important institution set up in 1955 that supplies primarily imported machinery on easy finance terms, provides marketing assistance, operates 'Prototype Development and Training Centers' (PDTC) in specific fields such as machine tools, injection molding, leather manufacturing equipment etc. NISIET (now called National Institute of Entrepreneurship and Business Development i.e. NIESBUD) was set up to train and promote personnel, industrial managers and entrepreneurs. Other national level institutions that are supporting the small scale sector are 'National Research Development Corporation' (NRDC), 'Bureau of Indian Standards' (BIS), 'National Productivity Council' (NPC), 'Consultancy Development Center' (CDC) and 'Electronics Test and Design Centers' (ETDC). The central financial institutions have also set up the Entrepreneurship Development Institute of India (EDII) at the national level to promote entrepreneurship. All these institutions are largely meant for the modern small scale industry. In order to promote khadi and village industries, a separate high level commission has been set up under the Ministry of Industry. Similarly for the handlooms, handicrafts, sericulture and other non-modern small units there are separate divisions to promote them.

At the state level, the governments have set up institutions like Small Industry Development Corporations (SIDCs) to develop infrastructure in the form of industrial plots and industrial sheds; State Financial Corporations (SFCs) to provide long term credit facilities; State Exports Promotion Corporations to provide marketing assistance for exports from the small scale sector; Technical Consultancy Organizations (TCOs) that provide technical, financial and marketing consultancy to the sector; Center for Entrepreneurship Development (CEDs) and Institute of Entrepreneurship Development (IEDs) to promote entrepreneurship through training. At District level, in the year 1978, the central government launched a program of establishing District Industries Centers to provide under a single roof all the support services, clearances, licenses and certificates required by the small entrepreneurs. There are more than 400 such centers, one each in a district.
Table 2.10
Institutional Finance for Small Scale Industries

The following agencies through their various schemes provide finance to small scale industries sector under the overall policies and guidelines evolved by Reserve Bank of India.

At the National Level:
1. Small Industries Development Bank of India (Mainly through re-finance)
2. National Bank for Agriculture and Rural Development
3. National Small Industries Corporation
4. Khadi and Village Industries Commission
5. Nationalised Banks
6. Development Commissioner, Small Scale Industries (DCSSI)

At the State Level:
1. State Financial Corporations (SFCs)
2. State Industrial Development Corporation (SIDCs) - Infrastructure/Finance
3. State Cooperatives Banks
4. Khadi and Village Industries Board

At Regional and District Level:
1. Regional Rural Banks (RRBs)
2. District Central Cooperative Banks
3. Primary Cooperative Banks
4. Branches of State level institutions and nationalised banks about 65,000 in number
5. Khadi and Village Industries Commission
6. District Industries Center (DIC)

Source: Compiled from different sources

There are three national associations representing all type of industries, small and large. These are ‘Federation of Indian Chambers of Commerce and Industries’ (FICCI), Confederation of Indian Industries (CII) and ‘Association of Chambers of Commerce and Industries’ (ASSOCHAM). These associations represent mainly the interests of large scale industries. However, these associations have membership of small sector as well and represent mainly the policy related interests of SSI sector. The exclusively small industry related associations are diversified geographically and sectorally and are supposed to have been linked with ‘Federation of All India Small Scale Industries’ (FASSI), ‘Federation of Small and Medium Industries’ (FOSMI) and also Indian Council of Small Industries (ICSI). However these institutions are weak in character due to their working for cross purposes and lack of dynamic perspective for small scale sector growth. They have virtually no linkages with the small industry in general and their local associations in specific. Another institution that is concerned with the small and medium enterprises is ‘World Assembly of Small and Medium Enterprises’ (WASME). There are only a few of the local associations that are involved in providing specific individual level services to the small industry. However, all the associations are involved in lobbying with the government to provide one or the other facilities or benefits to the sector.
Energy Consumption has been considered directly proportional to the economic indicators like the Net State Domestic Product (NSDP). However, in a large country like India, where the Urban - Rural divide and the rich - poor divide still exists, in terms of their economic prosperity or purchasing power or life styles, the per-capita energy consumption do not strictly reflect their economic well-being and to a greater extent doesn’t have any correlation with the other human development indices. While there is good correlation between per capita energy consumption and percentage of population covered by sewerage, for all other HDI parameters, the correlation is not very good. But the conventional wisdom demands a good correlation with at least majority of HDIs, if not all. This argument (the poor correlation between per capita energy use and HDIs) tends to lead to the conclusion that energy (particularly in the developing world) is still treated as a market commodity, not really linked to the improvement of HDIs, if not treated entirely as a development tool, by the policy makers. The burning of energy resources leads to environmental damages by polluting the atmosphere. The energy use which attracted such huge attention now-a-days is more importantly due to the associated global climatic impacts. Increasing fossil fuel use has led to increasing Carbon dioxide emissions leading to Greenhouse effect and global warming. International accords, began in Rio de Janeiro in 1992 (Rio Earth Summit), wherein developed nations were asked to reduce GHG emission to 1990 levels by the year 2000.

Energy efficiency is often viewed as a resource option like coal, oil or natural gas and one of the cost-effective tools to improve the profitability of enterprises. It provides additional economic value by preserving the resource base and reducing pollution. In order to institutionalize energy conservation efforts in the country, the Energy Conservation Act was passed in 2001, which established the BEE. The BEE has launched a number of initiatives, including the launch of the ECBC (Energy Conservation Building Code) for large and new commercial buildings; the launch of energy labelling scheme for appliances; the initiation of process for the development of energy consumption norms for industrial subsectors; and an annual examination to certify energy auditors and energy managers, which are expected to further accelerate the reduction of energy intensity of India.
The progress of industrialization during the last 50 years since 1951 has been a striking feature of Indian economic development. A significant feature of the Indian economy since independence is the rapid growth of small industry sector. The SME sector is one of the backbones of the development process mainly because of its greater employment potential, lesser capital intensiveness and scope for flexible and decentralized operation even in rural environment, contributing greatly to rural industrialization. With a contribution of 40% to the country’s industrial output and 35% to direct exports, the Small Scale Industry (SSI) sector has achieved significant milestones for the industrial development of India. Within the SSI sector, an important role is played by the numerous clusters of micro enterprises that have been in existence for decades and sometimes even for centuries. According to a UNIDO Survey (2002) of Indian SSI clusters undertaken in 1996, there are 350 SSI clusters and approximately 2000 rural and artisan based clusters in India. It is estimated that these clusters contribute 60% of the manufactured exports from India.

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UNIDO (2002): General review study of small and medium enterprise (SME) clusters in India, Vienna.