CHAPTER –1
INTRODUCTION

Energy is an essential input for sustainable development. The method of its production, distribution and its usage affects the social, economic and environmental dimensions of development. Although energy in itself is not a basic human need, it is critical for fulfillment of all needs. Lack of access to diverse and affordable energy services means that basic needs of the people have not been met. Energy is a vital entry point for the improvement of quality of life of the poor. Energy is needed to create jobs, develop industries, enhance value added economic activities and support income earning activities. Energy is an essential input to modern productive activities as well as communication and service industries. If energy has not been available in sufficient quantity, it interrupts or cause serious, financial, economic, and social losses. Energy must be available at all times, in sufficient quantities and at affordable prices, to support the goals of sustainable development. From a balance of payment perspective, energy import is the major cause of high import dependency. Attention to energy security is critical because of the uneven distribution of renewable and non-renewable sources across the globe. (Chaturvedi, 2003)

Energy is derived from non-renewable and renewable resources and the former are in process of depletion. These are fossil fuels- oil, coal and natural gas. It took million of years to build up these resources. Renewable resources are solar energy, water, and biomass. Approximately 80% of the world’s energy has been produced by fossil fuels. However, in France, the French Atomic Energy commission established nuclear reactors that produce enough energy to meet 70% of country’s energy requirement. Now how much energy is available and how much will be available? To answer this question is not easy task. Change in energy production and consumption practices has also been related to emission of carbon dioxide (CO₂). Today concentration of CO₂ and other greenhouse gases is increasing. It is estimated that CO₂ emissions are increasing at the rate of 5 percent per year and large tracts of vegetation absorb it. However, there is still uncertainty about how much of CO₂ will be produced in future and will be absorbed by
vegetation. *(Uberoi, 2003)*

The country is relatively well endowed with both renewable and exhaustible sources. As mentioned, coal, oil and natural gas are the primary commercial sources of energy. Coal is the major exhaustible energy resource in the country. Although reserves are substantial, Indian coal is primarily non-cooking, coal of poor quality with high ash content (40%-50%) and low calorific value (1300-4200 kcal/kg). India also has substantial reserves of nuclear fuels - the world’s largest deposits of uranium about 363 thousand tonnes, and about 34 thousand tonnes of the uranium ore (though only 44% of it is economically exploitable). India also has reserves of natural gas. Renewable sources are also expected to play an important role in solving the energy problems in decentralised locations and in some remote inaccessible areas where the extension of the grid system may be uneconomical. *(Teddy 2005)*

The rising energy demand has resulted in the setting up of more power plants which are based on primarily fossil fuel (coal, oil or gas). The fossil fuel based plants not only emit green house gases like Carbon Dioxide (CO₂) but also generate fly-ash-which is dangerous to human health. The emission of CO₂ the main green house gas, is expected to surpass the level of the Organization for Economic Corporation and Development countries by the year 2015. Hydro plants have also been installed to generate energy but these plants also create problems like human displacement and are damaging the ecosystem *(TERI, 2003).*

There is shortage of energy due to fast depletion of fossil fuels and the demand for energy is increasing due to the increase in population and the growth of industry. The energy demands are increasing while conventional energy sources are diminishing at a much faster rate.

The present mode of electricity generation all over the world is largely dependent on fossil fuels. The consumption of fossil fuels for power production is expected to continue to rise steadily in India. Experts have estimated that the availability of coal will be only enough for another 100-200 years while the oil sources, at the present rate of consumption are only expected to last for another three decades or so. Energy shortages have been expected to be double in the next decade. A shortfall of 50,000 MW by the
year 2004 was estimated. It has been estimated that a capacity of 6500 MW per year is required until 2010 to meet the shortfall. Against planned addition of 30,000 MW during the Eighth Five-year plan, the actual capacity addition was a dismal 19,000 MW against the planned target (Uberoi, 2003).

Coal will continue to remain the principal source of commercial energy in the county for the near future. 24 billion tonnes (bt) of incremental coal reserves and 25 billion tonnes of incremental lignite reserves have been established through regional and promotional exploration during tenth five year plan. During the Tenth Five Year Plan, it is estimated that about 70 percent of the power generated is coal and lignite based and this trend is likely to continue in the near future. According to Tenth Five Year Plan, the transportation sector is the main driver for the projected increase in oil demand. The import dependency for oil that is presently about 70 percent, which is likely to increase further during Eleventh Plan. India's per capita energy consumption is one of the lowest in the world. India consumed 455 kilogram of oil equivalent per person of primary energy in 2004, which is around 26 percent of world average of 1750 kgoe (Kilogram oil equivalent) in same year. The main challenge before the energy sector for fuelling the proposed growth in the Eleventh Plan is to enhance energy supply in cost effective ways. (Planning Commission 2007).

Renewable energy resources are solar, wind biomass (specially wood) and hydropower. The developed countries are interested in using and exploring the possibility of increase in non-conventional resources especially for environmental reasons. The developing countries do so for economic reasons. Among renewable energy resources, hydropower is the largest. Hydropower projects are in operation both in developed and developing countries- notable among the latter are China, India and Brazil. Hydropower potential is huge and at present only 15 percent of the potential in the developing world is being utilized (Mitra AP and others, 2002).

Wind power also has a great potential. Windmills have been in use since ancient times. It is a fast-growing resource. In 1980s, wind energy generation of the world was 10 megawatts. In the year 2000, it was 140000 megawatts. According to World Watch reports, wind turbines installed in 1999 were worth over 3 billion US dollars all over the
world and it supported 86000 jobs. Germany dominated wind installation in 1999 providing in windy regions upto 10% of country’s electricity. Greenpeace International estimates that if the present trend continues, wind power would supply 10% of world’s electricity by 2020 (Swaminathan M.S., 2002).

The use of solar energy is through Photovoltaic Cells. The Photovoltaic News reported that World’s Photovoltaic production climbed from 0.1 megawatts to 200 megawatts in 1999. To increase the use of Solar Power in developing countries serious efforts have been made by the Governments and International agencies (UNEP 2004).

The biomass resources are various types of cultivated or uncultivated vegetation. Wood forms the chief resource and is the primary fuel for the poor people in Africa and Asia. Excessive use of wood has led to depletion of forests. (dghindia.org)

**Highlights of Energy Production and Consumption Pattern in India**

- India ranks third amongst the coal producing countries of the world. Coal production has grown significantly from 100 mst (million short tonnes) in 1975/76 to 527.2 mst in 2007-08. (EIA, 2007).

- India is one of the least explored regions with an oil well density of 20 per 10,000 sq km as against a world average of 100. The current domestic production of crude oil caters to nearly 30 percent of the demand that leads to a continue growth in net imports. India imports 70 percent of crude oil with more than 60 percent of which is coming from Middle East country.

- The power generating capacity in India comprises a mix of hydro-coal-based thermal, oil-fired thermal, gas and nuclear sources. Lately non-conventional energy sources, particularly wind energy, have also become important. While the share of gas-based thermal has also gone up, that of nuclear has declined, in spite of a high degree of self-reliance in nuclear technology. Financial constraints, long-term nuclear waste management and eventual decommissioning of plants remain issues of concern in this sector.

- Due to economic growth of India over the period of 30 years the demand for
electricity has grown at an average of 3.6 percent per annum. Despite a substantial increase in electricity generation, energy shortages affect all sectors of the Indian economy. (Planning Commission, Government of India, 2000).

- There has been a steady increase in power generation based on renewable sources and as on December 2004, 1600 MW representing a little over 1.5% of the total grid capacity was based on renewable sources. These include solar, wind, biomass, and small hydro sources. In March 2009, the power generation capacity of India is estimated as 147000 MW. (TERI-2004).

- India has one of the highest potential for effective use of renewable energy. India is world's fifth larger producer of wind power after Denmark, Germany, Spain, and USA. There is a significant potential in India for generation of power from renewable energy sources—small hydro, biomass, and solar energy. (Indiaenergyportal.org).

**On the Energy Consumption Front**

- Industrial sector is the largest consumer of energy, consuming about 50% of the total commercial energy produced in the country followed by the transport sector. Of the commercial sources of energy used in the industrial sector, coal and lignite contribute about 57%, oil and gas around 33%, hydroelectric power 3% and nuclear power 0.2% (TERI – 2005)

- Transport sector is the larger consumer of petroleum—mainly in the form of high-speed diesel (HSD) and gasoline, which account for nearly 50% of the total consumption (GOI –2005).

- Agricultural sector’s consumption of commercial energy has grown significantly. The relative share of electricity and diesel power as against human and animal labour has increased significantly during last 50 years. (Planning Commission 2005).

- In the domestic sector, the consumption of biomass (mostly wood) energy is very high. Around 78% of rural and 30% of urban households depend on firewood.
However, the mix of traditional fuels in the national energy mix is decreasing as more efficient commercial fuels are increasingly substituting (GOI-2005).

- About 76 percent of the electricity consumed in India has been generated by thermal power plants, 21 percent by hydroelectric power plants, and 4 percent by nuclear power plants. The per capita power consumption in India is 612kwh (Kilowatt per hour). (Indiaenergyportal.org)

Industrial Issues cutting across the environmental, economic, and social dimensions are prominent in the sustainability debate. Environmental constraints to development have acutely been felt in the industrial sector in relation to both production and consumption of manufactured goods. The structure of India industry is not completely rational. In many cases, resource allocation is not appropriate and product quality too has much room for improvement. Again the overall level of industrial technology is low which results in wastage of resources and harmful pollution of environment. These factors cause bottleneck to sustainable economic development.

The small-scale industries (SSI) sector is one of the biggest employment generating sectors, and contributes to about 40% of industrial output and 35% of direct exports. It also happens to be one of the most polluting and waste generating sectors of the economy. As one of the measures to improve the situation is a number of items have been de-reserved (51 items were de-reserved in the year 2002-03). While this has positive implications in terms of growth, the net adverse impact on the environment increases due to the growth of the industry and on the other hand due to lack of implementation of environmental laws, lack of economic and appropriate technologies and general lack of sensitivity towards environment issues remains a issue. (GOI, 2006).

The increase in pollution loads has mainly been due to the increased volume of activity in the manufacturing sector, without a corresponding improvement in pollution prevention and control technologies. There are though, instances of some units that have been able to reduce the impact on environment from their operations. In the cement industry, use of power plant fly ash in the manufacturing of cement has picked up and there are cement brands in the market that are made of as much as 20% fly ash.
The air and water pollution has increased at a pace that exceeds the levels of technological development in the industrial sectors. Managing such quantities of pollution and waste requires a new look at the current policies in this respect. This calls for additional funding of environment conservation efforts including greater focus on research and to development activities and increased compliance with environment norms & standards.

Considering the rate of growth of manufacturing at 5% the air and water pollution would cumulatively grow by another 30-35% by the year 2010 (BAU) from the 2002 levels. This would have considerable impact in the ambient air and available water quality in industrial areas. The results could include problems of availability of water, as well as the presence of toxics in air (Shukla et. al, 2003).

At the current rate of growth in waste generation, the total waste generation has increased to about 150 mtpa by the year 2007. Correspondingly, the energy and resources use in the manufacturing sector is also bound to grow. Though there has been a trend to infuse resource use efficiency in the manufacturing operations across most sectors, the net energy usage is still on the rise. According to a demand forecast the demand for coal is slated to grow to 460 mt by the year 2010 in manufacturing sector (Nair et. al, 2003).

A number of legislations which deal with different categories of pollution control and environmental protection, have been enacted by India.

- National Environment Policy, 2006
- Policy statement on Abatement of Pollution, 1992.
- The Urban Land (Ceiling and Regulation) Act, 1976.
- The Industries (Development and Regulation) Act and Amendment, 1975.
- Provision in state acts on Town and Country Planning.
- The water (Prevention and Control of Pollution) Amended rules, 1989.
The Factors act and Amendment, 1987).
The motor Vehicles (Amendment Act, 1986).
The Air (Prevention and Control of Pollution) Union Territory Rules, 1983
The Air (Prevention and Control to Pollution) Rules 1982.
The air (Prevention and Control of Pollution Amendment Rules, 1988.
The Indian Boller Act, 1923.
Notification on restriction of ash content of coal to be used in TPPs thermal power plants).
Bio-chemical waste (Management and Handling) Rules, 1998
Batteries (Management and Handling) Rules, 2001
Hazardous (Microorganisms and genetically modified organisms (Manufactures, use, import, export, and storage) Rules, 1999.
Municipal Solid Waste (Management and Handling Rules), 1999.
Dumping and Disposal of Fly Ash Discharged from Coal or Lignite based Thermal Power Plants or Land, 1989.

**Need for reforms in the energy sector**

The demand for energy has continued to increase rapidly the development in the energy sector under present rising demand scenario is a matter of serious concern. The
demand of the time is to bring regulatory reforms in the energy sector, which can help this sector to play vital role in development of different sectors of society. The oil pool account deficit, the slow pace of expansion and generation of power generating capacity and to increase private participation in coal mining and natural gas EXPLORATION requires major energy sector reforms in the following sectors:

- Coal
- Oil
- Natural gas
- Power

The coal industry needs an urgent set of reforms because the expansion of further capacity is critically dependent on funding from outside the government. In addition, there is need to improve the functioning of the industry as a whole, which unfortunately has been neglected by policy makers for a considerable period of time. The coal industry in India has a long history. However, in recent years, despite significant expansion and major investments largely from government sources, little analysis has been carried out, of the steps that need to be taken for critical reforms.

The rationale for rapid expansion of coal mining and production arises from a number of factors. Firstly, coal is the major fossil fuel resource available in India, and despite problems in the entire coal chain, it has provided a major portion of energy supplies for power generation, particularly in the past two decades. Coal is the cheapest fuel option for power generation in most regions of the country. Hence, increase in coal supply is essential for the expansion of power generation to meet the demand from an expanding economy in the country. Secondly, the growing dependence on oil imports places India in a difficult situation with respect to energy security. An additional reason for the expansion of coal supply is the major employment potential this industry has in a region that is generally poorer than the rest of the country. Clearly, employment cannot be a major factor for stimulating growth of the coal industry, but it certainly is a significant reason for ensuring that in a labour-surplus economy, coal production and supply receive greater importance than other energy forms that entail capital-intensive production (Thangapandium, 2006).
Because of these considerations, 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. The major initiatives taken thus far by the government are as follows (Ministry of Coal, 2000).

- Public sector undertakings, which constitute the major share of the coal supply industries are provided freedom of action without constraints thus reducing excessive government controls and regulation thereby creating better commercially dynamic environment.

- The Government is set to create conditions whereby the private sector can participate in the extraction and marketing of coal. While the response thus far has not been up to expectations, there is now growing interest on the part of the private sector both in India and overseas to involve itself in the whole chain of coal industry operations. There are still a number of hurdles and barriers which have not allowed private sector participation to grow in the desired manner, but it is expected that with the exercises currently under way, there would be a significant improvement in the involvement of the private sector in this industry.

- The government has also taken in hand the restructuring of the legal and regulatory framework governing operations in the coal industry so that a more investor-friendly framework is put in place for attracting private sector investments in the sector.

The ultimate objective of some of the ongoing measures and other factors under consideration is to see that a competitive environment is created for the functioning of various entities in this industry. This would not only bring about gains in efficiency but also effect cost reduction, which would consequently ensure supply of coal on a larger scale at lower prices. Competition would 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.

The oil industry in India is a relatively efficient and well-organized industry, particularly in respect of downstream operations. This is because most of the public
sector companies operating at the downstream end have drawn heavily in terms of personnel and practices from established International oil companies. The oil pricing has generally allowed these companies to earn reasonable returns, they have been able to invest in improvements and upgradation of equipment and technologies and, in general, maintain a level of efficiency in their operations, which have provided a healthy base to the industry's evolution and development. With the Government of India's move towards dismantling the APM (administered pricing mechanism), on the basis of which prices of oil products are set currently, there is a need to think through and Implement early a post-APM structure for regulation of this industry (Ministry of Petroleum and Natural Gas, 2002).

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. The government is considering the establishment of a single regulator who will be responsible for regulating the prices of petroleum products and natural gas, for different end-users. Because natural gas is a substitute for several petroleum products and pricing decisions will have to be consistent to ensure that the right mix of energy sources is used in the economy. The prices must be set in a manner that leads to a desirable outcome and does not result in any distortions, surpluses, and shortages of one or the other fuel. The difference between natural gas and petroleum products lies in the fact that the transportation of natural gas through pipelines has substantial economies of scale. The exploitation of these economies of scale requires regulatory decisions in the market. In other words, if transportation economies have to be fully exploited, then a certain magnitude of transportation of gas by pipeline would have to be ensured to achieve these economies of scale. Hence, the regulatory body established for the purpose would have to ensure that demand centers are developed in a manner that allows the consumer the benefits of economies of scale in pipeline transportation (Bureau of Energy efficiency, 2003).

The basic problem in power sector arose from the fact that the state electricity boards are bankrupt and cannot be seen as reliable entities for business, with little or no assurance of payments to any supplier that provides them with either electricity or other
goods and services. It is also now evident that starting with investments in power generation without considering privatization of distribution was a beginning made at the wrong end.

Reforms are being undertaken for the regulation of this industry. With most electricity boards pricing power for certain groups of consumers, such as agricultural consumers and some high-tension Industries, with varying levels of subsidies, their financial health and accountability remained seriously eroded. It is only with the passage of the Central Electricity Regulatory Commission Act in 1998 that regulatory reforms have been initiated, and both the central and the state regulatory commissions are now functioning with growing effectiveness and larger geographical coverage. Over a period of time, this would help to rationalize electricity operations and ensure efficiency gains that, for instance, can be expected based on the experience of the UK model of electricity regulation.

The most important challenge facing the electricity supply Industry is to be seen in two parts, which are interrelated. Firstly, the regulatory structures and systems have to function effectively, and for this considerable training and learning is required for all the stakeholders involved, namely regulators, consumers, the regulated utilities, and others. Secondly, to introduce privatization of the distribution of power, governments will have to show originality and political will so that concerns often voiced by labor unions and employees do not halt the progress of privatization of distribution. Essentially, this would require careful understanding of all implications involving labor and then devising packages that are mutually acceptable to the management and labor. It is not expected that radical changes would take place in the industry in a short period of time, but at the same time it would be incorrect to assume that merely setting up regulatory bodies would bring about the change required. A much higher level of expertise would have to be brought to bear on developments in this sector if progress is to be achieved. This should also be accompanied by a clear strategization of other steps to be taken in bringing about a higher level of competition in the industry.

In the light of above, the energy is most essential requirement for the development for a economy like India. Whenever we think about economic planning, we have to give
priority to energy sector. Because without it’s planning the overall development of the economy is not possible. Rise in population, urbanization, and economic growth all these factors increase the demand for commercial energy. Still India’s per capita consumption of different energy sources is very less as compared to other countries.

**Energy and Environmental Concerns**

The environmental effects of the use of various fuels are of serious concern owing to increasing consumption levels. Pollutants associated with the combustion of fossil fuels, viz., sulphuric fluoride, nitrous oxide and carbon dioxide pose a major threat to environmental quality and human health. TERI (Tata Energy Research Institute) study 2006 noted that in the majority of Indian cities, air quality standards are violated. The problem has been compounded due to the poor quality of Indian coal, the predominant source of energy in the country. In addition to emissions, land requirements for the disposal of fly ash generated in thermal power plants is a major concern. Electric power generation is also the largest source of green house gases and accounts for 48% of carbon emission. (cpcb.nic.in)

The nuclear option comes with its own set of problems. Uncertainties surrounding the safety and economics of radioactive waste disposal and decommissioning remain. Nuclear accident of Chernobyl in Russia and recent mishap at Tokaimura, in Japan shows that the danger of a nuclear accident is still very real. Large hydro projects in turn, may entail severe and often irreparable social and environmental costs including the dislocation of people, submergence of valuable resources including forests and wildlife habitats, destruction of wild life sanctuaries and adverse impacts on downstream hydrology (TERI, 2004).

The final use of energy also imposes severe environmental costs. Industrial and vehicular emissions have assumed serious proportions in urban areas. Petrol-driven vehicles form the major source of CO₂ emissions contributing over 85% of them, while diesel-driven vehicles are the major source of nitrogen oxide contributing over 90%. Indoor air pollution due to the domestic consumption of both traditional and commercial fuels is also significant. In fact, the total human exposure to many important pollutants may be much more substantial in the homes of the poor in developing countries such as
India than in the outdoor air of cities in the developed world, due to high concentration of the large population. (TERI 2005)

The major global environment problems we face, as identified and addressed by the United Nations in the earth summit in Rio-de Janeiro in 1992 are global warming and loss of biodiversity, inextricably linked with the environmental problems. The problem of global warming is fundamentally a problem of how to deal with the energy sector. The historical evolution of global consumption of energy shows a steady growth of 2 percent a year since the middle of the last century. The growth in the United States has been about 3 percent a year. It is clearly evident that any serious measure to achieve environmental sustainability from the point of view of global warming necessarily involves dealing with the future of the generation and use of energy (Shukla et al., 2003)

The recently concluded Copenhagen Summit of world leaders proposed a global emission goal for 2050. The European Union offer of 7.3 billion euros of climate aid over the next three years, has been welcomed by the United Nations. Yvu-de-Boer, head of UN climate change secretariat has clearly stated that time has come to focus on the climate change and energy conservation.

The need of the hour is to explore all opportunities for further improvement of efficiency in both the production and consumption of energy. Any energy programme must be linked to the increase of the efficiency in energy use and reduction of CO$_2$ emission (The Tribune, Dec 14, 2009).

Global climate change has emerged as a threat to sustainability. In the absence of adaptation and mitigation strategies climate change can seriously damage agriculture, water resources, forests, coastal areas and health, etc. in the Indian economy.

**Global warming** means gradual increase in world temperature caused by greenhouse gases (GHGs). The main greenhouse gases are-

(i) Carbon Dioxide (CO$_2$)
(ii) Nitrous Oxide (NO)
(iii) Chlorofluro Carbons (CFCs).
Green house gases come from various sources, mostly from burning of fossil fuels. These gases trap the sunrays from the earth’s atmosphere causing the temperature to rise resulting in, which is known as green house effect or global warming. The research on this issue has indicated that there has been 25% increase in carbon dioxide concentrations during the last 100 years and it has been expected that this will double in the next 50 years. (TERI 2001)

Much of the interest and controversy surrounding the “greenhouse” effect has surfaced in recent years, as a growing number of scientists have suggested that greenhouse gases could possibly raise world temperatures between 2 and 5 degrees Celsius (approximately 3 to 9 degree Fahrenheit, respectively) by the middle of the 21st century. If this happens, both the magnitude and the rate of change would be unprecedented in mankind’s history on earth. Over the last century, the earth’s temperature is thought to have risen only about 0.3 to 0.6 degrees Celsius, and it probably has not varied more than 1-2 degrees Celsius in the last ten thousand years, or more than 6-7 degree Celsius in the last million years. (Anthony et. al, 2000)

Various atmospheric trace gases-mainly carbon dioxide (CO2) methane (CH4), tropospheric ozone (O3), and nitrous oxide (N2O) – trap some of the radiant heat that the earth emits after receiving solar energy from the sun, such as panes of glass hold heat inside a greenhouse. This phenomenon is normal to earth and essential to life. Without it, the earth would be more than 30 degree Celsius cooler, and life as we know it, would not exist. The industrially produced halons (CF3Brs) and chlorofluorocarbons (CFCs) have also been added to the natural occurring greenhouse gases during the past 30-60 years. (Anthony et. al, 2000).

Another certainty is that greenhouse gasses are accumulating rapidly since the beginning of the Industrial Revolution and have been changing the chemical composition of the earth’s atmosphere. There is a complex interaction between trees, water vapor, dust
particles, oceans, clouds, ice, volcanoes, snow and greenhouse gases. These all continue to preserve a sense of mystery. Researchers have given a number of explanations for environmental changes but no explanation is available with certainty. If the researchers blamed green house gases for warming in that case they have not agreed on exactly that how much the earth has warmed over the past century and in future how much warming will take place and when and at what rate of warming will be expected. The researchers cannot answer with certainty that what a warmer earth would mean for mankind. All long term prediction scenarios are mere guesses than literal prediction because the researchers are not certain that will plants do better with the increased CO₂ concentration? Will increase in cloud cover; actually help to mitigate the green house effect? Will rise in temperature lead to poorer soil moisture, rising ocean levels and change in pattern of rainfall?

Nations all over the world have become increasingly troubled by the buildup in the atmosphere of “greenhouse” trace gases. These gases – it is feared, could trigger a significant warming of the earth’s surface with potentially harmful, even devastating, social, and economic consequences for mankind. Scenarios about vastly changed patterns of rainfall, different temperature levels, radically changed ocean currents, increased frequency, and intensity of natural disasters, and rising sea levels. The ramifications could include severe damage to vegetation in some areas, parts of entire countries being submerged underwater, fertile lands being turned into deserts, and hence mass migrations. However, at this stage, clear scientific evidence confirming such as enhanced greenhouse warming is still lacking. (epa.gov/climatechange)

Most developed countries have already begun debating domestic policy options for reducing greenhouse gas emissions. In fact, they are now spearheading efforts to craft a global climate convention. However, the developing nations could be the most vulnerable to any significant global climate change.

Even within the tremendous uncertainties surrounding the changes that might be brought about by global warming, there are clear actions to take and policies to follow aimed at diminishing risk while simultaneously carrying out research that reduces the uncertainties. In fact, developing countries now have a major opportunity to increase
incentives for sustainable energy resource use, shift to cleaner alternative fuels and technologies, and improve efficiency in energy production, distribution, and end use. Such initiatives not only address the greenhouse gas problem but they also in most instances, make good economic sense. Future hinges on expanding energy use in the whole range of economic and social activities but this requires huge amount of capital, a commodity in scarce supply in the third world. For electric power supply alone, the annual investment bill for all developing countries has been projected to be up to $100 billion per year – with China, Indian and Brazil accounting for nearly half – and this does not include the large additional investments that have been needed to consume this energy (e.g., motors, vehicles, appliances, air conditioning, and light bulbs).

Most of the green house gases released by industry are the result of energy use, rather than specific industrial processes. Scientists across the globe are trying to predict the effects of green house gases. Their entire theory on climate change due to global warming may not be valid. However, scientists agree that (Aggarwal A. Sharma, 2002):

- Actual warming has been taking place during the last 100 years.
- Warming would further raise the temperature of earth by 3-5 if increase in Co₂ doubles in next 50 years.
- If warming continues, coastal areas would see a rise in sea level, if temperature rises further by 3-5°C sea levels may rise by 0.5ft to 5.0ft, because of melting of mountain glaciers and expansion of oceans. This would result in Islands like Maldives getting submerged and many coastal cities, getting flooded, forcing the people to leave their original homes.
- Glaciers may further retreat throughout the world and the evidence of extreme weather events are increasing in some parts of the world.
- The composition and geographic distribution of many eco systems will shift as individual species respond differently to changes in climate. There will probably be reductions in biological diversity (particularly species diversity) and changes in the goods and services provided by the eco system (for example food, fiber, medicines, recreation and tourism).
• Models predict that possible changes in temperature and water availability under doubled carbon dioxide equilibrium conditions will cause a substantial portion of the world’s existing forested areas to undergo major changes in broad vegetation types.

• The existing studies show that the main direct effects will be through changes in factors such as temperature, precipitation, length of growing season, and timing of extreme or critical threshold events relative to crop development. Indirect effects will include potentially detrimental changes in diseases, pests and weeds, the effects of which have not yet been quantified in most available studies. In the tropics where some crops are near their maximum temperature tolerance and where dry land, non-irrigated agriculture predominates, yields are likely to decrease.

Rice crops can tolerate a maximum air temperature of around 30°C during most of the growing period although it has to be subject to higher temperatures for shorter periods during breaks or early withdrawals in monsoons. Temperature influences the growth rates and productivity of rice crops. Higher temperature has negative impact on the rice growth and productivity. The situation is similar for sorghum, and pearl millet, which are exposed to temperatures in Rajasthan, India (Mitra, A.P., 1996).

According to Panayotou et al., (1999) India will suffer severely from potential changes in temperature and perception. Sinha and Swaminathan (2002) have shown that a 1°C increase in temperature will reduce the duration of the wheat crop by one week. A one week reduction in crop duration may lead to a reduction in yield by 400 to 500 kg/ha. Hence, the potential rise in temperature would have disastrous consequences on wheat production in India. Adverse changes in precipitation will affect rice production adversely since nearly 60 percent of the rice area is rain fed. Wheat and rice contribute nearly 75 percent of total cereal production in the country (Swaminathan M.S., 2002). Also studies carried out in the later half of the 1990s (Gadgil, 1995; Sinha, 1997; Lal et al., 1998; Sinha et al, 1998; Watson at al., 1998; Kumar and Parikh, 1997) indicate that grain yield of wheat in Punjab will reduce by 8.1%, 18.7% and 25.7% if the temperature increases by 1°C, 2°C and 3°C respectively.
Vulnerability of agriculture production to climate change depends not only on the physiology response of the affected plant, but also on the ability of the affected socio-economic systems of production to cope with changes in yield, as well as to changes in the frequency of droughts or floods. The adaptability of farmers in India has been severally restricted by their heavy reliance on the vagaries of monsoon and the paucity of complementary inputs and/or institutional support systems. (Swaminathan M.S., 2002).

- A rising sea level caused by climate change could have negative effects on tourism, freshwater supplies, fisheries, exposed infrastructure, agricultural land, dry lands, and wet lands effects may vary across regions. An average of about 46 million people a year are currently experience flooding because of storm surges. A 50 cm sea level rise would increase this number to about 92 million, a 1 meter sea level rise would increase it to 118 million. The estimates would be substantially higher if population growth projections were incorporated. Several studies have shown that small islands and delta areas would be particularly vulnerable to a 1 meter sea level rise. Estimated land losses range from 0.05 percent for Uganda, Netherlands, 1.0 percent for Egypt, 6 percent for the Netherlands, and 17.5 percent for Bangladesh, to about 80 percent of the Marshall Islands, displacing tens of millions of people. (Lysen, 2003)

- Existing scientific studies show that an increase in atmospheric temperature results in a higher rate of water evaporation from the hydro reservoirs, thus reducing available reserves for power generation. The limited availability of water in the reservoirs will require complex water management issues in the areas of power generation and irrigation in multipurpose reservoirs. The efficiencies of thermal generation plants, other industrial thermal installations, and engines used in vehicular transport are directly related to the atmospheric temperature. Therefore, any increase in atmospheric temperature results in lower plant efficiencies thereby affecting overall efficiency of the plants. In addition, with increased atmospheric temperature, the efficiencies of cooling equipment drop affecting all forms of industrial, commercial and domestic sector installations involving a cooling component. Further, there will be an increased demand for
air-conditioning and ventilation due to high temperature environment. This in turn will increase GHG emissions per unit of energy output.

**Energy, Environment and International Concerns**

First World Climate Conference in Geneva was held on February 12-23, 1979 and concluded that anthropogenic carbon dioxide emissions have long-term impact on climate change.

The Bellagio Conference was held on November 9-13, 1987 as part of the World Climate Programme, in which scientists pointed out that consequence of sea level rise, would outweigh any direct temperature effects of climate change in coastal regions.

New Delhi Conference of Selected Developing Countries, held on April 1990 on Global Environmental issues, puts the responsibility of climate change primarily on industrialist countries. Developing countries do not agree on commitments concerning emission cuts.

Fourth Plenary Session of Intergovernmental Panel on Climate change (IPCC) was held in Sundsvale, Sweden on August 27-30, 1990, to formally adopt IPCC First Assessment Report, which estimated that under a business as usual scenario, global, temperature would increases by about 1°C above 1990-value by 2005, and 3°C before the end of 21st century.

Second World Climate Conference in Geneva was held on November 1-7, 1990 in which 137 countries agreed to negotiate a word climate treaty.

Framework Convention on Climate Change was held at the United Nations Conference on Environment and Development, Rio De Janeiro on June 5,1992 in which committed governments were asked to prepare national strategies for emission of CO₂ and set targets. The Framework Convention on Climate Change (FCCC), which was drafted at the Summit in Rio, has now been ratified by almost all the countries involved. These countries have committed themselves to achieve stabilization of green house gases concentrations in the atmosphere at a level, which would prevent dangerous interference with the Climate System. The stabilization requires long-term measures to lower the
emission of green house gases in particular that of CO₂ from energy use.

At the first Conference of parties (CoP 1) in Berlin held on March 26-April 7,1995 in which, India broke deadlock in negotiations on emission cuts by tabling a Green Paper, urging industrialized nations to cut their carbon dioxide emissions by 20% by 2000.

The second conference of parties (COP-2) met in Geneva from 8-10 July 1996. Negotiators released the Geneva declaration, which was based on US policies statement offering medium term targets to reduce emissions.

Kyoto Protocol to the Framework Convention on Climate Change adopted at CoP 3 on December 1-10, 1997 at which all industrialized countries agreed to reduce GHG emissions to 5.2 per cent below 1990 levels by 2008-2012. Japan agreed to reduces six per cent, the United States seven per cent and the Europe eight per cent below 1990 levels.

Kyoto conference on climate, has achieved the world’s first climate protection through legally binding targets for green house gas reduction by the industrialized countries. If implemented seriously, this would reduce fossil fuel consumption for the industrialized nations. The protocol was initially adopted on 11 December 1997 in Kyoto, Japan and entered into force on 16th February 2005. The main objective of the climate change conference was to establish a legally binding international agreement, whereby all the participating nations commit themselves to tackling the issue of global warming and green house gas emissions. Under the protocol, 37 industrialized countries commit themselves to a reduction of four greenhouse gases. The industrialization nation agreed to reduce their collective greenhouse gas emissions by the year 2012. According to this protocol each annexure I (List of countries is given in appendix III) country is required to submit an annual report on inventories of all anthropogenic greenhouse gas emissions from different energy sources. As of in November 2009, 186 countries and one regional economic organization have ratified the agreement. The most notable non-party to the protocol is the United States, which is a party to UNFCCC and responsible for 36.1 percent of the 1990 emission level.
In the first phase between 2008 and 2012, the industrialized nations are to reduce green house gas emissions by an average of 5.2% from 1990 levels. For the European Union and Several Eastern European countries, the target is 8 percent, for USA 7%, for Japan, Canada, Hungary, and Poland it is 6% from 1990 levels.

On June 2-12.1998, CoP 4 in Buenos Aires adopted Action Plan, which puts a year 2000 deadline on areas critical to the implementation of the Kyoto Protocol.

On December 1999, CoP 5 on Bonn was held where no major progress was made on the two-year plan to work out protocol details.

At Seventh Conference of Parties- CoP 7, in 2001, it was agreed to adopt a fast track procedure for small-scale projects in renewable energy and efficiency. CoP 7 also agreed to replenish and establish adaptation fund and special climate change fund.

CoP 8, held in November, 2002 at Delhi, where ministers and other heads of delegates made Delhi Ministerial Declaration on Climate Change and Sustainable Development suggesting a number of energy conservation measures and cuts on GHG emissions.

CoP-9 was held in 2003 at Italy (Milan). The parties reached numerous decisions and conclusions on several issues: definitions and modalities for including a forestation and reforestation activities under the clean development mechanism, good-practice guidance on the land-use, land-use change and forestry, Special Climate Change Fund, and Least Developed Countries Fund were thoroughly discussed.

CoP-10 held in Buenos Aires 2004 at Argentina. A Programme of Work on Adaptation and Response Measures was agreed upon to support countries to prepare for climate change. It was agreed that the activities of the Programme would include vulnerability assessment and adaptation studies; support to the National Action Plans that the least developed countries can adopt; and research on various dimensions of climate change. The Parties to the Convention also prepared themselves for the implementing the Kyoto Protocol and brainstormed over the next steps for the future climate regime.

G8 Summit was held in Gleneagles, from 6 to 8 July in 2005, where the G8
leaders signed a communiqué (comprising a political statement, and an action plan covering climate change, clean energy, and sustainable development; leaders from Brazil, India, China, Mexico, and South Africa were also present). Asia-Pacific Pact (spearheaded by the US and Australia) to promote cleaner energy technologies (including carbon capture, methane capture, or nuclear power) across Asia-Pacific was signed by Australia, India, China, Japan, South Korea, and the US.

CoP-11/MoP (Meeting of Parties)-1 was held in Montreal, Canada, in October 2005.

CoP-12/MoP-2 held in Nairobi, Kenya from 6-17 November 2006, it address linkages between climate change, employment and sustainable development.

CoP-13 was held in Bali, Indonesia from 3-14 December 2007, in this conference the party has heightened global concern over the increasing green house gas emission and concentration in the atmosphere.

CoP 14 was held in Poland from 1-12 December 2008, it was the most prestigious forum of political discussion in scope of climate protection.

The draft pact that has been framed at recently concluded Copenhagen Convention (CoP 15) of world leaders in December 2009, gave a clear message to halve the CO₂ and other emissions by 2050. The pact offers arrangement for global cuts in green house gas emission mainly from burning of fossil fuels.

A clear massage came that a new approach to energy management is required. So, far as the demand side is concerned there is growing recognition that some of the most cost effective methods for sustainable energy development are available. These methods involve improving end-use efficiency by providing same energy service with less energy inputs. There is an urgent need to improve energy efficient technology especially in industries like iron and steel, refineries, paper and pulp, cement and chemicals; because these constitute 45% of industrial energy consumption. So far as supply side of energy is concerned, attention is to be paid to energy production from primary sources, and reduction in wastes.

Source: Cseindia.org, ccsr.u-tokyo.ac.jp, global-unions.org
The Kyoto protocol sets binding targets for 37 countries for reducing green house gas emissions at an average of 5 percent against 1990 levels over the five-year period 2008-2012.

The twelve days United Nations climate change conference in Copenhagen have projected that global emissions will peak in 2015-16 and then decline annually at a rate of 4 percent. The Summit discussed that wealthy nations need to peak emissions by around 2012 and achieve at least 60 percent reduction in emission from energy by 2030 and fully decarbonize their energy system by 2030.

Prof. Anderson, one of the world’s leading expert on CO₂ emissions suggest that the industrialized nations need to peak their collective emissions by around 2025 and fully decarbonize their energy system by 2050. On the eve of Copenhagen conference, the executive secretary of UN framework convention on climate change (UNFCCC) Yvu-de-Boer said negotiators have the clearest signal ever from world leaders to create solid proposals to implement rapid action. Further, he said that during the period of 17 years of climate negotiations, never so many different nations made so many pledges together. However, India suspects that Europe’s support for a new protocol is an attempt to weaken the Kyoto protocol, which sets binding targets for 37 developed countries for reducing green house gas emissions to an average of 5 percent against 1990 levels over the five year period 2008-2012 (The Tribune, December 14, 2009).

According to Sunita Narain, Center for Science and Environment New Delhi, “just a year increase in industrialized country emissions between 2006-07 is more than the total emission of 100 million Indians, who emit less CO₂ than all industrialized countries taken together.”

India’s emissions may have gone up due to rapid industrialisation but its per capita CO₂ emissions are only 1.1 tonne as against 20.1 tonne for its US, 17.8 tonne for Canada, and 11.5 tonne for Russia. Per capita emissions of China are only 3.7 tonne (The Tribune, Nov. 8, 2009).

At Bali in 2007, participating countries adopted the Bali Road Map as it is the two-year process to finalize a binding agreement in Copenhagen. Though there were no
consensuses on specific numbers, there was a call for “deep cut emissions” and that developed nations must cut emissions 40 percent by 2020.

There is also a dire need to reform the industrial management system, in keeping with the requirements of the social and economic sustainable development strategies.

It is true to say that without rapid industrialization it is too difficult to satisfy the needs of the people. In the same time, it has also compelled many sections of society to live inhuman, unhygienic, and degraded environment.

The industries that are largely responsible for environmental degradation and pollution are chemicals, pesticides, cement, ferrous and non-ferrous, dyes and pigments, paper and pulp and fertilizers. In modern era, corporations are known as citizens of the country but being good citizens of the country, they are also liable for polluting the environment. The action or inaction of the corporate citizen sometimes is injurious to society. The constitution [Article 51A (9)] imposes as one of the fundamental duties on every citizen-the duty to protect and improve the natural environment including forests, lakes, rivers, and wild life and to have compassion for living creatures, which implies the environmental responsibility of corporate citizens as well.

A few top Indian companies have agreed on a best practice charter embodying environmental responsibility of Corporate India. Among those are few top companies such as Gujarat Ambuja, Ashok Leyland, Hindustan levers, Reliance, Ranbaxy, Tata Iron and Steel Company, Indian Oil Corporation, Bharat Heavy Electrical Limited, Dupont. In the present scenario, industry has to show responsibility toward environmental and natural resources. The members of the industrial group must recognize environment as the highest corporate priority. The companies will have to be serious about environmental and energy saving measures. The Indian industry was sheltered earlier and now it has to adopt strict environmental measures especially in today’s context of global markets. TERI officials say, investors would rate companies on the basis of environmental performance and energy efficiency as well from the year 2008. It is also presumed that energy would be more expensive and if the companies do not use energy efficiently, the shareholders value of company would go down. The value of the company reflects the
efficiency with which it uses the natural resources. The companies, in the long-run, are going to suffer unless they become energy and environment conscious.

In response to the threat, major industries have also indicated that they are perfectly capable of preparing model laws and regulations, usually on a national basis. In this regard, it seems that corporate sector has risen late to the threat of eco-degradation. The companies have to think seriously that if they can put them together in advance of the public outcry, so that they become the solution rather then the problem. The industry needs to work with governments to get pollution prevention technology installed in manufacturing processes.

The need of time is that energy sectors will have to ensure adequate energy supplies at minimum possible cost. It is required to meet the challenge of fast depleting energy sources and growth of economy on one side and protect the environment by making deep cuts in the emission levels. Keeping in view the total energy environment scenario, the difficulties, and the challenges and needed reforms in the energy environment sector the following objectives have been determined for the purpose of study.

**Objectives of the study**

The present study entitled as Indian Energy Sector – Environmental Challenges and Role of Corporate Sector has the following objectives:

1. To study the trends in the growth and structure of Indian energy sector in the light of growing energy needs and suggest beneficial shifts in the present mix of energy production and consumption pattern.

2. To study the energy sector reforms especially in the light of curbing widening gap between production and consumption of energy.

3. To study the trend of green house gases and other harmful emissions and find cause and effect relationship with various economic sectors.

4. To study the sensitivity of Indian corporate sector regarding conservation of energy, use of eco friendly technology and appropriate reporting in the form of
environmental accounting in their annual report.

5. To suggest reforms in the energy sector, carbon mitigation strategies and appropriate reporting regarding energy conservation and eco friendly technologies by Indian corporate sector.

6. To suggest recommendation and conclusions based on the findings of the study.

Plan of the study

The study consists of seven chapters. Chapter 1 deals with introduction of the study. Chapter 2 reviews the studies related to the topic of the study. Chapter 3 consists of database and methodology. Chapter 4 studies the Growth and Structure of Indian Energy Sector, Challenges and Reform. Chapter 5 analyses the Relationship between GHG emissions and Economic Growth in India. Chapter 6 analyses the Environmental–Energy Disclosure by Indian Companies. Chapter 7 consists of Summary and Conclusions of the study.