Climate Change Mitigation Projects
in
The Decentralised Energy Sector
and
Building Materials Sector

Background Paper

by

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Energy Scenario in India

Energy is a critical input for economic development and the development experience all over the world is associated with a massive increase in energy requirement. During the last fifty years since independence, there has been an expansion in the total energy use in the country with a shift from non-commercial to commercial sources. The use of commercial energy has increased ten fold over this period. Nevertheless, per capita energy use in India remains very low and growth in future requires a large increase in commercial energy. This calls for optimisation of capacity to expand domestic production of commercial energy and the ability to do so will be a crucial constraint upon future growth. Even with the best efforts in this area India will remain energy deficient and import of energy in the form of crude oil and petroleum products and also coal will continue.

Decentralised Energy Sector in India

A large potential of non-conventional sources exists in the country. These include bio-gas, solar PV, solar thermal, bio-gas gasified, wind power, small hydro power, co-generation. These sources, besides being low carbon-dioxide emitters, also are generally distributed in the country thus having lower needs for transportation. In view of the issues linked to climate change, these distributed energy sources seem to be a better alternative for sustainable development of the country for which energy is the most important input. These decentralised sources can play a significant role in the development of the country and in addressing Climate Change issues :

United Nation Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) was the first international effort to address the issue jointly by all signatory nations, based on the scientific assessment of Climate Change by the IPCC in 1990. The ultimate objective of the Convention is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This should be achieved within a timeframe sufficient to allow the ecosystem to adopt naturally to climate change, to ensure that food production is not threatened and economic development proceeds in a sustainable manner.

Under the convention, both developed and developing countries accept a number of general commitments. The convention states that all Parties will develop and submit "national communications" containing inventories of greenhouse gas emissions by source and greenhouse gas removals by "sinks". They will adopt national programmes for mitigating climate change and develop strategies for adapting to its impacts. They will also promote technology transfer and the sustainable management, conservation, and enhancement of greenhouse gas sinks and "reservoirs" (such as forests and oceans). In addition, the Parties will take climate change into account in their relevant social, economic, and environmental policies; cooperate in scientific, technical, and educational matters; and promote education, public awareness, and the exchange of information related to climate change.

The Convention recognizes that poorer nations have a right to economic development. It notes that the share of global emissions of greenhouse gases originating in developing countries will grow as these countries expand their industries to improve social and economic conditions for their citizens.

It acknowledges the vulnerability of poorer countries to the impacts of climate change. One of the Convention's basic principles is that the specific needs and circumstances of developing countries should be given "full consideration" in any action taken. This applies in particular to those whose fragile ecosystems are highly vulnerable to the impacts of climate change.

Kyoto Protocol

Kyoto Protocol on UNFCCC adopted at the third session of the Conference of the Parties (COP-3) in December 1997, contains legally binding emissions targets for Annex I (developed) countries for the post-2000 period : the developed countries commit themselves to reducing their collective emissions of six key greenhouse gases (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6) by at least 5.2%.

The Protocol will only become legally binding when at least 55 countries, including developed countries accounting for at least 55% of developed countries' 1990 CO_2 emissions, have ratified it. 83 countries plus the European Community signed the Protocol during a one-year signature period that concluded 15 March 1999.

Countries have a certain degree of flexibility in how they make and measure their emission reductions. In particular, an international "emissions trading" regime will be established allowing industrialized countries to buy and sell emissions credits amongst themselves. They will also be able to acquire "emission reduction units" by financing certain kinds of projects in other developed countries. In addition, a "clean development mechanism" will promote sustainable development in developing countries by enabling industrialized countries to finance emission-reduction projects in developing countries and to receive credit for doing so. The reductions achieved through these various schemes are to be supplemental to domestic action.

It may however be mentioned that participation by each country in the Protocol and the above mechanisms is voluntary. The Protocol leaves it to individual countries to decide their own Sustainable Development priorities and develop projects for above mechanisms accordingly.

Climate Change Mitigation Strategies in India
As per the Asia Leastcost Greenhouse gas Abatement Strategy (ALGAS) study conducted by Asian Development Bank (ADB), the main source of GHG gases in India (as for other countries as well) is the energy sector. The general abatement strategy and goals as suggested by the ALGAS study include: efficient use of resources, promotion of renewables and enhancement of sinks. In the short and medium term, the country would focus on efficient use of resources and the promotion of renewables. The long term measures would be to enhance carbon sinks.

India's Development Objectives
*The stated objectives of the Ninth F*ive-Year plan *include:* priority to agriculture and rural development, accelerating the rate of growth of the economy with stable prices, drinking water, primary health etc, containing the growth rate of population, ensuring environmental sustainability of the development process, empowerment of women and socially disadvantaged groups, promoting and developing people's participatory institutions, strengthening efforts to build self- reliance.

Sub-sectoral strategy: Ninth Plan

Renewables
In continuation of the concerted efforts for the promotion of renewables, the government aims for the gradual commercialization of non-conventional energy and to exploit the large co-generation potential. Appropriate legislative framework and related measures would be undertaken to enable power producers to sell it to the grid at a remunerative price.

Most of the renewable sources have small generating capacity. The renewables tend to be competitive vis-à-vis fossil fuel sources in remote sparsely populated locations (typically rural locations) where it is not economical to extend the grid. Renewables thus have large potential in meeting the development needs of small rural communities. Simultaneously, renewables have significantly lower emissions as compared to fossil fuel sources and hence are being viewed as an important technology to reduce the global emissions. This potential of the renewables to meet the growing energy demand of the world poor communities at substantially lower level of emissions is being termed as the Win-Win potential of renewables.

The ALGAS study by ADB also estimated the cost of various mitigation options. This can give an estimate of the potential of various options and the estimated cost of each option. The ALGAS study shows that the renewables have the highest GHG emission reduction potential. The cost per tonne of CO_2 saved is also low for renewables as is the absolute amount of investment. These renewable projects can hence meet the development needs of the country and at the same time help in reducing carbon-dioxide emissions and addressing climate change.

The potential of the renewable or distributed energy projects need to be exploited to meet the development objectives of India and to address the climate change issues. The Kyoto commitments shall mean that there would be finance available to direct decisions away from fossil fuel energy sources to these sources. These financial sources need to be tapped for promotion of these distributed renewable projects.

Building Sector in India
The key objective of the National Housing Policy (NHP) 1994 is to provide access to adequate shelter to all. Eighth Plan target was 7.80 million new housing stock. The rapidly growing demand for housing and infrastructure is exerting heavy pressure on the natural environment. To promote sustainable development of the construction industry the Government of India has taken several initiatives to promote energy efficient building materials and shift the reliance from non-renewable resources to renewable resources.

Focus of the Workshop
The focus of the Pune workshop is on "Climate Change Projects in the Decentralised Energy Sector and Building Materials Sector". This workshop is a part of Climate Change Outreach and Awareness (CCOA) programme of USAID, being carried out at Development Alternatives and some other organisations in India. This programme seeks to increase the level of awareness and institutional capacity within the key Indian institutions and sectors. In this workshop a number of Indian business organisations will present project proposals in the decentralised energy sector and building materials sector such as : Biomass combustion / Biomass gasification / Solar PV cell / PV lighting / PV pumpsets / Wind energy / Mini and micro hydel and utilisation of flyash and wood substitutes.

This workshop is also a part of our outreach activity and aims to develop networking with the Indian business community and funding sources and provide a platform for interaction of the two. This will also lead to capacity building in design and implementation of Climate Change Mitigation projects (CCMPs). The workshop will also address to the immediate objectives of developing a portfolio of CCMPs in the Decentralised Energy and Building Materials Sectors in India.

1.0 Introduction
The ultimate objective of the Framework Convention on Climate Change is to stabilise greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This should be achieved within a time frame sufficient to allow the eco-system to adapt naturally to climate change, to ensure that food production is not threatened and economic development proceeds in a sustainable manner.

Both developing and developed countries have accepted certain commitments under the principle of common but differentiated responsibilities. One of the commitments is to formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by reducing anthropogenic emission by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol. Further in the Kyoto Protocol to the Convention on Climate Change the developed countries agreed to reduce their aggregate emissions by 5.2 % from 1990 level by the period 2008 - 2012. The Kyoto Protocol also included four 'flexibility mechanisms' such as Joint Implementation, Bubbles, Clean Development Mechanism (CDM) and International Emission Trading. Out of these mechanisms the Clean Development Mechanism allows industrialised countries to implement climate change mitigation projects in collaboration with business partners from developing countries to achieve compliance with their quantified emission limitation and reduction commitments in the Protocol. In the context of the climate change mitigation, projects in the decentralised energy sector assume great importance for rural India and remote areas. The present workshop is therefore focussed to discuss and develop project concept to operationalise project for implementation in India in the near future.

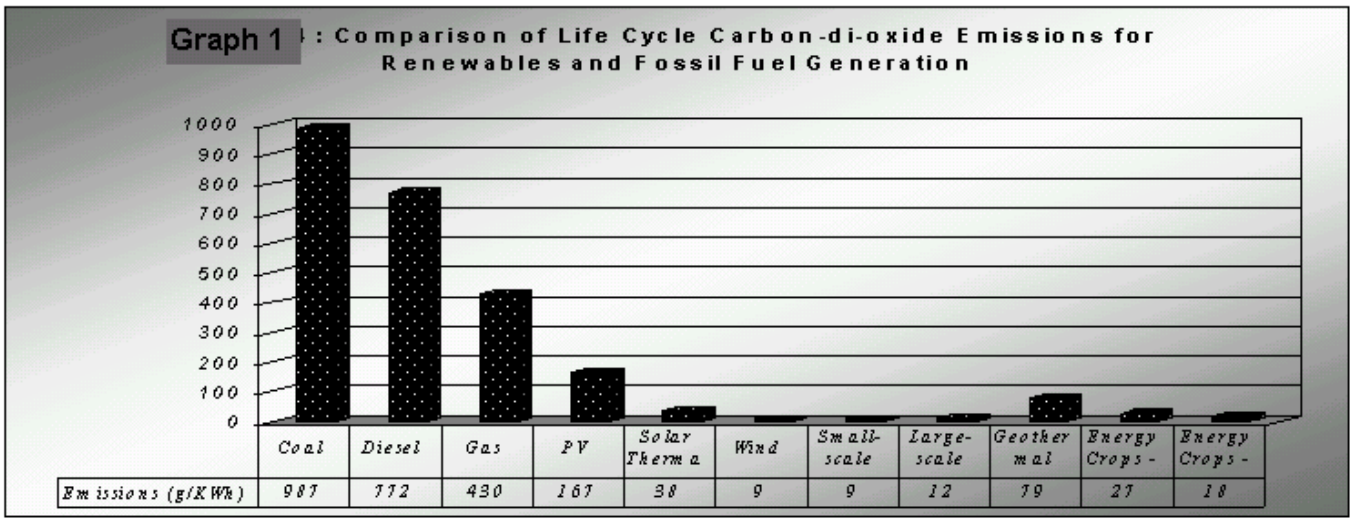
Though fossil fuels will continue to be India's major energy source and will continue to play a critical role in our country, a major challenge for us is to **develop programmes and policies that will reduce our dependence on fossil fuels in order to achieve sustainable economic growth and environmental stability. Decentralised energy can make a significant impact in the generation of electricity in view of rapid technological development and improving cost effectiveness**.

Considerable progress has been made in India over a wide range of programmes particularly in the production of electricity from renewable energy resources. Notable among these has been installation of the wind power capacity of nearly 600 MW which has placed India among the top three countries in the world in harnessing this wind resource. This capacity is expected to reach upto 2000 MW by the turn of the century. Another priority area is small hydro power development. An ambitious programme has been launched to harness the 3500 MW potential available in the sugar industry through advanced bagasse co-generation. In the area of solar photovoltaics, India has achieved a leading position for the world in the development and use of technology. India is the second largest manufacturer of the world of crystalline silicon modules. Industrial production has reached a level of 7 MW / year. The main emphasis of this programme is to provide solar lantern and solar pumps. Other uses are solar thermal water heating system for commercial and industrial establishments.

Another area is the biomass based gasification programme. The technology has been known for quite some time and was extensively used in Germany, UK and even in India during the second world war when oil and gas became scarce. The gas produced by the biomass gasifier is fed into an internal combustion engine which can then drive an electrical generator to produce electricity and conserve diesel oil, thus avoiding GHGs emission. Such a technology can be used in **climate change mitigation projects particularly in the decentralised sector visibly in rural India**.

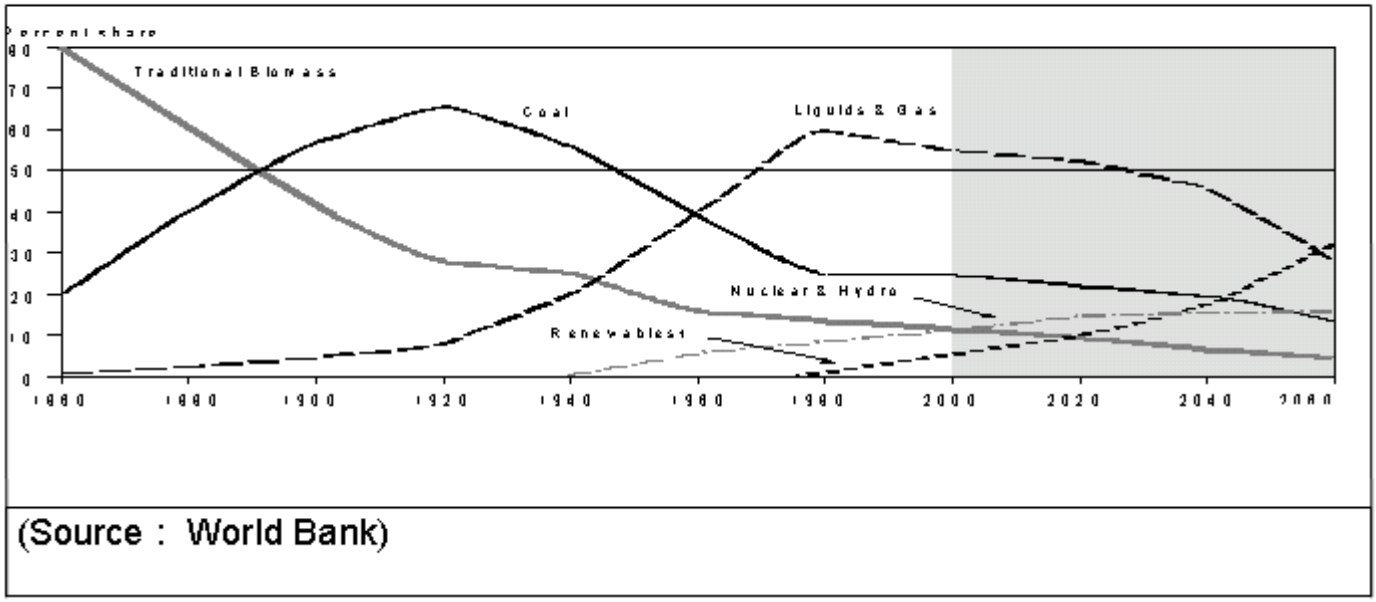
Most of the renewable sources have small generating capacity. The renewables tend to be competitive vis-à-vis fossil fuel sources in remote sparsely populated locations (typically rural locations) where it is not economical to extend the grid. Renewables thus have large potential in meeting the development needs of small rural communities. Simultaneously, renewables have significantly lower emissions as compared to fossil fuel sources as depicted in the Graph 1 and hence are being viewed as an important technology to reduce the global emissions. **This potential of the renewables to meet the growing energy demand of the world's poor communities at substantially lower level of emissions is being termed as the Win-Win potential of renewables.**

Studies of future energy supply (globally) suggest that renewables will grow proportionally faster than any other method of electricity generation. As per the estimates by IEA, under the current policy scenario, the renewables are likely to contribute over 25% of the global electricity demand by the year 2020. In case more environment friendly technologies are adopted, this contribution could increase to 45%. The increased importance of renewables in meeting the future energy needs has been recognised by various other agencies, including the World Bank. The Graph 2 for the period 2000-2060 (World Bank) provides one possible scenario of future energy consumption that shows renewables (combined) having the highest share.



Source : Benign Energy? The Environmental Implications of Renewables, International Energy Agency publication

Graph 2 : Contribution of various sources in meeting the World Energy needs



(Source : World Bank)

1.1 India's Potential in the Renewable Sector

Non-conventional sources include biogas, solar PV, solar thermal, biogas gasified, wind power, small hydropower, co-generation. The estimated potential and the current status of their exploitation in India is given below :

Source/Technology	Potential/Availability	Potential Exploited
Biogas Plants	12 million	2.7 million
Biomass based Power	17,000 MW	69.5 MW
Efficient Woodstoves	120 million	20 million
Solar Energy	5×10^{15} Wh/Year	25 MW
Small Hydro	10,000 MW	250 MW
Wind Energy	20,000 MW	1,000 MW
Ocean Thermal	50,000 MW	
Sea Wave Power	20,000 MW	
Tidal Power	9,000 MW	

(Source : Ninth Five-Year Plan)

These sources besides being low carbon-dioxide emitters also are generally distributed in the country thus having lower needs for transportation. In view of the issues linked to climate change, these distributed energy sources seem to be a better alternative for sustainable development of the country for which energy is the most important input. The role these sources can play in the development of the country and in addressing Climate Change issues is detailed below.

1.2 Building Materials Sector and Climate Change Mitigation in India

Out of India's total emission of CO_2 in 1990 (Base Year) of 159 million tonnes of carbon, the construction sector contributed about 22% of the total CO_2 emissions. This is attributed to the energy intensive building materials such as iron and steel, cement, bricks, lime, alluminium, glass. The wood use of building material sector also contributes the CO_2 emissions from deforestation.

India's per capita emissions of carbondioxide (CO_2) is small (0.22 tc/yr) at present in comparison to the world average (1.17 tc/yr). With the liberalisation of India's economy, and its heavy dependence on coal as energy source, and taking into account India's rapid population growth, it is likely that total CO_2 emissions for India may increase considerably in future though per capita emissions may not be very much different than at present.

2.0 Climate Change

2.1 Climate Change : An Emerging Global Problem

The problem of global climate change is one of the most complex environmental problems mankind has faced so far and is posing a serious threat to the existing social and ecological systems on the planet.
There are many factors both natural and of human origin that determine global climate.

What Natural Factors are Important?

Solar radiation : about a third of it is reflected back and the rest in absorbed by the different components (atmosphere, ocean, ice, land and biota) of the climate system.

Energy absorbed form solar radiation is balanced by outgoing radiation from the Earth and the atmosphere, in the form of longwave radiation (invisible infra red radiation).

There are several other natural factors which can change the balance between the energy absorbed by the Earth and the energy emitted by it.

Such factors are :

- Output of energy from the sun (its variability over the 11 year solar cycle and slow variations in the Earth's orbit).
- Apart from solar radiation itself, the most important radiative forcing arises from **the greenhouse effect.**

Greenhouse Effect

- Short wave solar radiation can pass through the clear atmosphere relatively unimpeded but long wave radiation emitted by the warm earth surface is partially absorbed and then re-emitted by a number of trace gases also known as greenhouse gases (GHGs) in the atmosphere.
- Main natural atmospheric GHGs are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone.

How do we know that natural greenhouse effect is real ?

Natural greenhouse effect keeps the earth warmer by 33^0C (from minus 18^0C to plus 15^0C) than it would otherwise be, thus making it warm enough to be habitable.

Secondly, measurements from ice cores going back 160,000 years show that the Earth's temperature closely paralleled the amount of CO_2 and methane in the atmosphere.

The greenhouse effect is real; it is a well understood effect, based on established scientific principles. Satellite observations of the radiation emitted from the Earth's surface and atmosphere demonstrate the absorption due to the greenhouse gases.

Effective emitting temperature of the Earth as seen from space is about 255 K and the globally averaged surface temperature is about 285K.

Why the GHGs are increasing

The GHGs in the atmosphere are increasing mainly due to human activities which include :

- Energy production from fossil fuels
- Industries
- Transport
- Construction
- Agriculture
- Land use change and deforestation
- Rapid population growth

What is the role of the atmosphere ?
The mean annual concentration of CO_2 is relatively homogenous through out the troposphere (the troposphere is mixed on a time scale of about 1 year).
The pre-industrial atmospheric CO_2 concentration was about 280 ppmv as reconstructed from ice core analyses, today (1990) the level is about 353 ppmv (1ppmv CO_2 equals to 2.12 GtC or 7.8 $GtCO_2$).

What is the role of Ocean ?
On time scales of decades or more, the CO_2 concentrations of the unperturbed atmosphere is mainly controlled by the exchange with the oceans, which is the largest of the carbon reservoirs.

What is the role of earth's vegetation and soils ?
The most important processes in the exchange of carbon are photosynthesis, plant respiration, and microbial conversion of the organic material in the soil back into CO_2 .

The carbon balance can be changed considerably by the direct impact of human activities (burning of fossil fuels for energy and land use change, particularly deforestation).

Intergovernmental Panel on Climate Change (IPCC).
The first assessment report was brought out in 1990 by the IPCC. The Second Assessment Report (SAR) was brought out by the IPCC in 1995, and a considerable progress has been made in attempts to distinguish between natural and anthropogenic influences on climate.

The main conclusion of the SAR is that the balance of evidence suggests **a dissernible human influence on global climate**.

Human induced Greenhouse Gases:
Carbon Dioxide (CO_2): is responsible for more than half of the human contribution to the greenhouse effect. Every year human activities are responsible for putting 6 billion metric tonnes of this fossil carbon from the earth to the atmosphere in the form of 22 billion tonnes of carbon dioxide. The destruction of forests and the degradation of soils adds an estimated 5.9 billion tonnes of carbon dioxide to the atmosphere.

Methane (CH_4): is released as a result of combination of carbon and microbial decay in the absence of oxygen. This occurs from the rice paddy cultivation (in wet land), burning biomass, landfills and digestive system of cattles and termites.

Nitrous Oxide(N_2O): is produced from soil cultivation, biomass burning, fossil fuel combustion. Other major sources are the production of nylon and nitrogen fertilizers

Ozone (O_3) : is a powerful greenhouse gas, particularly formed in the lower atmosphere (near ground) from vehicular pollution in the sunlit atmosphere.

Chloroflurocarbons (CFCs): are responsible for depletion of stratospheric ozone and greenhouse effect. Choloroflurocarbons are to be phased out totally by 2010 by all the countries. Industrialised countries have already phased out the chlorfluorcarbons.
[Source: Second Assessment Report, IPCC(1995)].

Other findings of the IPCC Second Assessment Report
1. Chemical composition of the atmosphere is being altered by anthropogenic emissions of greenhouse gases.
2. Continued building of these gases will enhance the natural greenhouse effect and cause the global climate to change.
3. Model projection of global mean surface air temperature relative to 1990 (on assumptions concerning population and economic growth, land-use, technological changes, energy available by and fuel mix during the period 1990 to 2100) is between 1^0C to 3.5^0C with the best estimate at 2^0C by 2100.

In all cases the average rate of warming would probably be greater than any seen in the last 10,000 years.

4. Average sea level is expected to rise as a result of thermal expansion of the oceans and melting of glaciers and ice-sheets. Model projection with different emission scenarios - sea level rise varies between 15 cm to 95 cm with best estimate at 50 cm from the present to 2100.

Lower temperature projections from the IPCC, 1990 projections are due to cooling effect of aerosols taken into account. This cooling effect is not uniform over the globe. Aerosals reduce the global warming by about one third (ranging between 20 and 40 %).
5. Global mean surface air temperature has increased between 0.5°C to 0.7°C since 1860.
6. Recent years have been among the warmest in human history.

Climate Change would have potential impacts on :

- water resources
- rainfall and its distributions
- sea level rise etc.
- cyclones
- agriculture
- energy
- forests
- urban centres
- human health
- economy and quality of life

Present Difficulties in the Climate Change Impact Studies are :

- uncertainties of Climate Change
- difficulties in quantification of impacts, particularly in economic terms
- data gaps
- incomplete knowledge of linkages between climate change and other systems
- stabilise GHG concentration with a time-frame that allows the eco system to adapt naturally to climate change and to ensure food security for all

2.2 Climate Change Convention and the Protocol

Main objectives of United Nations Framework Convention on Climate Change:

- To stabilize GHG concentration in the atmosphere to a level that prevents dangerous anthropogenic interference with the climate system.
- To achieve stabilization within a time-frame that allows the ecosystem to adapt naturally to climate change
- To ensure food security for all
- To enable economic development to proceed in a sustainable manner

In the Climate Change Convention all Parties accepted certain commitments taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances.

Some of the common commitments of all the Parties are :

- Preparations and updating of national greenhouse gas inventories of anthropogenic emissions by sources and sinks.
- Promotion and cooperation in the development, application and diffusion, including transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions in all relevant sectors including energy, transport, industry, agriculture, forestry and waste management sectors

The industrialised countries (developed) accepted some differentiated responsibilities which aim at individually or jointly returning to their 1990 levels of anthropogenic emissions of greenhouse gases (excluding those being phased out under the Montreal Protocol viz. , CFCs etc.)

The developed countries also accepted differentiated responsibilities to transfer clean technologies and knowledge and additional financial resources to developing countries to help them to mitigate climate change.

The Kyoto Protocol to the Convention on Climate Change and the four flexibility mechanisms

In December 1997, the Third Conference of the Parties (COP 3) held in Kyoto, Japan (Parties refer to member nations who have ratified the Convention) adopted a Protocol to the Convention commonly referred to as the Kyoto Protocol (KP). The Kyoto Protocol includes a binding commitment on the part of the Annex I Parties (industrialized countries) to bring down their emissions of greenhouse gases (CO_2 equivalent) on an aggregate by 5.2% below their 1990 levels. This is to be achieved by the first commitment period 2008-2012. This Quantified Emissions Limitation and Reduction Commitments (QELRCs), however, is differentiated among countries. The US has committed to a 7% reduction, the European Union (EU) to 8%, Japan to 6% below their 1990 (base year) emissions. The Kyoto Protocol also established four 'flexibility' mechanisms to enable the Annex I countries to **supplement** their domestic actions to fulfill their QELRC to make Climate Change mitigation actions cost effective. They are:

(i) Joint Implementation (among developed countries) (Article 6 of the Protocol).
(ii) The 'bubble' concept among the economic group such as the EU (Article 4).
(iii) Clean Development Mechanism (CDM) between Annex I and non- Annex I countries i.e. between developed and developing countries (Article 12).
(iv) Emission Trading among Annex B countries (as given in the Annex of the Protocol).

3.0 India's Development Objectives

The Indian economy is currently in a state of transition, from a protected regime to a more liberalized, market oriented one. India's population has already breached the one billion mark and the rate at which the population continues to rise is more worrisome than its size. With a population density of over 270 persons per sq. km, the population

pressure on the resource base is simply unsustainable. In 1995, 48 percent of the adult population in the country was illiterate. Every second Indian lives below the poverty line - which is very modestly calculated at around $1 a day (based on purchasing power parity). Just for the sake of a comparison, the average percent of people living below this poverty line for all developing countries is 32 %, which is more than a third less than India's figure at 52.5% (UNDP, 1997). And we can safely add limited access to basic health care, a near absence of safe water and sanitation facilities in the rural areas, compounded by low levels of literacy and an increasing population to have an idea of how severe the problem is at the current moment, and exactly what are the levels of investment required to even stop the situation from exacerbating any further, let alone considerations of a possible redemption.

3.1 India's Ninth Five Year Plan (NFYP) Objectives as Formulated are :

Priority to agriculture and rural development, accelerating the rate of growth of the economy with stable prices, drinking water, primary health etc, containing the growth rate of population, ensuring environmental sustainability of the development process, empowerment of women and socially disadvantaged groups, promoting and developing people's participatory institutions, strengthening efforts to build self- reliance.

3.2 Sub-sectoral strategy : *Renewables of NFYP*

The Indian policy on the renewables sector is in keeping with our overall objective to make the key sectors of the economy more competitive and consumer - oriented. Accordingly, the government aims for the promotion of renewables in the overall fabric of our energy sources through the gradual commercialization of non-conventional energy. There is also a vast pool of resources in the cogeneration sector to be tapped in a sustainable manner. Appropriate legislative framework and related measures would be undertaken to enable power producers to sell it to the grid at a remunerative price**.**

3.3 Sub-Sectoral Strategy : Building Sector

The key objective of the National Housing Policy (NHP) 1994 is to provide access to adequate shelter for all. There is an enormous shortage in the housing sector and major deficiencies in the housing related infrastructure. Several estimates are available for the present housing shortage and the projected shortage at a fairly disaggregated level. The National Buildings Organisation (NBO) had estimated the 1991 shortage at 8.23 millions, up from 7.0 millions in 1981, but expects the absolute shortage to decline progressively to 7.57 millions units in 1997 and 6.64 millions in 2001. However other estimates indicate that the shortage will increase 109.4 million units in 2001 (Habitat II estimates).

Eighth Plan target was 7.80 millions new housing stock. In the NFYP Government has set the goal to provide housing for all and towards this end it proposes to facilitate the construction of 20 lakh additional housing units annually out of which 13 lakh will be in the rural areas and 7 lakh in the urban areas.

Sustainable Development

The rapidly growing demand for housing and infrastructure is exerting heavy pressures on the natural environment. To promote sustainable development of the construction industry, GOI has taken several initiatives to promote energy - efficient building materials and shift the reliance from non-renewable resources to renewable resources.

Wood Substitution

The Council of Scientific and Industrial Research (CSIR) is coordinating the R & D activities on the development of new wood substitute for use in construction activity. New wood substitutes can considerably reduce CO_2 emissions that results from deforestation.

4.0 India's Greenhouse Gas Inventory

As per the study "Climate Change in Asia" carried out by the Asian Development Bank (ADB) in 1994, the total emissions in India increased from 117 Tg/year in 1986-87 to 222 Tg/year in the year 1994-95 (estimated) which were expected to increase to 289 Tg/year by the year 2000. The historical growth rate of emissions of 9% was expected to be maintained at 5-7% over the next 20 years. The study estimated the future emissions based on three different methods :

1. 6% growth rate of emissions
2. increase in per capita carbon dioxide emissions from 0.2 tonne/year to a specified value in the year 2070
3. detailed considerations of projections of energy use and energy intensity

Based on the same, the study concluded an increase in emissions to 1300 Tg/year by the year 2070. There have been various other studies as well which have estimated the detailed sources of carbon dioxide emissions in India. The table below summarises a few of these studies. The differences in estimates may be attributed to methodological differences, diverse data sources and depth of detailing.

Gas/Source	Mitra 1989-90	TERI 1989-90	Gadgil 1986
Carbon Dioxide (Tg C/year)			
Coal Combustion	99.3	116.92	
Oil Combustion	41.4	44.08	
Gas Combustion	6.5	6.5	
Cement	5.6	6.3	
Transport	Included in oil		
Biomass combustion	42.52		
- Deforestation	0.25		
- Shifting Cultivation	5.35		
- Accidental fires	19.82		1.56
- Controlled Burning	0.64		31.97
- Fire Wood Burning	9		
- Release soil	0.96		3.91
- Biomass decomposition	Not included		18.82
- Long/Short Use of Forestry	42.52		63.58
Total	**195**	**174**	**60**
Methane (Tg CH4/Year)			
Paddy Fields	3-6(4)	3.938	
Livestock	7	6.91	
Coal Mining	0.4	0.346	
Gas venting, leaking		0.147	
Landfills	1.7	2.35	
Biomass Burning	3.4		
Wetlands	2		
Total	**16**		
Nitrous Oxide (Tg N_2O/Year)			
Combustion			
- Coal		0.04	
- Oil		0.01	
- Gas		0.002	
Fertiliser use		0.012	
Total		**0.064**	