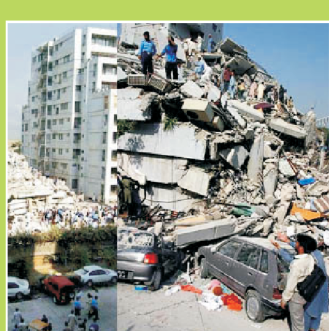
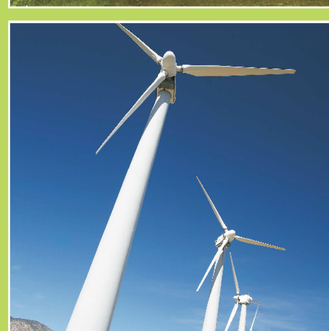
Discussion Paper

Confederation of Indian Industry

Building a Low-Carbon Indian Economy





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Foreword

Climate change is at the centre stage of global discussions. The warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. Climate change is undoubtedly one of the greatest environmental, social and economic threats, our planet faces today. It impacts all countries, but is particularly severe for developing countries like India, given their vulnerabilities, inadequate means and limited capacities to adapt to its effects.

Government of India (GOI) favours a multilateral response to the issue of climate change; based on the principle of 'common but differentiated responsibility'. GOI maintains that green house gas mitigation and adaptation strategies should be designed to allow developing countries to achieve rapid economic growth and meet millennium development goals with sufficient resources to support adaptation efforts. The just concluded 'Bali Roadmap' has underscored the need for a national agenda of action to address climate change issues.

Indian industry understands the risks associated with climate change on their corporate functioning. While appreciating GOI's stand on the issue, it is to be noted that industry and other stakeholders in India are well positioned to transform this challenge into an opportunity. Ample evidences indicate that Indian economy is on a low energy intensity path by adopting innovative practices. This paper notes the strategies adopted and outlines technologies, practices and policies for the future that will help India leapfrog to a low carbon economy.

The recent initiatives taken by CII in developing the 'CII-Sohrabji Godrej Green Business Centre' and 'CII-ITC Centre of Excellence for Sustainable Development' are proving that 'triple bottom-line' approach makes sound business sense. Mindsets of corporates are towards responsible and inclusive growth. In continuation, CII reaffirms its commitment to maintain leadership in exploring and promoting best global business practices in tackling the challenge of climate change.

The present paper is meant for due contemplation, reflection and fortifying conviction of Indian corporates in securing a global solution to reduce carbon footprints.

Jamshyd N. Godrej
Past President, CII and Chairman, CII Mission for
Sustainable Growth & Climate Change



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Abbreviations Used

AHU	Air Handling Units
APDRP	Accelerated Power Development and Reform Programme
APP	Asia-Pacific Partnership on Clean Development and Climate Change
BAU	Business as Usual
BEE	Bureau of Energy Efficiency
Bkwh	Billion kilo watt hour
BLY	Bachat Lamp Yojana
CAFÉ	Corporate Average Fuel Economy
CCI	Clinton Climate Initiative
CCS	Carbon Capture and Sequestration
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CERs	Certified Emission Reductions
CFL	Compact Fluorescent Lamp
CII	Confederation of Indian Industry
ClO_2	Chlorine Dioxide
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CSLF	Carbon Sequestration Leadership Forum
C-WET	Centre for Wind Energy Technology
ECBC	Energy Conservation Building Code
EE	Energy Efficiency
EOF	Energy Optimization Furnace
EREC	European Renewable Energy Council
ERP	Enterprise Resource Planning
EU	European Union
FAO	Food and Agriculture Organisation
FBC	Fluidized Bed Combustion
GBC	Green Business Centre
GDP	Gross Domestic Product
GHG	Green House Gas
GW	Giga watt
H_2O_2	Hydrogen Peroxide
HMV	Heavy Motor Vehicle
HRC	High Rupturing Capacity
IEA	International Energy Agency
IEO	Independent Evaluation Office
IGCC	Integrated Gasification Combined Cycle
IPCC	Inter-Government Panel on Climate Change
IPHE	International Partnership for the Hydrogen Economy



IREDA	Renewable Energy Development Agency Limited
ITER	International Thermonuclear Experimental Reactor
Kgoe	Kilogram of Oil Equivalent
KVA	Kilo Volt-Ampere
kW	kilo watt
KWh	kilowatt-hour
LDV	Light Duty Vehicle
LED	Light Emitting Diode
LEED	Leadership Energy and Environmental Design
LIC	Level Indicator Controller
LMV	Light Motor Vehicles
LP	Low Pressure
MDG	Millennium Development Goals
MP	Medium Pressure
Mtoe	Million tones of oil equivalent
MW	Megawatt
NGO	Non-Government Organisation
Nox	Nitrogen Oxide
NVI	New Ventures India
PPP	Public Private Partnership
PRDS	Pressure Reducing and Desuperheating solutions
PRV	Pressure Reducing Valves
R&D	Research and Development
R&M	Renovation and Modernization
RE	Renewable Energy
REST	Rural Electricity Supply Technology
RET	Renewable Energy Technology
RoR	Run of the river
RVE	Remote Village Electrification Programme
SEWA	Self Employed Women's Association
SEZs	Special Economy Zones
SO^2	Sulphur Dioxide
TERI	The Energy and Resources Institute
TIC	Temperature Indicator Controller
TINOR	Titanium Boride
TUF	Technology Up-gradation Funds
UCG	Underground Coal Gasification.
UNDP	United Nations Development Programme
UPS	Uninterruptible Power Supply
USA	United States of America
VER	Voluntary Emission Reduction
VFD	Variable Frequency Drives
WWF	World Wide Fund for Nature



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Building a Low-carbon Indian Economy

Executive Summary

A. Climate Change: Global Challenge and Response

There is universal consensus that global warming has taken place over last century and is directly attributable to human activities. The impacts of global warming include rise in average sea level and ocean heat content, decrease in snow cover and ice glaciers, as well as extreme weather conditions including long dry spells and unpredictable, heavy rainfall. These changes result in drop in agricultural yield, increased possibility of floods and droughts, adverse effect on human health and loss of bio-diversity. The number of people affected by all disasters has risen from an average of 174 million a year between 1985 and 1994 to 254 million a year between 1995 and 2004. It is inevitable that economic development will be affected.

Despite the fast pace of these changes, it is still possible to avert the worst consequences of climate change while expanding our energy supplies to meet the needs of both developed and developing countries. However, the decisions made in the next five to ten years are extremely important in determining the trajectory of required technology, systems, infrastructure and resource exploitation to ensure that global green house gases (GHGs) would peak and start to decline within ten years.

While global mitigation strategies are still being debated and discussed in various fora, there are clear signs and directions that industry in India has adopted an approach that sets the trend towards a low carbon economy. India's increasing participation in the global economy through trade, outsourcing, technology deals and acquisition of companies and businesses also indicates that Indian companies are acquiring the best climate friendly technologies and adopting processes and practices that would bring down the dependence on fossil fuels; the steady GDP growth rate of over 8% has been accompanied by a less than 4% growth in energy consumption.

This paper outlines the proactive role being played by Indian Industry, with support from the government, in adopting technologies and practices that will help India leapfrog to the low carbon economy and effectively meet the great challenge posed by climate change. It also notes the various initiatives taken by civil society in this direction and illustrates how the risks posed by climate change can be tackled and converted into business opportunities.



B. India: Current And Alternative Energy Scenarios

Energy is a fundamental factor in the developmental process. India, with over a billion people, today produces 660 billion KWh of electricity and over 600 million Indians (equal to the combined population of USA and EU) have no access to electricity and limited access to other clean, modern fuels. Low energy availability and consumption is reflected in the relatively low Human Development Index of India. Enhancing energy supply and access is, therefore, a key component of the national development strategy.

However, over the past decade, while gains in poverty reduction and economic growth have been significant, energy growth has been significantly lower than economic growth. India's energy intensity of GDP has reduced from 0.30 kgoe per $ GDP in PPP terms in 1972 to 0.19 kgoe per $ GDP in PPP terms in 2003; this is equal to that of Germany and compares favourably with those of other major economies. Thus India has achieved some success in de-coupling the energy-GDP link at a much earlier stage of development.

This reduction in energy intensity has been made possible by a range of factors, including India's historically sustainable patterns of consumption, enhanced competitiveness, proactive policies to promote energy efficiency, and more recently, the use of the Clean Development Mechanism (CDM) in promoting the adoption of clean energy technologies. India hosts the largest number of CDM registered projects among all the countries.

The nature of India's energy scenario and the extent to which India can meet the challenge of climate change in the coming decades will largely depend on the energy use choices and policies adopted. The next few years, in fact, present India with an opportunity to design energy policies in a way that can contribute to substantial mitigation of climate change risks while simultaneously ensuring energy security and contributing to high rates of economic growth.

The Planning Commission has listed a set of recommendations (listed in Table ES.1below) from the point of view of India's long-term energy needs and addressing these through an integrated energy policy that is also sensitive to climate change concerns.



Table ES.1: India's Integrated Energy Policy:
Priority Recommendations of the Expert Committee

Recommendation	Targets / goals
Ensure adequate supply of coal of consistent quality	Make more coal blocks eligible for development by private companies or joint ventures; build infrastructure to facilitate steam coal imports; rationalise coal pricing; amend the Coal Nationalisation Act to facilitate private participation.
Address the concerns of resource-rich states	Allow these states to share in profits; revise royalty rates; create national policy on domestic natural resources.
Ensure availability of gas for power generation	No new gas fired capacity to be built until firm gas supply agreements are in place.
Reduce the cost of power	Reduces losses through use of automated meters and separate metering of agricultural pumps; proper setting of cross-subsidy surcharges and wheeling and backup charges; create an efficient interstate and intrastate transmission system; refurbish power stations; generation and transmission projects built on tariff-based bidding.
Rationalise fuel prices	Price energy at trade-parity prices; remove administered pricing scheme.
Enhance energy efficiency & demand-side management	Improve power generation efficiency from 36% to 38-40%; information dissemination; minimum fuel standards.
Augment resources for increased energy security	Carry out surveys of energy resources; enhanced recovery of domestic resources; private sector involvement.
Use more energy abroad	Invest in captive fertilizer and gas liquefaction facilities.
Enhance role of nuclear and hydropower	Tap thorium reserves; create more hydro storage facilities.
Enhance role of renewables	Link incentives to outcomes like energy generation, not installed capacity; enact policies to promote alternative like plantations, gasifiers, solar thermal and photovoltaic, biodiesel and ethanol; expand equity base of the Indian Rural Energy Development Agency.

Recommendation	Targets / goals
Ensure energy security	Maintain strategy oil reserves in line with IEA standard of 90 days; engage in bilateral agreements to reduce supply risk.
Boost energy related R&D	Set up a National Energy Fund to finance energy R&D.
Improve household access to energy	Provide electricity to all household by 2009/10 (Rajeev Gandhi Grameen Vidhyutikaran Yojana); target subsidies using debit card systems; improve efficiency of cook stoves and kerosene lanterns; use more distributed generation; increase access to financing for micro enterprises; involve rural communities in decision-making.
Enable environment for competitive efficiency	Devolve regulatory responsibilities from ministries to state level; regulators should mimic competitive markets.
Address climate change concerns	Enhance energy efficiency in all sectors; increase mass transit; use more renewables and nuclear; invest in clean coal technologies; more research and development.

Source: Planning Commission (2006)

If appropriate steps such as these are taken by government as well as industry in the next two decades, it is feasible for India to substantially reduce the emissions of green house gases. This can be done by progressively reducing the demand and consumption of primary energy deriving from coal, oil and gas while consistently increasing the share of primary energy deriving from biomass sources, other renewables, nuclear and hydro generation.

A comparison between the reference scenario and the alternative policy scenario for India made by the World Energy Outlook 2007 of the International Energy Agency (2007) is illustrative in this regard. **The Reference Scenario** takes into account government policies and measures that were enacted or adopted by mid-2007. However, not all of these policies are assumed to be fully implemented in the Reference Scenario. This scenario assumes an average annual GDP growth rate 6.3% during the period 2005 to 2030. In the **Alternative Policy Scenario** full implementation of these policies is considered, along with implementation of other policies which are currently in rumination or seem likely to be adopted. (However the rate of economic growth and structure of GDP in India are assumed to follow the same trajectory). Domestic energy prices are assumed to follow international prices and subsidies

are assumed to be reduced progressively till 2030.

While in the reference scenario carbon intensive fuels such as coal, oil and gas will provide for nearly 80 per cent (1041 Mtoe) of the total primary energy demand (1299 Mtoe) in 2030, up from 71.7 per cent in 2005. In the alternative policy scenario, total primary energy demand itself will be 16.7 per cent less than the total demand in the reference scenario, and coal, oil and gas will provide only 37.2 per cent (402 Mtoe) of this reduced overall demand (1082 Mtoe).

Lower overall energy consumption, combined with a larger share of less carbon intensive fuels in the primary energy mix, will yield savings of 27% in carbon dioxide emissions by 2030. Switching to the alternative scenario would require implementation of key policy measures in various sectors - power generation, industry, transport, residential and services sector - simultaneously. The various measures are listed in a series of tables in the paper (Tables 4 to 8).

C. India's Response to Climate Change

India's Official Position: The Indian Government has taken a stand in global fora that developmental issues and concerns should be integrated into climate change framework, if the issues are to be effectively addressed. **GHG mitigation and adaptation strategies should be designed to allow developing countries to achieve rapid economic growth and meet millennium development goals (MDGs) and have sufficient resources to support adaptation efforts.**

In the global response to climate change, there is a need for common but differentiated responsibilities to be borne by the developed and the developing economies. India and other developing countries have to find solutions which can meet the MDGs, reduce poverty, and can lead to economic and industrial growth without sacrificing the long term objectives of energy security and climate change. India will adopt both adaptation and mitigation strategies to deal with climate change.

India's response to climate change is broad-based, enabling the country to move consistently towards a low-emission growth trajectory. It includes changing trends in overall consumption patterns, a thrust on the use of renewable energy sources and on improved energy efficiency, a transport policy that seeks to encourage an efficient rail-road mix and developing an efficient highways network, an automobile policy that is aligned to the best international safety and emission norms, and urban planning that aims to optimise living and working spaces as well



as restore depleted green cover. India is emerging as the global hub for further energy efficiency in industry, buildings, residential and commercial sectors and is playing a key role in the identification, development and utilization of new and renewable energy sources.

Recent Initiatives: New initiatives being taken to deal with climate change include energy labelling, energy audits, energy efficient and low carbon emission transport systems and vehicles and further improvements in energy efficiency in industries and power plants. Indian industry is actively participating in CDM projects. 282 projects registered by the CDM Executive Board have already resulted in over 28 million tones of certified CO_2 emissions reductions, and have directed further investments in renewable energy and energy efficiency projects.

Besides these initiatives, the CII-Sohrabji Godrej Green Business Centre is operating as a "Centre of Excellence" of the CII for energy efficiency, green buildings, renewable energy, water, environment, recycling and climate change activities in India. Another CII centre, the CII-ITC Centre of Excellence for Sustainable Development aims to enable businesses to transform themselves by embedding the concepts of sustainable development into their own strategies, decisions and processes.

Global recognition to Indian pioneers: India's leadership in countering the challenge of climate change has been further highlighted by the recent global recognition awarded to Indian pioneers such as the R. K. Pachauri (Pachauri-led IPCC was awarded the Nobel Peace Prize), Tulsi Tanti of Suzlon Energy and the glaciologist Dr Dwarika Prasad Dobhal of the Wadia Institute of Himalayan Geology (included in the Time 2007 list of environmental heroes around the world).

D. Business and Climate Change

For business, global climate change is a source of risk and opportunity to be understood and managed. The increasing scientific understanding, growing public concern and international treaty activity, and the seriousness of potential consequences are convincing many business leaders to address these concerns in their business plans.

Climate change could have catastrophic effect upon many industries. It could increase some costs of doing business and in some cases may completely disrupt the supply chain of the company. If environmental change and degradation were to occur on a large scale, suppliers, employees, operations and customers all could be affected, usually adversely. The business risks associated with climate change have four drivers, namely public concern, governmental action, developments in markets, knowledge and technology and climate change itself. The



effects of these drivers on business, discussed in the paper (see Table 9), must be properly understood by all business leaders.

E. An Opportunity for Industry

Efforts to mitigate climate change and global warming offer new opportunities for Indian industry and business to leapfrog the energy and resource intensive development process witnessed in the developed world. India can lead the newly industrialising countries in developing and adopting technologies and processes, and demonstrate a growth path and low-energy consumption pattern that would be far more sustainable than that of the industrial countries.

Since the Indian economy and infrastructure is relatively new compared to most of the large developed economies and is likely to add massive industrial and capital assets in the near future, India can opt for efficient, clean technologies, and resource efficient infrastructure. **Environmentally conscious investment decisions can allow the country to leapfrog into an era of carbon-efficient advanced technologies.** There are a large number of examples wherein foreign direct investment in India has yielded high benefits for the investor, while simultaneously leading to a strong development surge locally.

ITC presents an interesting case-study of a company responding in numerous ways to make their systems and processes environment–friendly, energy-efficient and responsive to climate change. Through a large number of initiatives in its various manufacturing plants, hotels and units, ITC has charted out a quiet but ambitious move to become the only corporation on earth to achieve triple green rating - it is already water positive, and is now moving to become both carbon positive and have zero solid waste.

F. Strategies To Mitigate Climate Change

Climate change mitigation strategies involve a whole range of actions across a number of sectors. Besides the focus on promoting renewable energy technologies (RETs) and energy efficiency in industries and power plants, other issues and sectors that need significant attention are the transport and the aviation sector, green buildings, greening of consumer choices by adopting appliance and equipment standards, free and open energy and carbon markets, a thrust on cleaner conventional energy technologies for the future, as well R&D for the development of new climate-friendly technologies. In addition, focus on water use efficiencies and better and more suitable agriculture and afforestation activities will also be needed.



Renewable Energy: India's multifaceted renewable energy programme, supported by the Ministry of New and Renewable Energy has already achieved installation of over 10,000 MW of renewables-based capacity. During the past three years, about 2,000 MW of renewable-electricity capacity has been added in India every year. India is the fourth largest country in terms of wind energy installed capacity. Hydropower capacity in India is now over 35,000 MW and the accelerated hydro development plan aims to build 50,000 MW of new capacity by 2025-26. The private sector, accounts for around 95% of the total investment in the sector. Government policy support will be necessary to keep up the momentum in this sector.

India is today in a position to play a major role in large-scale commercialization of RETs and can partner other developing countries as a technology provider, equipment supplier and capacity builder. India's experience in harnessing RETs for rural electricity supply linked to job creation is a powerful business model for ensuring economically, socially and ecologically viable development of the rural areas of the Third World and it is attracting a great deal of interest from countries in Asia, Africa and South America.

Energy Efficiency: Over the past decade, energy efficiency in Indian industry has increased steadily. In the major energy-consuming industrial sectors, such as cement, steel, aluminium, fertilizers, etc., average specific energy consumption has been declining because of energy conservation in existing units, and (much more) due to new capacity addition with state-of-the-art technology. Key factors pushing the energy saving programmes include liberalisation of the economy which forces the Indian industry to be more competitive.

Measures undertaken to promote energy efficiency include an exclusive Energy Conservation Act to provide regulatory impetus to energy efficiency activities, and an institutional framework through the Bureau of Energy Efficiency (BEE) to promote energy efficiency. Other measures include task-forces for 7 energy intensive sectors, a roadmap for Demand Side Management and reform of government procurement systems to take into consideration life-cycle costs.

This paper lists a large number of technological measures to be adopted in the short-, medium- and long-term in the aluminium, cement, ceramics, glass, pulp & paper, co-generation steam and condensate systems, sugar, textile, foundry, iron and steel, fertilizer and engineering industries and for enhancing the efficiency of power plants. A special focus for energy efficiency in coal-based power plants that currently account for about two-thirds of the total electricity-generation installed capacity of about 135,000 MW. Some new plants have adopted the more-efficient super-critical technology for power generation.



The Transport Sector: The transport sector, particularly road transport is dependent on fossil fuels and is the second largest consumer of energy after industry. Rapid economic growth, increased urbanisation, rising income levels and increased motorization coupled with shortage of reliable public transportation system may lead to exponential growth in number of vehicles and consequent increase in carbon emissions. Government policies, therefore, have an important role to play by providing adequate infrastructure and effective traffic management while also strongly supporting the development of public transport. Therefore, while vehicle ownership may increase, there can be a reduction in the average vehicle-kilometres driven if suitable multi-modal alternatives are available. Government policies can help moderate energy demand further by increasing energy efficiency through setting gradually tougher fuel efficiency standards for vehicles and by promoting alternatives such as freight transportation by waterways.

The Aviation Sector: Aviation contributed about 2 per cent of global fossil fuel carbon dioxide emissions in 2005, but aviation emissions could account for 5 per cent of the total warming effect (of all global CO_2 emissions) in 2050. Since the expansion of air transport in India is among the fastest in the world, India needs to take steps to set emission targets for airlines, as has been done in Europe and USA. India also need to formulate policies to encourage a shift from aviation to high-speed rail, to explore possibility of carbon credits for the Indian civil aviation sector and to pay attention to air traffic management and advances in aircraft technology.

Cleaner Conventional Energy Technologies: According to the IEA reference scenario, by the year 2030, almost 50% (620 Mtoe out of 1299 Mtoe) of India's total primary energy demand is likely to be met by coal. Even under the alternative policy scenario share of coal would be over 37% by 2030. Thus, any climate change mitigation strategy for India is not complete without finding the cleaner and more efficient ways of exploiting fossil fuels. These technologies include supercritical coal fired power plants and ultra super-critical boilers. Other promising technologies include Integrated Gasification Combined Cycle (IGCC) and Underground Coal Gasification (UCG).

Nuclear Energy: In the medium and long term future, nuclear energy will play an important role in India's energy scenario, considering the enormous demand of electrical energy in the future, and will also be essential from the point of view of combating climate change. According to the International Energy Agency, fusion energy has the potential to be a very safe, cost-effective and environmentally attractive source of power, although it cautions that a significant amount of research is still to be accomplished and safety aspects of various fusion systems need to be developed.

Water: Water use is directly linked to energy supply, availability and price. Water pumping takes up 25-30% of electrical energy consumption in India. Low power tariffs or free supply of power, especially at unregulated times and frequency leads to wastage of water. Supply of water to urban and municipal areas at potable purity is a huge drain on the limited financing resources of urban and municipal bodies. Numerous ways of using water more efficiently need to be adopted. These include efficient water pumping systems, demand side management and community involvement in water management and in restoration of water bodies, water harvesting and conservation as shown by the numerous instances.

Agriculture: Climate change can have extreme impacts on agricultural production, slashing crop yields and forcing farmers to adopt new agricultural practices in response to altered conditions. Climate change thus has an impact on food security and can be a matter of serious concern even in the short to medium term. A number of improvements in agricultural practices are needed to make agriculture more sustainable, climate friendly as well as to adapt to climate change. These include improvement and development of efficient crop varieties compatible to climate change, efficient utilisation of biotechnology for breeding, sustainable use of biological/ecological resources through organic farming and promotion of agro-forestry. A switch-over to sustainable modes of farming (e.g. reducing excessive use of nitrogenous fertilisers) and changes in paddy cultivation methods would go a long way in tackling the problem of climate change. To minimise the threat of extreme weather events and breakouts of plant diseases due to climate change, setting-up of advanced monitoring and early warning system is critical.

Afforestation: The basic components of India's forest conservation efforts include protecting existing forests, putting a check on the diversion of forest land for non-forestry purposes, encouraging farm forestry/private area plantations, expanding the protected area network and controlling forest fires.

Open Energy and CDM Markets: India needs a well-instituted market mechanism, where energy prices are based on the interaction of demand and supply. Subsidies in certain energy segments, particularly in fossil fuels, have distorted the market, have perpetuated inefficient use of energy and have serious repercussions for climate change.

CDM and other types of carbon markets such as voluntary emission reduction (VER) are proving to be effective tools for India for technology transfer and capacity building to cope with climate change. However certain deficiencies have impeded the full-scale exploitation of carbon opportunities by the country. The paper discusses the need to set-up an organised domestic carbon market in the country and the features of such a market.



Carbon Capture and Sequestration (CCS): India's current dependence on coal and existence of large coal reserves make it important that carbon capture and storage if proven and successful is made intrinsic to future coal use in India. India can take a lead in developing the roadmap towards commercialisation of CCS by adopting suitable measures such as a legal and regulatory framework and undertaking a national CO_2 sequestration capacity assessment.

G. Adaptation

Adapting to climate change will entail adjustments and changes at every level – from community-based to the national and international levels. Adaptation activities are particularly important for India. Adaptation will involve diverse practices, such as changes in behaviour (e.g. in water use or farming practices), structural changes (e.g. in the design specification of bridges and roads), policy based responses (e.g. integrating risk management and adaptation into development policy), technological responses (e.g. increased sea defences, improved forecasting) or managerial responses (e.g. improved forest management and biodiversity conservation).

H. Conclusion

Climate change is one of the most serious and urgent challenges that humanity face today. Global and national level decisions at present and in the next few years are crucial in determining how effectively we will be able to meet the challenge. Both developed countries and the fast growing developing countries such as China, India, Brazil and South Africa need to work together to synchronize their energy and developmental policies addressing both energy needs and climate concerns.

There are clear signs, however, that industry in India has adopted an approach that can help India leapfrog to a low carbon economy. India has already achieved some success in de-coupling the energy-GDP link at a much earlier stage of development. This goal can be achieved further by adopting suitable policies to promote non-carbon intensive fuels, renewables and state-of-the-art technologies and processes to promote energy efficiency in industries, power generation and in the transport, residential and commercial sectors. Indian industry stays committed to work towards finding new and innovative solutions and approaches to deal with climate change; and to imbibe these approaches in an accelerated manner.

India needs to focus both on adaptation and mitigation strategies to deal with challenges posed by climate change. The climate change issue is part of the larger challenge of sustainable

development. The most effective way to address climate change, therefore, is to adopt a sustainable development pathway by shifting to environmentally sustainable technologies and promotion of energy efficiency, renewable energy, forest conservation, reforestation, water conservation, etc. The issue of highest importance to India is reducing the vulnerability of its natural and socio-economic systems to the projected change in climate.

Addressing climate change mitigation and adaptation involves many stakeholders and cuts across short and long timeframes. The integration of climate concerns in the development process in India has been mainstreamed through the involvement of all stakeholders, which include government, industry, civil society, citizens and consumers and even the Indian diaspora, but continued and more vigorous efforts are needed in this direction. With a concerted, timely and focussed effort India can take leadership in building a low-carbon economy.



1.Climate Change: Global Challenge and Response

There is universal consensus that global warming has taken place over last century. Strong, new evidence indicates that the warming of the last 50 years is directly attributable to human activities.

The impacts of global warming include rise in average sea level and ocean heat content, decrease in snow cover and ice glaciers, as well as extreme weather conditions including long dry spells as well as unpredictable, heavy rainfall. These changes result in drop in agricultural yield, increased possibility of floods and droughts, adverse effect on human health and loss of bio-diversity. It is inevitable that economic development will be affected.

Despite these dark storm clouds, there is a ray of hope. Despite the fast pace of these changes, it is still possible to avert the worst consequences of climate change while expanding our energy supplies to meet the needs of both developed and developing countries. However, the decisions made in the next five to ten years are extremely important in determining the trajectory of required technology, systems, infrastructure and resource exploitation to ensure that global GHG would peak and start to decline within ten years (WWF, 2007).

Several recent studies and scenarios drawn up by institutions and think tanks give us reasons to believe that technology and resources are available to avert a dangerous disruption of global climate.

A key step forward would be for the high GHG emitting countries to agree on targets to collaborate on effective strategies, and to influence and coordinate the investments of many trillions of dollars (which in any event will be invested in energy in the coming decades), so that future needs are met in a safe and sustainable manner.

According to a study commissioned by Greenpeace, it is possible to change fundamentals of our energy supply systems sufficiently by 2050 to check climate change. If the recommendations of the study are implemented, 50% of global energy needs will come from renewables, while also reducing energy consumption by 50% compared to a business as usual (BAU) scenario through energy efficiency (EE) measures (EREC Greenpeace International 2007). This will only be possible if the developed countries and the fast growing developing countries such as China, India, Brazil and South Africa work together to synchronize their energy and developmental policies addressing both energy needs and climate concerns.

While global mitigation strategies are still being debated and discussed in various fora, there are clear signs and directions that industry in India has adopted an approach that sets the trend towards a low carbon economy. India's increasing participation in the global economy through trade, outsourcing, technology deals and acquisition of companies and businesses

also indicates that Indian companies are acquiring the best climate friendly technologies and adopting processes and practices that would bring down the dependence of fossil fuels. The steady growth rate of over 8% has been accompanied by a less than 4% growth in energy consumption.

India's response to climate change is broad-based, enabling the country to move consistently towards a low-emission growth trajectory. It includes changing trends in overall consumption patterns, a thrust on the use of renewable energy sources and on improved energy efficiency, a transport policy that seeks to encourage an efficient rail-road mix and developing an efficient highways network, an automobile policy that is aligned to the best international safety and emission norms, and urban planning that aims to optimise living and working spaces as well as restore depleted green cover. India is emerging as the global hub for further energy efficiency in industry, buildings, residential and commercial sectors and is playing a key role in the identification, development and utilization of new and renewable energy sources.

Over the past decade, energy efficiency in Indian industry has increased steadily. In the major energy-consuming industrial sectors, such as cement, steel, aluminium, fertilizers, etc., average specific energy consumption has been declining because of energy conservation in existing units, and (much more) due to new capacity addition with state-of-the-art technology. The specific energy consumption of Indian cement plants and of Indian iron and steel plants, for instance, has been declining rapidly. In the cement sector, the specific energy consumption of some of the plants in India is now comparable to that of the most efficient plants in the world.

New initiatives being taken by Indian industry include energy labelling, energy conservation in buildings, energy audits, energy efficient and low carbon emission transport systems and vehicles, further improvements in energy efficiency in industries and power plants, and active participation in CDM projects. In the transport sector, there are low carbon emission public transport systems like the CNG run public vehicles and the Metro in New Delhi, and the envisaged fuel efficient Rs 1 lakh ($ 2500) people's car by the Tatas. The energy-labelling programme for appliances introduced comparative star-based labelling for fluorescent tube lights, air conditioners, and distribution transformers. The recently launched Energy Conservation Building Code (ECBC) addresses the design of new, large commercial buildings to optimize the buildings' energy use. Indian industry is actively participating in CDM projects. 282 projects registered by the CDM Executive Board have already resulted in over 28 million tones of certified CO_2 emissions reductions, and have directed further investments in renewable energy and energy efficiency projects.

This paper outlines the proactive role being played by Indian Industry, with support from the government, in adopting technologies and practices that will help us leapfrog to the low carbon economy and effectively meet the great challenge posed by climate change. It also notes the various initiatives taken by civil society in this direction and illustrates how the risks posed by climate change can be tackled and converted into business opportunities.



2. Impacts of Climate Change on India and the Global Economy

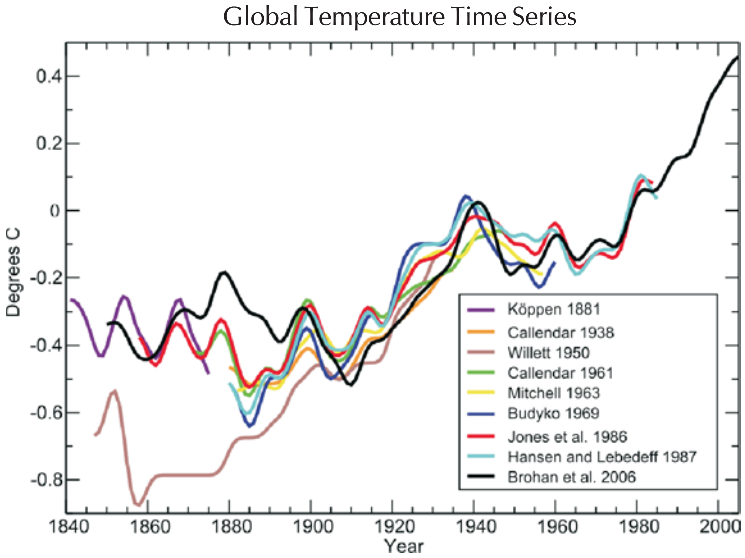
2.1. Global Impacts of Climate Change

The fourth assessment report conducted by IPCC reinforced it's previous findings and concluded that global warming has taken place over the last century, and there is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities. Over the past five decades there has been global warming of approximately 0.65 °C (1.17 °F) at the Earth's surface (picture 1 shows the earth surface temperature pattern in recent years). Other prominent impacts indicated by the fourth assessment report include rise in global average sea level and ocean heat content, and decreases in snow cover and ice extent both in mountain glaciers and Arctic sea ice. Recent evidence suggests that a predicted slow-down in the deep ocean circulation driven by variations in temperature and salinity may also be occurring. These changes in global climate may result in drop in agricultural yield, increased possibility of floods and droughts, adverse effects on human health and loss in bio-diversity.

2.1.1. Earth's Surface Temperature

Since the end of the 19th century, the earth's average surface temperature has increased by 0.3-0.6 °C. Over the last 40 years, the rise has been 0.2-0.3 °C. The recent IPCC report further predicted that over the next 100 years, the earth's average temperature could rise by another 1.4-5.8 °C.

Figure 1:
Global Temperature Time Series



Source: Intergovernmental Panel on Climate Change



2.1.2. Agriculture

Climate change will affect agricultural yield directly because of alterations in temperature and rainfall, and indirectly through changes in soil quality, pests, and diseases. Indian farmers would be among the worst hit.

2.1.3. Weather

A warmer climate will change rainfall and snowfall patterns, lead to increased droughts and floods, cause melting of glaciers and polar ice sheets, and result in accelerated sea- level rise. Rising warmth will lead to an increase in the level of evaporation of surface water; the air will also expand and this will increase its capacity to hold moisture.

2.1.4. Sea level rise

The heating of oceans, and melting of glaciers and polar ice sheets, is predicted to raise the average sea level by about half a metre over the next century. Sea-level rise could have a number of physical impacts on coastal areas, including loss of land due to inundation and erosion, increased flooding, and salt-water intrusion. These could adversely affect coastal agriculture, tourism, freshwater resources, fisheries and aquaculture, human settlements, and health. Rising sea levels threaten the survival of many low-lying island nations, such as the Maldives and Marshall Islands. In India, according to an approximation around 20% of the coastal population would need to migrate. The entire 7,600 km of the Indian coastline will be adversely hit.

2.1.5. Health

Global warming will directly affect human health by increasing cases of heat stress. Present temperature zones are likely to become vulnerable to disease outbreaks like malaria and dengue.

2.1.6. Biodiversity

Present climate change pattern has endangered both wildlife and marine life. Mountainous wildlife, polar fauna, coral reefs; all are at risk due to high surface and ocean temperature.



2.2. Climate Change Impacts on the Poor

Weather-related disasters have quadrupled over the last two decades, from an average of 120 a year in the early 1980s to as many as 500 today. There has been a six-fold increase in floods since 1980. The number of floods and wind-storms has risen from 60 in 1980 to 240 last year. Meanwhile the number of geothermal events, such as earthquakes and volcanic eruptions, has stayed relatively static. At the same time as climate hazards are growing in number, more people are being affected by them because of poverty, powerlessness, population growth, and the movement and displacement of people to marginal areas (Oxfam, 2007).

The number of people affected by all disasters has risen from an average of 174 million a year between 1985 and 1994 to 254 million a year between 1995 and 2004. For poor people who are dependent upon the land even a slight change in the climate can have a long term impact on their livelihoods. Dramatic weather events, however, do not in themselves necessarily constitute disasters; that depends on the level of human vulnerability – the capacity to resist impacts. Poor people and countries are far more vulnerable because of their poverty. One shock after another, even if each is fairly small, can push poor people and communities into a downward spiral of destitution and further vulnerability from which they struggle to recover.

The impact of a natural disaster is anything but natural: it is based on inequalities. In general, extreme climatic events in the rich world result in large economic losses and few deaths. In the poor world the impact is the other way round – greater loss of life and relatively less economic damage, because poor countries have fewer assets. But the damage can be proportionately more crippling. Between 1985 and 1999 the losses of the richest countries due to natural disasters were just over two per cent of GDP, while the poorest countries' losses were 13 per cent (United Nations, n.d.)

Clearly enough, eradication of poverty and empowerment of poor are essential components of climate change impact mitigation strategy for counties like India. In addressing this challenge, inclusive growth with its focus on creating economic opportunities and ensuring equal access to them will play a pivotal role. India has already adopted such strategy by focusing on raising economic growth and making growth more inclusive (Planning Commission of India, 2006). While, several national and international agencies forecast India's medium term GDP growth rate to be around 6 - 8%; Industry believes that a sustainable growth rate of 10% is possible if government pursues ambitious and wide-ranging economic reforms and invests sufficiently in social schemes with the productivity and efficiency gains ploughed back in the economy.



2.3. Impacts of Climate Change on India

As indicated above, climate change is undoubtedly one of the greatest environmental, social and economic threats, our planet faces today. It impacts all countries, but is particularly severe for developing countries, given their vulnerabilities, inadequate means and limited capacities to adapt to its effects. India, like several other developing countries, does not have infrastructure to deal with several of its impacts such as extreme weather events, rising sea levels, desertification, agricultural crisis, water crisis etc. Some of the expected impacts of climate change on India are:

- India's 7600-km long densely populated and low-lying coastline would be worst hit due to rise in sea level
- 20% of the coastal population may need to migrate
- 25% of the country's population would be exposed to increased cyclone and flood risk
- Melting and receding of Himalayan glaciers leading to reduced flow of water in perennial rivers
- 70% plants may not be able to adapt to new conditions
- More than 20,000 villages may have to be deserted
- Adverse impact on agricultural yield
- Increase in incidence of diseases like malaria

3. India's Official Position and the Current Energy Scenario

The Indian Government has taken a stand in global fora that developmental issues and concerns should be integrated into climate change framework if the issues are to be effectively addressed. GHG mitigation and adaptation strategies should be designed to allow developing countries to achieve rapid economic growth and meet millennium development goals and have sufficient resources to support adaptation efforts.

In the global response to climate change, there is a need for common but differentiated responsibilities to be borne by the developed and the developing economies. For developing countries like India the right to development is extremely important and is not negotiable. India has to find solutions which can meet the MDGs, reduce poverty, and can lead to economic and industrial growth without sacrificing the long term objectives of energy security and climate change. India is conscious of its responsibility to tackle the problem of climate change and will adopt both adaptation and mitigation strategies to deal with it.

Energy is a fundamental factor in the developmental process. India, with over a billion people, today produces 660 billion KWh of electricity and over 600 million Indians (equal to the combined population of USA and EU) have no access to electricity and limited access to other clean, modern fuels. Low energy availability and consumption is reflected in the relatively low Human Development Index of India. Enhancing energy supply and access is, therefore, a key component of the national development strategy.

However, over the past decade, while gains in poverty reduction and economic growth have been significant, energy growth has been significantly lower than economic growth. This reduced energy intensity of the economy, in the period since 2004, has been marked by an economic growth rate of over 9% per annum, which has been achieved with an energy growth of less than 4% per annum. Energy intensity of the Indian economy now compares favourably with those of other major economies.

India has achieved some success in de-coupling the energy-GDP link at a much earlier stage of development. During the tenth plan period (2002-07), average GDP growth rate was significantly higher than projected growth rate. During the same plan period, power capacity addition was only 50% of what was planned for the period. Even though oil prices have risen sharply in recent years hampering the bottom-line of manufacturing companies all over the world, industrial growth and profitability have been high in India; indicating energy-GDP decoupling and energy efficiency improvement.

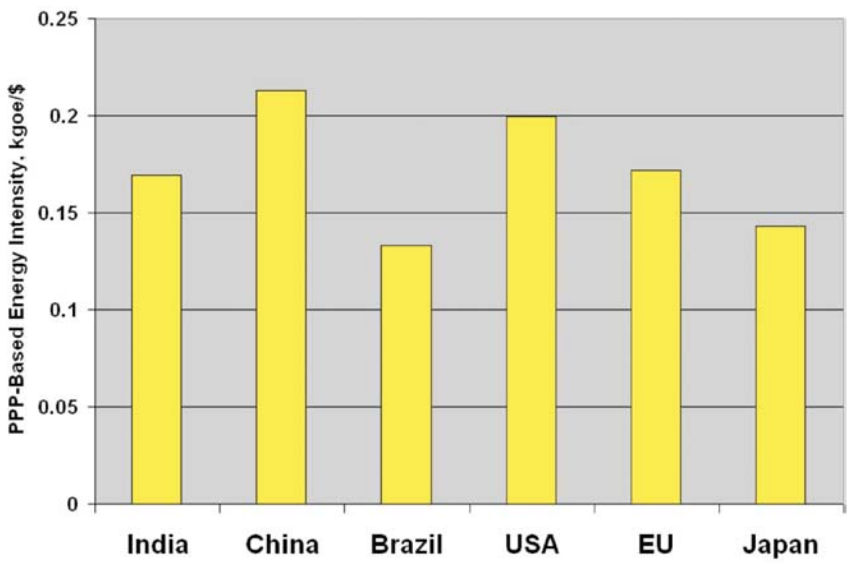
This reduction in energy intensity has been made possible by a range of factors, including India's historically sustainable patterns of consumption, enhanced competitiveness, proactive

policies to promote energy efficiency, and more recently, the use of the Clean Development Mechanism (CDM) in promoting the adoption of clean energy technologies. India has directly contributed to GHG mitigation through the CDM mechanism, and hosts the largest number of registered projects among all the countries.

Several other climate-friendly initiatives being put in place include increasing the capacity of renewable energy installations; improving the air quality in major cities (CNG public transport); promoting energy efficiency in the industrial and household sectors and afforestation programmes.

The outcome of all these initiatives is that India's energy intensity of GDP has reduced from 0.30 kgoe per $ GDP in PPP terms in 1972 to 0.19 kgoe per $ GDP in PPP terms in 2003 (figure 2 below); this is almost equal to that of EU. Currently, the primary energy sector growth rate is 2.76% per year, against GDP growth exceeding 8%. The share of renewable energy in total primary energy is 34%. In all the major energy intensive sectors – steel, aluminium, fertilizer, paper, cement, levels of energy efficiency are striving to reach global levels. Especially in the cement sector, the energy efficiency of Indian plants is among the world's highest.

Figure 2:
Total Primary Energy Intensities of the Major Economies



Source: Bureau of Energy Efficiency

There is a strong indication that with the proactive and multi-faceted response from Indian industry, government and civil society, Indian economy and industry would be able to adapt rapidly and efficiently to meet the challenges generated by climate change.

Nuclear Energy: In the medium and long term future, nuclear energy will play an important role in India's energy scenario and will also be essential from the point of view of combating climate change. According to the International Energy Agency, fusion energy has the potential to be a very safe, cost-effective and environmentally attractive source of power, although it cautions that a significant amount of research is still to be accomplished and safety aspects of various fusion systems need to be developed (International Energy Agency, 2007).

India, needing enormous electrical energy to sustain high GDP growth, considers nuclear power as an important constituent in the power mix. The best way to achieve this will be the opening of the nuclear market to private and foreign players. The inherent risks and concerns in nuclear application can be tackled appropriately.

4. Alternative Energy Scenarios for the Future

The nature of India's energy scenario and the extent to which India can meet the challenge of climate change in the coming decades will largely depend on the energy use choices and policies adopted. The next few years, in fact, present India with an opportunity to design energy policies in a way that can contribute to substantial mitigation of climate change risks while simultaneously ensuring energy security and contributing to high rates of economic growth.

The table below (Table 1) lists a set of recommendations from the Planning Commission

Table 1: India's Integrated Energy Policy:
Priority Recommendations of the Expert Committee

Recommendation	Targets / Goals
Ensure adequate supply of coal of consistent quality	Make more coal blocks eligible for development by private companies or joint ventures; build infrastructure to facilitate steam coal imports; rationalise coal pricing; amend the Coal Nationalisation Act to facilitate private participation.
Address the concerns of resource-rich states	Allow these states to share in profits; revise royalty rates; create national policy on domestic natural resources.
Ensure availability of gas for power generation	No new gas fired capacity to be built until firm gas supply agreements are in place.
Reduce the cost of power	Reduces losses through use of automated meters and separate metering of agricultural pumps; proper setting of cross-subsidy surcharges and wheeling and backup charges; create an efficient interstate and intrastate transmission system; refurbish power stations; generation and transmission projects built on tariff-based bidding.
Rationalise fuel prices	Price energy at trade-parity prices; remove administered pricing scheme.
Enhance energy efficiency & demand-side management	Improve power generation efficiency from 36% to 38-40%; information dissemination; minimum fuel standards.



Recommendation	Targets / Goals
Augment resources for increased energy security	Carry out surveys of energy resources; enhanced recovery of domestic resources; private sector involvement.
Use more energy abroad	Invest in captive fertilizer and gas liquefaction facilities.
Enhance role of nuclear and hydropower	Tap thorium reserves; create more hydro storage facilities.
Enhance role of renewable	Link incentives to outcomes like energy generation, not installed capacity; enact policies to promote alternative like plantations, gasifiers, solar thermal and photovoltaic, biodiesel and ethanol; expand equity based of the Indian Rural Energy Development Agency.
Ensure energy security	Maintain strategy oil reserves in line with IEA standard of 90 days; engage in bilateral agreements to reduce supply risk.
Boost energy related R&D	Set up a National Energy Fund to finance energy R&D.
Improve household access to energy	Provide electricity to all household by 2009/10 (Rajeev Gandhi Grameen Vidhyutikaran Yojana); have more targeted subsidies using debit card systems; improves efficiency of cook stoves and kerosene lanterns; use more distributed generation; increase access to financing for micro enterprises; involve rural communities in decision-making.
Enable environment for competitive efficiency	Devolve regulatory responsibilities from ministries to state level; regulators should mimic competitive markets.
Address climate change concerns	Enhance energy efficiency in all sectors; increase mass transit; use more renewables and nuclear; invest in clean coal technologies; more research and development.

Source: Planning Commission (2006)

from the point of view of India's long-term energy needs and addressing these through an integrated energy policy that is also sensitive to climate change concerns.

If appropriate steps such as these are taken by government as well as industry in the next two decades, it is feasible for India to substantially reduce the emissions of green house gases. This can be done by progressively reducing the demand and consumption of primary energy deriving from coal, oil and gas while consistently increasing the share of primary energy deriving from biomass sources, other renewables, nuclear and hydro generation.

Tables 2 and 3 below show the profile of India's primary energy demand in the reference and alternative policy scenarios envisaged by the World Energy Outlook 2007 of the International Energy Agency (2007). The Reference Scenario takes into account government policies and measures that were enacted or adopted by mid-2007. However, not all of these policies are assumed to be fully implemented in the Reference Scenario. This scenario assumes an average annual GDP growth rate 6.3% during the period 2005 to 2030. In the Alternative Policy Scenario full implementation of these policies is considered, along with implementation of other policies which are now in contemplation or seem likely to be adopted. However the rate of economic growth and structure of GDP in India are assumed to follow the same trajectory as in the reference Scenario. Domestic energy prices are assumed to follow international prices and subsidies are assumed to be reduced progressively till 2030.

While in the reference scenario carbon intensive fuels coal, oil and gas will provide for nearly 80 per cent (1041 Mtoe) of the total primary energy demand (1299 Mtoe) in 2030, up from 71.7 per cent in 2005, in the alternative policy scenario, total primary energy demand itself will be 16.7 per cent less than the total demand in the reference scenario, and coal, oil and gas will provide only 37.2 per cent (402 Mtoe) of this reduced overall demand (1082 Mtoe).

Lower overall energy consumption, combined with a larger share of less carbon intensive fuels in the primary energy mix, will yield savings of 27% in carbon dioxide emissions by 2030.

Table 2: India's Primary Energy Demand in the Reference Scenario (Mtoe)

	1990	2000	2005	2015	2030	2005-2030*
Coal	106	164	208	330	620	4.5%
Oil	63	114	129	188	328	3.8%
Gas	10	21	29	48	93	4.8%
Nuclear	2	4	5	16	33	8.3%
Hydro	6	6	9	13	22	3.9%
Biomass	133	149	158	171	194	0.8%
Other renewables	0	0	1	4	9	11.7%
Total	320	459	537	770	1299	3.6%
Total excluding biomass	186	311	379	599	1105	4.4%

Source: IEA 2007

Table 3: India's Primary Energy Demand in the Alternative Policy Scenario (Mtoe)

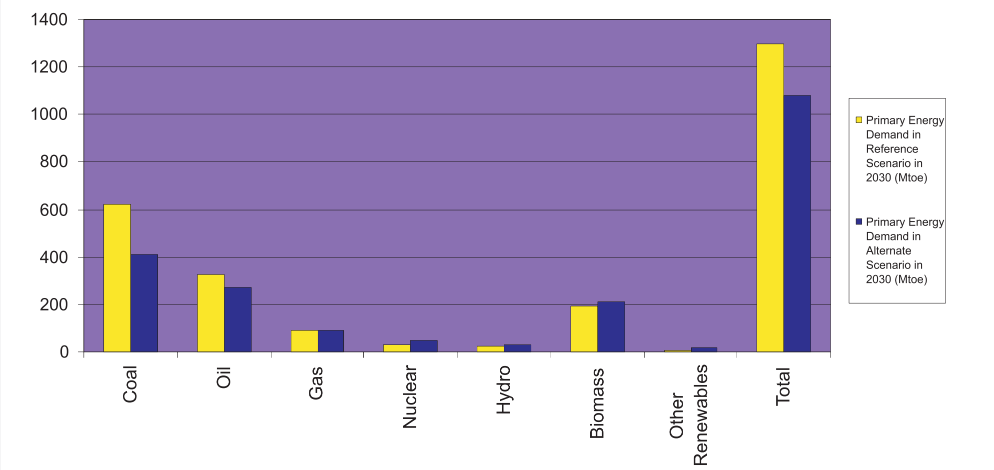
					Difference from the Reference scenario in 2030	
	2005	2015	2030	2005 - 2030* (%)	Mtoe	%
Coal	208	289	411	2.8	-209	-33.7
Oil	129	173	272	3.0	-56	-17.1
Gas	29	47	89	1.6	-4	-4.3
Nuclear	5	19	47	9.9	14	41.9
Hydro	9	17	32	5.3	9	42.3
Biomass	158	168	211	1.2	17	8.5
Other renewables	1	6	21	18.8	12	145.5
Total	537	719	1082	2.8	-217	-16.7

Source: IEA 2007*

Average annual rate of growth

Figure 3 below shows the difference in India's energy mix and total energy demand in reference scenario and alternate scenario.

Fig No. 3 : India: Reference Scenario and Alternate Energy Scenario



Switching to the alternative scenario would require implementation of key policy measures in various sectors - power generation, industry, transport, residential and services sector - simultaneously. These measures are listed in the various tables below:

Table 4: Key Policies in India's Power Generation Sector in the Alternative Policy Scenario

Policy / measure	Assumption
Integrated Energy policy recommendation to increase coal plant efficiency from 30.5% to 39%	Two percentage points higher efficiency for new plant compared to Reference Scenario
Development of IGCC programme	More R&D, IGCC becomes available in 2020
Renovation of electricity networks, accelerated power development and reform programme (APDRP)	Six percentage point decline in losses compared to reference scenario in 2030
R&M (renovation and modernization) programme of power stations	One percentage point efficiency improvement of existing coal fired power stations
Greater use of hydropower	Approaches full economic potential by 2030
New and renewable energy policy statement 2005 – draft II Rural Electricity Supply Technology (REST) Mission, Remote Village Electrification Programme (RVE)	Faster deployment of renewable energy technologies through incentives
Expand use of nuclear	24 GW by 2030

Source: IEA 2007



Tables 4 and 5 list the key policies to be adopted in India's power generation and industrial sectors respectively in the Alternative Policy scenario.

Table 5: Key Policies in India's Industry Sector in the Alternative Policy Scenario

Policy / measure	Assumption
National steel policy - aims to reduce costs and improve efficiency and productivity in the iron and steel sector	Efficiency improves by 15% over reference scenario
Greater use of CHP	Increased use of biomass potential in CHP
Higher efficiency processes in energy intensive industries, particularly cement	Reduction in energy intensity of cement industry of 3% per year
Energy Conservation Act 2001	Stricter enforcement; increased efficiency of motors by 15%

Source: IEA 2007

Table 6 below shows that alternative policies followed in the Industry sector will lead to 13.9 per cent savings in total energy consumption as compared to the Reference Scenario in 2030.

Table 6: India's Industrial Energy Consumption and Savings in the Alternative Policy Scenario (mtoe)

				Difference from the Reference scenario in 2030	
	2005	2015	2030	Mtoe	%
Coal	29	50	79	31.3	-28.3
Oil	19	25	34	3.8	-10.2
Gas	5	7	9	0.8	-7.8
Electricity	18	38	78	5.2	-6.2
Biomass	27	30	33	-2.9	9.7
Total	99	149	234	37.8	-13.9

Source: IEA 2007



Similarly, Table 7 below indicates the key policies to be adopted in the transport sector in the alternative policy scenario and Table 8 indicates the policies to be adopted in the residential and services sector.

Table 7: Key Policies in India's Transport Sector in the Alternative Policy Scenario

Measure	Description	Assumption
Fuel economy standards LDVs	India has yet to enact fuel economy standards	10% increase over all vehicles compared with reference scenario
Vehicle emission standards	Following the European vehicle emission standards	Impact on pollution and CO_2 emissions, secondary impact on fuel consumption
Biofuels	5% ethanol blended gasoline was introduced in 9 states and 4 union territories in 2003 and was reintroduced and extended nation wide in 2006 although subject to availability	Ethanol share in gasoline increases to 10% in 2012*. Biodiesel blending in diesel starts in 2009 increasing to 5% by 2015 and 8% share by 2018
CNG	All commercial vehicles in Delhi, Mumbai and Kolkata run on CNG	Doubling of CNG vehicles compared with reference scenario.
Public transport and infrastructure development	Construction of bus lanes and suburban and underground rail systems to ease road congestion	5% increase in the number of buses (+200 00) compared with reference scenario in 2030

Source: IEA 2007

* In September 2007 the Indian Agriculture Minister announced that the government would soon mandate an increase in the ethanol content in gasoline from 5% now to 10%.

Lower energy demand in the power and transport sectors reduces SO^2 emissions by 27% and NOx emissions by 23% in 2030, compared with the Reference Scenario. Lower overall energy consumption, combined with a larger share of less carbon intensive fuels in the primary energy mix, will yield savings of 27% in carbon dioxide emissions by 2030. Energy efficiency improvements on both the demands and supply sides account for most of the savings.

Table 8: Key policies in India's residential and services sectors in the alternative policy scenario

Measure	Description	Assumption
Building codes & standards	Set minimum requirements for the energy efficient design and construction of commercial buildings or complexes with electricity load of 500 kW or capacity of 600 kVA or more	Greater building stock efficiency improvements
Energy efficiency labelling	Mandatory labelling covers frost free refrigerators and tubular fluorescent lamps. Labelling for other productions will be introduced in a phased manner	50% of all lights bulbs are CFLs in 2030; average appliance efficiency is 30% higher in 2030
Improved cook stoves (chulhas)	Installation of improved chulhas in rural and semi urban households	120 million improved cook stoves by 2030, scale up of the pilot programmes
Biogas	Promote family type biogas units for recycling of cattle dung to harness its fuel value without destroying manure value	12 million biogas plants by 2030
Solar devices	Construction of solar water heating systems solar air heating /steam generating systems for community cooking	Increased penetration of solar water heaters

Source: IEA 2007



5. India: Leading by Example

India has been an early mover in increasing the use of renewable energy through the formulation of appropriate policies and in a number of sectors has effectively addressed major barriers to developments.

For instance, scarcity of food, malnutrition and diseases, poor availability of modern and convenient forms of energy, the lack of technology in several key sectors, low level of telecommunications infrastructure, have all been addressed in effective ways. India's experience in dealing with these problems provides valuable lessons and practical models for turning liabilities into assets, and climate change could well be another area in which the country can show how barriers can be overcome effectively.

Supplying energy to remote rural areas: Energy shortages in rural and remote areas were a major drag on bringing the poor and isolated population groups into the mainstream of development. Through a dedicated Ministry for New and Renewable Energy (formerly Non-conventional Energy Sources), and through a combination of support based on subsidies and grants, as well market-oriented policies Renewable energy technologies (RETs) have played a key role in supplying energy to areas where conventional grid power cannot reach. There is a wealth of experience in a wide range of RE technologies and their applicability to different regions. This includes extensive R&D efforts in development, innovation, customization and maintenance of RETs and their deployment in varied and niche areas.

Box 1 : The Energy and Resources Institute (TERI)

TERI was formally established in 1974 with the purpose of tackling and dealing with the acute problems that mankind is likely to be faced in the years ahead

- on account of the gradual depletion of the earth's finite energy resources which are largely non-renewable and
- on account of the existing methods of their use which are polluting

Over the years the Institute has developed a wider interpretation of this core purpose and its application. Consequently, TERI has created an environment that is enabling, dynamic and inspiring for the development of solutions to global problems in the fields of energy, environment and current patterns of development, which are largely unsustainable. The Institute has grown substantially over the years, particularly, since it launched its own research activities and established a base in New Delhi, its registered headquarters.

Source: TERI



India is now a world leader in the application of certain RETs. Approximately 10,000 MW of RE based installed capacity[1] is already in place. Financial Institutions such as the Indian Renewable Energy Development Agency Ltd (IREDA), dedicated to financing and developing renewable energy and energy efficiency in India, are in place. IREDA has played a key role in channelling private finance and entrepreneurship into developing the RETs. R&D and technological support for RETs has also been addressed through institutions such as Centre for Wind Energy Technology (C-WET). The Indian company Suzlon Energy Ltd. is now the world's 4th largest wind energy company. The country is emerging as an export hub in wind, solar and biomass equipment.

Addressing lack of technology: To address the issue to lack of technology, Indian companies have made rapid strides in shopping for the best technologies world-wide. In recent years several global acquisitions have taken place. A key objective of these acquisitions has been to access to cutting-edge technology. For instance, Tata Steel acquired Corus, Suzlon acquired RE Power and Hansen Transmission while Hindalco acquired Novelis. Multinationals are setting up R&D facilities in India (GE, AREVA, etc.) and Indian companies are increasingly investing in R&D in India and abroad.

Improving poor telecommunications infrastructure and low tele-density: Today India is one of the fastest growing telecom markets with one of the cheapest call rates in the world. Indian telecom companies now offer a variety of world class services and service providers.

Combating climate change and related natural disasters: Since the early years of development planning, India has had to contend with climate-related impacts and natural disasters affecting economic development. These have been in the form of droughts and floods, tidal waves and cyclonic storms, earthquakes and epidemics, localized scarcity of food and water. Over the years the economy has built up resilience to cope with these crises and reduce their overall impact. Even though the frequency and intensity of these calamities has increased, there are many cases where effective policy and local response has helped in cushioning the impact and in assisting the local population to return to normal life, and in the restoration of their livelihoods.

Technical departments and organizations of the government, R&D institutions, industry and civil society organizations have also actively supported efforts to minimize the impact of natural calamities on the population. Industry and business too have complemented government efforts to rebuild lives, incomes and infrastructure.

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[1] This figure does not include large Hydro, which is another significant energy source



Global recognition to Indian pioneers: Due to its size and the fast pace of economic growth in recent years, India is crucial to the global response in countering the challenge of climate change. India's lead in promoting renewables and in achieving low energy intensity at a much earlier stage of development is a significant model for other developing countries.

India's leadership in meeting the challenge of climate change has been further highlighted by the recent global recognition awarded to a number of Indian pioneers. The recently announced Nobel Peace Prize was shared by the R. K. Pachauri[2]-led IPCC while Time magazine has included the entrepreneur Tulsi Tanti of Suzlon Energy and the glaciologist Dr Dwarika Prasad Dobhal of the Wadia Institute of Himalayan Geology in its 2007 list of environmental heroes around the world. Tanti has been recognised for his work on promoting wind energy while Dr Dobhal has been recognised for his work on studying glaciers.

[2] Dr. R. K. Pachauri is also founder Director General of The Energy and Resource Institute (TERI); (see Box 1)



6. Business and Climate Change

For business, global climate change is a source of risk and opportunity to be understood and managed. Though climate predictions vary, the increasing scientific understanding, growing public concern and international treaty activity, and the seriousness of potential consequences are convincing many business leaders to address these concerns in their business plans.

6.1. Business Risk and Climate Change

An actual change in climate could have catastrophic effect upon many industries. It could increase some costs of doing business and in some cases may completely disrupt the supply chain of the company. If environmental change and degradation were to occur on a large scale, suppliers, employees, operations and customers all could be affected, usually adversely. The impact of severe weather storms, droughts, hurricanes or similar weather disturbances suggests that the economic impact of major climate change could be significant. The business risks associated with climate change have mainly four drivers (Table 9) that must be properly understood by all business leaders.

Table 9: Factors Influencing Business Environment

Drivers	Effect on Business
Public Concern	Public concern about the environmental consequences could further strengthen the market pressures favouring "green" companies. This may affect ability to market products and ability to mobilize investment for perceived 'dirty industries'.
Governmental Action	Governmental action to reduce emissions of greenhouse gases, varying in strength, emphasis and from one jurisdiction to another.
Developments in Markets, Knowledge and Technology	Recent and ongoing developments in markets, knowledge and technology, which enable businesses to cut their carbon emissions while increasing productivity.
Climate Change itself	Can cause physical risks such as disruption of supply chain, physical infrastructure and networks.



There are many types of possible risks for business that could emanate from the four drivers mentioned above. Public concern about climate change may translate into consumer preference and market preference that may disfavour brands perceived as dirty. Governmental action may result in regulatory risk for certain companies due to change in policy and regulation. Due to change in technologies and know-how, new companies may take environmental leadership and may put existing firms in a competitive disadvantageous position. There are many such risks that can hit the bottom-line of existing businesses. An indicative list of these risks is provided below:

- **Regulatory Risk:** frequent changes (tightening of) national/international regulatory structure (provisions).
- **Physical Risk:** possible damage to physical infrastructure, inventories of companies due to drought, flood, cyclone and other extreme events.
- **Competitive Risk:** due to rise in the cost of energy-intensive processes and a decline in demand for energy-intensive products.
- **Reputational Risk:** from customers and investors. Perception of inaction on climate change.
- **Litigation Risk:** threat of lawsuits for units emitting GHG gases.
- **Product & Technology Risk:** various technologies will be at risk due to carbon constraints.
- **Supply-chain Risk:** vulnerability of inputs such as energy and agricultural products.

Businesses all over the world and in India have responded to mitigate the threat of climate change. There are several examples of such efforts including formation of Business Council of Sustainable Development, voluntary emission reduction targets by many companies (primarily traded in CCX) and corporate investment in R&D for clean technologies. In India, industry has been the prime investor in energy efficiency, renewable energy and green building projects. Companies are competing to improve efficiency of their business processes and reduce energy and material consumption by utilising instruments like supply-chain management, ERP, automation, etc.



7. Industry Poised

7.1 The New Economy of India: Opportunities for Climate Change Initiatives

Efforts to mitigate climate change and global warming offer new opportunities for Indian industry and business to leapfrog the energy and resource intensive development process witnessed in the developed world. India can lead the newly industrialising countries in developing and adopting technologies and processes, and demonstrate a growth path and low-energy consumption pattern that would be far more sustainable than that of the industrial countries.

Technologies and practices affecting durable long-lasting systems are difficult to penetrate once assets have been constructed. Typically, power plants and industrial facilities last for 50 years or more. Buildings, once constructed, can stand for many decades. An automobile or truck has a life span of 15-20 years. Indian economy and infrastructure is relatively new compared to most of the large industrialising economies. The country is likely to add massive industrial and capital assets, and create huge infrastructure in the near future.

Developed countries have to retire old assets, created over the years, before they can build new assets based on cleaner technologies. India, on the other hand, can opt for efficient, clean technologies, and low-intensity resource efficient infrastructure. It is clear that environmentally conscious investment decisions can allow the county to leapfrog into an era of carbon-efficient advanced technologies.

There is abundant proof and a large number of examples wherein foreign direct investment in India has yielded high benefits for the investor, while simultaneously leading to a strong development surge locally. These investments need to be channelled in a direction which promotes low energy development.

Indian industry is determined to adopt the more energy efficient and cost-effective technologies and processes available in the world. It is also able to suitably adapt these to local conditions and environment. Some of the technologies that can help leapfrog the conventional energy intensive growth path are LEDs and solar lighting, and a wide array of energy efficient systems and processes.

For instance, Cosmos Ignite Innovations, a spin-off from Stanford University that is now based in New Delhi, has developed the Mighty Light, a solar-powered LED-based lamp that is waterproof, portable and runs for up to 12 hours. So far, Cosmos has sold nearly 5,000 of its $50 lamps to various charities. The lamp is potentially a very attractive and appropriate solution for kerosene replacement.



Box 2 : Case Study - ITC

ITC presents an interesting case of a company responding in numerous ways to make their systems and processes environment–friendly, energy-efficient and responsive to climate change. Various initiatives taken by ITC include the following:

ITC (tobacco, hotels, paper, food) has charted out a quiet but ambitious move to become the only corporation on earth to achieve triple green rating - it is already water positive, and is now moving to become both carbon positive and have zero solid waste.

Carbon positive: Implies a company, through afforestation programmes and efficient use of energy, eliminates more carbon dioxide from the atmosphere than the sum of the carbon emitted by the company through areas like the generation of electricity, running A-C plants and so on. Water positive: This implies that an organization generates more volume of fresh water through various water harvesting methods than it consumes in its factories. Zero solid waste: A company that achieves this is either able to utilize its entire waste as raw material for some other industry, or recycle it for use again in the factory.

- In all its hotels, high-tech water treatment plants (that cost Rs 40 lakh each) ensure that the water used in the rooms, the kitchen and by the laundry department is recycled back for use in the hotel gardens, in the cooling towers for the A-Cs, and even for flushing toilets.
- It has succeeded in registering as many as seven CDM (clean development mechanism) projects (three large-scale and four small), accounting for nearly one million CERs (certified emission returns).
- In 2004, the company created a total rainwater harvesting potential of 16.1 million kilolitres with the company consuming only half of this.
- The carbon sequestered during 2003-04 at 1,74,000 tonnes, offsetting carbon dioxide to the tune of 6,36,000 tonnes. The wood production during 2003-04 is put at 3,48,000 tonnes. As per current pulp requirements, the company needs only 4,000 ha of plantations annually, but is actually covering more than 10,000 ha, delivering bumper yields.

Sonar Bangla, Kolkata (Hotel)

- Energy Reduction is 20% by using solar heaters, condensed steam to generate hot water and using variable frequency valves in fans.



- In the process of getting certification for a reduction of 3,000 tonnes of carbon dioxide emission achieved by energy reduction.

Bhadrachalam Paperboard Plant

- Fly ash generated from the boilers in the mill is used to make bricks.
- Promoted 74,427 hectares of plantations (both Eucalyptus and Subabul trees) by distributing 313 million saplings in Andhra Pradesh in a bid to achieve 'greening of wastelands' through its ongoing social forestry programme.
- This unit which accounts for 60% of the carbon dioxide emitted by ITC Units has significantly enhanced the use of black liquor, a biomass waste generated in the pulping process, as fuel.



8. Recent Initiatives to Address Climate Change

There have been a number of recent initiatives with a favourable impact on climate change, some examples are presented below:

- **CNG-based public transport:** New Delhi is the first city to switch to CNG in public transport. Now other metros are also in the process of mandating CNG along with tightening vehicle emission norms.
- **Dedicated bus lane in large cities:** Few large Indian cities (e.g. Banglore, Chennai) have started to Introduce exclusive lane for buses. While, city of Delhi is experimenting with high capacity bus corridors. Several other Indian cities are also planning similar initiatives.
- **Metro Rail System, Delhi:** The Delhi metro Rail has provided a major boost to public transport, especially in the most congested sections of the Delhi metropolis. In a short span of 5 to 10 years a city-wide network is expected to provide a major mass transport alternative to the population.
- **The People's Car:** The concept of a Re 1 lakh ($ 2,500) people's car by Tata Motors was considered impossible some time back, but is soon to be a reality. The car will have the best fuel efficiency and emission norms in industry and provide personal mobility at very low cost. The company claims that the fuel efficiency of the car would be higher than average fuel efficiency of two-wheelers. The car would definitely be a forerunner towards a global compact-stroke frugal car. If this is coupled with a policy to provide efficient low-cost public mass transport facilities, then even if vehicle ownership goes up in India the growth in passenger kilometres travelled by private cars and total consumption of fossil fuels can remain within sustainable limits. Other industry initiatives that are pioneering environmentally benign transportation options are the electric car developed by REVA Motors, electric two-wheelers by Hero Honda and other manufacturers.

  Further tightening vehicle fuel efficiency standards will boost India's role in the global automotive map as one of the leading pioneers in automotive R&D. New technologies on the anvil include Hydrogen spiked CNG fuel vehicles and Fuel cell/Hybrid cars.
- **Standards and Labelling Programme for Appliances:** An energy labelling programme for appliances was launched by Bureau of Energy Efficiency in 2006, and comparative star-based labelling has been introduced for fluorescent tube lights, air conditioners, and distribution transformers (model labels given in figure 4).

  The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. Almost all fluorescent tube lights sold in

Figure 4: Energy Labels for Refrigerators and Fluorescent Lamps

India, and about two-thirds of the refrigerators and air conditioners, are now covered by the labelling programme.

- **Energy Conservation Building Code:** An Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the building's energy demand. Commercial buildings are one of the fastest growing sectors of the Indian economy, reflecting the increasing share of the services sector in the economy. Nearly one hundred buildings are already following the Code, and compliance with it has also been incorporated into the Environmental Impact Assessment requirements for large buildings.

- **Urbanisation and IT:** The expansion and development of Indian cities provides a great opportunity to find ways for Indian citizens to live and work in ways that are more efficient and less polluting than many of the existing cities. The major IT infrastructure and skill base in India is already allowing Indian companies to access and service global market without the need to fly people around the world. Ensuring that even within cities commuting distances are minimized, public transport is available and new buildings are efficient will all contribute to an ongoing shift to the low-carbon economy.

- **Energy Audits of Large Industrial Consumers:** In March 2007, the conduct of energy



audits was made mandatory in large energy-consuming units in nine industrial sectors. These units, notified as "designated consumers" are also required to employ "certified energy managers", and report energy consumption and energy conservation data annually.

- **India's Active Participation in the CDM Process:** Over 747 CDM projects have been approved by the CDM National Designated Authority, and about 282 of these have been registered by the CDM Executive Board. The registered projects have already resulted in over 28 million tones of certified CO2 emissions reductions, and directed investment in renewable energy and energy projects by reducing the perceived risks and uncertainties of these new technologies, thereby accelerating their adoption.

- **Promoting Green Entrepreneurship:** New Ventures India, a joint initiative of CII-Sohrabji Godrej Green Business Centre (refer to box 3 for details on GBC) and World Resources Institute, Washington D.C., supported by USAID has been facilitating sustainable enterprise growth by providing sound investment opportunities to emerging Green entrepreneurs since 2005. In early 2006, New Ventures India (NVI) received a total of 56 Business Plans from green entrepreneurs across the country, of which three were selected for investments. The three companies, namely Conserve HRP, HMX Sumaya and ABT Bio products have received total Green investments to the tune of Rs. 16.49 crores.

- **CII-UNDP project on decentralised generation of power:** Confederation of Indian Industry is implementing rural electrification projects based on renewable energy sources in several villages in states including Rajasthan and Jharkhand. This exercise has been supported by Ministry of New and Renewable Energy and UNDP. The main objectives of the initiative are to provide equitable, accessible energy for disadvantaged rural households in select

Box 3 : CII-Sohrabji Godrej Green Business Centre

CII-Sohrabji Godrej Green Business Centre is the "Centre of Excellence" of the Confederation of Indian Industry for Energy Efficiency, Green Buildings, Renewable Energy, Water, Environment & Recycling and Climate Change activities in India.

The Centre is a joint initiative of the Government of Andhra Pradesh, Confederation of Indian Industry (CII) and House of Godrej with the technical support of USAID – a unique model of a successful Public-Private partnership.

The objective of the Centre is to make the world a better place to live in, by providing world class 'green' services. The Centre promotes 'green' concepts leading to higher efficiency, equitable growth and sustainable development.



villages/states and to help alleviate poverty through creation of additional livelihood opportunities by way of community led participatory approaches of energy management. Projects based on renewable energy ensure that local resources are utilised best to meet local needs. The energy intervention in these villages is totally carbon neutral.

- **Biofuels:** It is estimated that upto 10 per cent blending of bio-fuels with fossil fuels can be implemented nation-wide for vehicle transport. In view of this plantations have been set up by the Tatas, Reliance and others. These are good from the point of view of fuel substitution and thus reducing carbon /GHG emissions, but this option needs to be treated with caution as biofuel plantations may have a negative effect on food security. The impact of biofuel plantations on carbon/GHG emissions has also not been studied adequately yet.

- **Carbon capture and Storage:** While India is not yet in the forefront of carbon capture and storage technology development, its current dependence on coal and existence of large coal reserves make it important that carbon capture and storage is proven and if successful made intrinsic to future coal use in India. Several national programmes are being conceptualised to develop and commercialise clean coal technologies, backed by international co-operation programmes both in the public and private sectors.

- **Voluntary Disclosure of GHG Emissions by Indian Companies:** The Carbon Disclosure Project (CDP) is an initiative to encourage investors and businesses to include climate-change in their strategies. The CDP was launched in India in May 2007 as a joint effort of the CII-ITC Centre of Excellence for Sustainable Development (refer to box 4), WWF-India and the CDP. It intended to help Indian industry chart its way forward while recognising the emerging challenges and opportunities of climate change. The top 110 Indian companies were requested to provide information on their GHG emissions. The findings of the survey were released in November 2007. Encouragingly, 35% of the companies responded on a topic that is completely unregulated. While 85% of the respondents perceived the commercial opportunities associated with climate change, nearly 75% have devised strategies to manage the emerging opportunities and risks of climate change associated with their businesses. Further, 79% of the FTSE 500 responding companies felt climate change raises commercial risks. It was also observed financial institutions in India are aware of the business implications of climate change. This is corroborated by the fact that 44% of the financial sector companies participated; this is higher than the national average of 35%. Also, 33% of the responding companies have set some form of reduction targets.

Box 4 : CII-ITC Centre of Excellence for Sustainable Development

The CII-ITC Centre of Excellence for Sustainable Development, launched in January 2006, is an institution that creates a conducive, enabling climate for Indian businesses to pursue sustainability goals. It seeks to create awareness, promote thought leadership and build capacity to achieve sustainability across a broad spectrum of issues. A pioneering effort by CII, the Centre is the fountainhead of ideas and practices to promote sustainability. It endeavours to enable Indian businesses to become sustainable and to channelise the potential of Indian industry to power India's agenda for inclusive growth and sustainable development. It aims to enable businesses to transform themselves by embedding the concepts of sustainable development into their own strategies, decisions and processes.



9. Strategies To Mitigate Climate Change

9.1. Renewable Energy

India has multifaceted renewable energy programme supported by a dedicated ministry for renewable energy – the Ministry of New and Renewable Energy. Indian renewable energy sector is dominated by the private sector, which accounts for around 95% of the total investment in the sector. Government policy support is necessary to direct these investments in the desirable direction. Some notable aspects of the thrust on renewable energy are as follows:

- Over 10,000 MW of renewable based capacity has already been installed.
- India is the fourth largest country in terms of wind energy installed capacity.
- Strong manufacturing and R&D orientation. India is emerging as a hub of wind, solar, biomass related manufacturing and exports.
- Dedicated financial institution for renewable energy – Indian Renewable Energy Development Agency (IREDA).
- Numerous fiscal and financial incentives are given for the promotion and exploitation of renewable energy.
- Move to set-up Special Economy Zones (SEZs) for renewable energy businesses.

The Electricity Act, 2003, requires State Electricity Regulatory Commissions to specify a percentage of electricity that the electricity distribution companies must procure from renewable sources. Several state commissions have already operationalised this mandate, and also notified preferential prices for electricity from renewables. This has contributed to acceleration in renewable-electricity capacity addition, and over the past three years, about 2,000 MW of renewable-electricity capacity has been added in India every year, bringing the total installed renewable capacity to over 10,000 MW. Of this, a little over 7,000 MW is based on wind power; India now has the fourth largest installed wind capacity in the world. Further, there is step-by-step target based approach has been taken by Indian Government for the development of renewable energy (box 5 summarise the renewable energy target for the 11th five-year plan). Indian hydel resources are estimated to be over 84,000 MW at 60 % load factor. The National Hydro Energy Policy [1998] has resulted in the accelerated addition of hydropower capacity in India, which is now over 35,000 MW. The accelerated hydro development plan aims to build 50,000 MW of new capacity by 2025-26. Out of this, 25960 MW are to be installed in Arunachal Pradesh. Of the 50,000 MW planned, 31,000 MW shall come from

Run of the river (RoR) schemes where problems of environment & ecology, R&R problems are manageable. However, the available energy varies from month to month and peaking capacity is minimal. It is estimated that 19,660 MW of ROR schemes generate 2 BkWh of energy in a lean month and 13 BkWh in a high inflow month, giving load factors of 14% to 90%. (Integrated Energy Policy, Planning Commission)

By virtue of decades of sustained support to R&D in the renewable energy sector, India is today in a position to play a major role in large-scale commercialization of RETs, such as large and small biomass and biogas technologies, wind generators, small hydro, solar thermal, solar PV, energy efficient lighting systems among others. India can partner other developing countries as a technology provider, equipment supplier and capacity builder. South-South-North partnerships which utilize innovative new solutions and the financial and marketing strengths of industrialised countries may be an effective instrument (IEO, KPMG/2006/RET Outlook).

Bioenergy: According to IEA projections, biomass may provide approximately 20% of total primary energy demand by 2030, under the alternate scenario (refer to table 3). Biomass has the advantage over other renewable energy technologies that it can be easily stored over a

Box 5 : Summary of Renewable Energy Targets for Eleventh Five-year Plan (2007-2012)

- **Grid-interactive Renewable Power:** A physical target of 14,000 MW is set for the Eleventh Plan for grid-interactive renewable power through wind, small hydro, bio-power and solar power.
- **Renewable Energy for Rural Applications:** Distributed/Off-grid Renewable Power through wind, small hydro, bio-power and solar power. A target of 1000 MW of renewable based distributed capacity for Eleventh Plan.
- **Incentives** provided for grid connected power from renewable sources would be linked to generation and not to power capacities created. Thus power regulators will be asked to create alternative incentive structures such as mandated feed-in laws or differential tariffs for grid interactive power.
- **National Bio-fuel policy** will be finalized that provides incentives and leads to a competitive industry.
- **IREDA** to be restructured by broad basing its equity structure for increasing availability of finance for new and renewable energy and its role to be enhanced.



long period of time. However, there are issues such as low energy density and threats such as diversion of agriculture resources for energy purposes. Biomass fuels and residues can be converted to energy or more efficient energy carriers such as producer gas by thermal, biological, mechanical or physical processes. The later concern can be addressed by using only agricultural residues, forestry waste etc for energy generation. There are several R&D priorities for bio-energy, which include: making available inexpensive feedstock and increasing conversion (short-term), capitalising on opportunities offered by bio-refineries (medium-term) and producing hydrogen from biomass (long-term).

Large Hydropower: Large hydropower has the potential to contribute significantly to the India's climate change mitigation strategy. However, most of the big hydropower projects are often surrounded by controversies due to rehabilitation of locals and potential threat to the ecological system. This requires careful selection of sites to minimise displacement of people and impacts on ecology. Besides, there are some technical challenges as well such as lack of manufacturing capability of large equipment. Nonetheless, these challenges must be overcome. Given the vast potential of hydropower development India, there is little doubt that large hydropower will stay as in important component of India's energy mix. However, the emphasis on large hydropower projects must move to more sustainable, small and micro hydro projects on a widely distributed basis.

Decentralised and distributed generation as a business model: India's experience in harnessing RETs for rural electricity supply linked to job creation is a powerful business model for ensuring economically, socially and ecologically viable development of the rural areas of the Third World and it is attracting a great deal of interest from many countries in Asia, Africa & South America.

Various models of promotion of RETs in India are available. These may be manufacturer-led (e.g. Tata-BP Solar), the entrepreneur driven model (Selco, Aditya Solar Lamp) and the NGO-driven model. The last includes initiatives for decentralised energy production through plants such as the DESI Power in Jhansi and initiatives wherein NGOs (for instance, Bunker Roy's Social Work and Research Centre at Tilonia, Rajasthan and Avni, Pithoragarh, Uttarakhand) have trained unemployed rural youth in the setting up and maintenance of RETs.

9.2. Energy Efficiency

Improving energy efficiency through technology and innovative approaches offers a significant opportunity to reduce greenhouse gas emissions. Indian government and industry have been proactive in formulating and adopting measures to improve energy efficiency, the outcome of

such efforts is already visible in terms of declining energy intensity of the economy. Some of the measures undertaken to promote energy efficiency include:

- An exclusive Energy Conservation Act to provide regulatory impetus to energy efficiency activities, and an institutional framework through the Bureau of Energy Efficiency (BEE), dedicated agency to promote energy efficiency.
- Energy audits for 9 government buildings completed including Rashtrapati Bhawan and Prime Minister's office. The practice is likely to become a norm for all Government buildings.
- BEE has been successfully conducting National Certification Examinations for selection of Energy Auditors and Energy Managers.
- Draft norms for fixation of specific energy consumption in Cement and Paper and Pulp industries.
- Task-forces have been set up for 7 energy intensive sectors
- Bachat Lamp Yojana for efficient household lighting has been launched
- An Energy Labelling and Certification Programme has been launched for select appliances.
- Energy Conservation Building Code (ECBC) has been developed and notified.

Table 10: Energy Efficiency Targets for Eleventh Five-year Plan (2007-2012)

SNo.	Name of the Scheme	Targeted saved capacity
1	Bachat Lamp Yojana (BLY)	4000 MW
2	Standards & Labelling programme	3000 MW
3	Energy savings in existing buildings	200 MW
4	Energy conservation building code (ECBC) implementation	500 MW
5	Agricultural DSM (Ag DSM) & Municipal DSM (Mu DSM)	2000 MW
6	Small & Medium Enterprises scheme	500 MW



- A Roadmap for Demand Side Management through the state power and municipal utilities has been drafted.
- Initiatives have been taken to reform government procurement systems to take into consideration life-cycle costs.
- Definitive energy efficiency targets for various five-year plans totalling 10,200 MW. (Table 10 provides energy efficiency plans for eleventh five-year plan).

9.2.1 Industrial Energy Efficiency

Energy intensive industries namely fertilizers, aluminum, textiles, cement, iron & steel, pulp & paper, and chlor- alkalis consume around 65 per cent of total industrial energy. A CII study on energy efficiency estimated that Indian Industry has the potential to save upto 20 to 30 per cent of total energy consumption. Table 11 below indicates the average energy conservation potential in various energy intensive industries.

Table 11. Energy Saving Potential in Indian Industry

Industry	Energy Saving Potential
Iron & Steel	10%
Fertilizers	15%
Textiles	25%
Cement	15%
Chlor-alkali	15%
Pulp & Paper	25%
Aluminium	10%
Ferrous Foundry	20%
Petrochemicals	15%
Glass & Ceramics	20%
Refineries	10%



Over the past decade, energy efficiency in Indian industry has increased steadily. In the major energy-consuming industrial sectors, such as cement, steel, aluminium, fertilizers, etc., average specific energy consumption has been declining because of energy conservation in existing units, and (much more) due to new capacity addition with state-of-the-art technology. The specific energy consumption of Indian cement plants and of Indian iron and steel plants has been declining rapidly. In the cement sector, the specific energy consumption of the most-efficient plants is now comparable to that of the most efficient plants in the world.

Key factors pushing the energy saving programmes include liberalisation of the economy and industrial sectors, which force the Indian industry to be more competitive. Foreign ownership of manufacturing or process industries (in JV partnership or 100% owned) also brings in new energy efficiency technologies. Secondly, the opening of carbon markets under CDM is promoting energy savings in areas, which would otherwise not do so. The SME sector and the agriculture sector, continue to be rather energy inefficient and major efforts are underway which would reduce the Indian GHG emissions significantly.

Going forward, many approaches and technological solutions are available; to be adopted in short, medium and long term; that can further help Indian industry accelerate the pace of energy efficiency improvement. Sector-wise inventory of such approaches and technologies is presented in the sections below:

9.2.1.1. Aluminium

The average specific energy consumption in the aluminium sector has decreased by nearly 20%. The small-scale aluminium processing sector may further reduce energy consumption with improved operations and maintenance systems. Various technological improvements and best practices that can be adopted in Aluminium sector to improve efficiency and reduce carbon emission are;

a. Aluminium Refinery

Medium Term:

- Variable frequency drives (VFD) for spent liquor pump feeding to evaporator
- VFD for red mud pond feed pump
- VFD for filtered aluminate liquor pump
- Seal pots for condensate recovery at digesters
- Optimising filter feed pumping system & slurry pumps in precipitation area.
- Optimising excess oxygen percentage in kiln by continuous monitoring
- Avoiding air infiltration in kiln flue gas exhaust line
- Replace old vacuum pumps with high efficiency vacuum pumps
- Utilise the standby body in evaporator and increase the steam economy

Long Term:

- Thermo-compressor and recover flash steam from pure condensate tank in evaporator section

- Mechanical conveying system to convey material from ESP bottom to kiln
- Segregate pick-up and drying zone vacuum in red mud filters
- Sweeten the digestion process by adding Gibbsitic bauxite having higher solubility in downstream of higher temperature digestion circuit

b. Aluminium Smelter

Medium Term:

- Correct size cooling water supply pump for rectifier cooling
- Installation of correct capacity & head pumps /fans in place of over designed pumps / fans
- Screw conveyor and avoid the operation of a centrifugal fan in carbon plant
- Installation of variable frequency drive for centrifugal pumps and fans, wherever there is a varying requirement
- Variable fluid coupling for scrubber fans
- Data acquisition and monitoring system
- Thyristor control in coke conveying vibrators in carbon plant
- Insulation of sidewalls of the pots

Long Term:

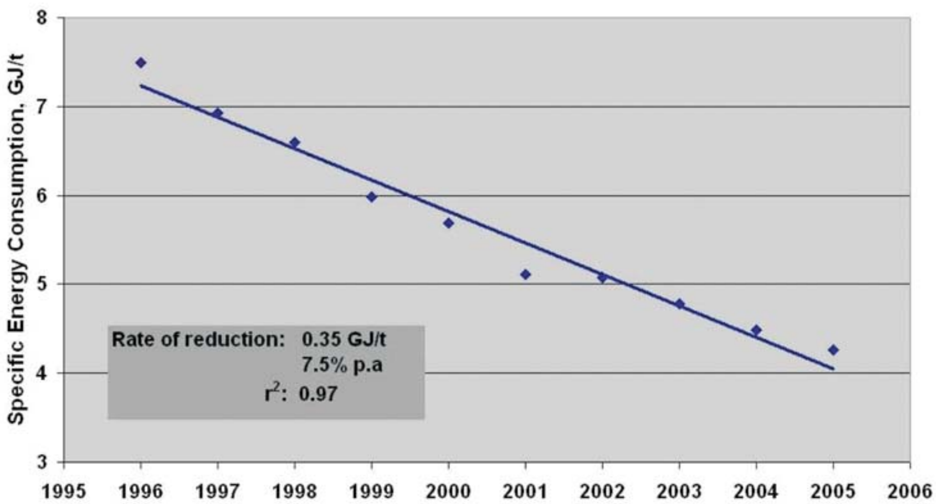
- Convert the soderberg technology to the pre baked cathode technology in the pots
- Point feeding in the aluminium pots
- Coating of cathode surface of electrolytic cells with Titanium Boride (TINOR)
- Replacing hot tamping mix with cold tamping mix

9.2.1.2. Cement

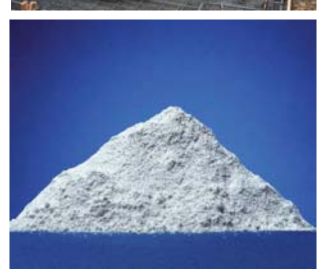
Average specific energy consumption in the cement sector has been declining continuously over the past few years because of energy conservation in existing units and due to new capacity addition with state-of-art technology (figure 5 below).

To further improve energy efficiency in the sector, a list of technologies to be adopted in the short-, medium- and long terms are as follows:

Figure 5: Trends in thermal specific energy consumption in the Indian cement sector



Source: Bureau of Energy Efficiency



a. Mines and Crusher

Short and Long Term:

- Increasing operating capacity of primary and secondary crusher
- Reducing idle operation of crushers and belts, dust collection equipment, Bulk analyzer for crushed limestone and coal weighing (long term)

b. Raw Mill Grinding and Storage

Short, medium and long-term:

- Avoiding idle running of raw mill conveyor system (auxiliaries)

- Avoiding idle operation of raw mill lubrication system
- Starting and stopping sequence of raw mill (to minimize idle running of fans)
- Variable louver system for roller mills, high efficiency dynamic separator for mills.
- Use of vertical roller mills instead of ball mills
- Tertiary crusher for raw meal
- Replacing pneumatic conveying system with mechanical conveying system
- Installation of efficient mill intervals –diaphragm and liners, high level automation system for raw mills
- Online x-ray analyzer for raw meal
- Slip power recovery system/VFD for raw mill fan/ESP fan
- External mechanical recirculation system for roller mills and optimizes airflow.

c. Kiln, Pre heater and Cooler

Short, medium and long-term:

- CO and O_2 analyser at kiln inlet and preheating outlet
- Maintain proper kiln seal (inlet and outlet) to avoid false aAr infiltration
- Reduce leakages in the preheater system
- Optimise primary air to kiln
- Utilise the cooler waste heat for fly ash/slag/coal
- Install soft starters for clinker breaker

- Install VFD for cooler fans and cooler ID fans
- Optimise the cooler exhaust chimney height
- Install advanced multi channel burner
- Conversion from single channel to multichannel burners
- Replace planetary cooler with grate cooler & conventional coolers (planetary/grate) with high efficiency coolers (MFR/Pendulum)

Coal Yard and Coal Mill

- Elimination of spontaneous combustion by proper stacking
- Avoid idle running of coal conveyor and crusher
- Optimise starting and stopping sequence of coal mill
- Maintain high residue for precalciner firing
- Reduce the power consumption of mill main drive by increasing the coal residue

d. Cement Grinding, Storage and Packing

Short-term:

- Water spraying system on the clinker at cooler outlet (Temp above 90 C consumes more grinding energy)
- Reduce cement mill vents and recirculate to reduce cement loss
- Avoid idle running of clinker conveyor – dust collector fan and cement silo exhaust fans

Other Long-term:

- Utilisation of cooler waste heat for drying fly ash/slag/coal
- Replacing conventional coolers (planetary/grate) with high efficiency coolers
- Power generation through waste heat recovery from pre-heater and cooler exhaust gas
- Utilization of waste fuels (industrial and municipal)

9.2.1.3. Ceramics

Technological improvements and best practices for the ceramics industry are;

a. Electrical:

- Install delta to star converters for lightly loaded motors
- Use translucent sheets to make use of day lighting
- Install timers for automatic switching on off of lights, yard and outside lighting
- Grouping of lighting circuits for better control
- Operate at maximum power factor, say 0.96 and above
- Switching off of transformers based on loading
- Optimise TG/DG sets operating frequency & Voltage
- Improve operating power factor of diesel generator

b. Kiln

- Auto interlock between the brushing dust collection blowers and the glazing lines
- Improving combustion efficiency of VSK by optimizing excess air levels

c. Spray Drier

- Arresting air infiltration in spray drier system
- Replacing LPG with diesel firing in the spray drier

d. Vertical Drier

- Switch off chiller circuit when hydraulic press is not in operation
- Reducing idle operation of hydraulic press pump by installing suitable interlocks

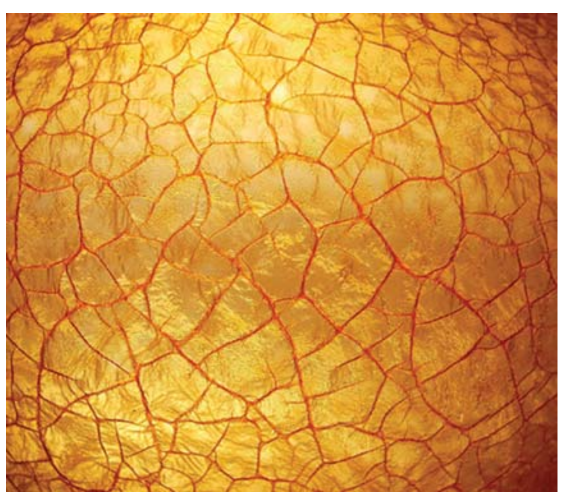
e. Utilities

- Optimising pressure setting of air compressors
- Replacement of aluminium blades with FRP blades in cooling tower fans
- Installation of temperature indicator controller (TIC) for optimizing cooling tower fan operation
- Installation of dual speed motors/VSD for cooling tower fans
- Avoid/minimize compressed air leakages by vigorous maintenance
- Install level indicator controllers to maintain chest level

9.2.1.4. Glass

Technological improvements that can increase energy efficiency and reduce carbon emissions in the glass industry are as follows:

- VFD for combustion air blower
- Installation of correct head & capacity fans for furnace cooling
- Reduce rpm of furnace chimney blower by 10%
- Replace the existing inefficient cooling blowers with energy efficient blowers with efficiency greater than 75%
- Replacing old inefficient blowers with high efficiency blowers
- Avoid recirculation through the standby blower of throat cooling
- VFD to screw compressor catering to process air requirements (furnace combustion requirement) and reduce power consumption
- Installation of demand & supply side control for compressed air system
- Reduce pressure settings of HP air compressors.
- Correct head pumps for cooling tower.
- Diagnostics and Modeling of Corrosion of Superstructure Refractories in Oxy-Fuel Glass Furnaces.



9.2.1.5. Pulp & Paper

In the paper and pulp industry, technological improvements at different stages of the manufacturing process to be adopted are;

a. Chipper, pulp mill and soda recovery

Short-term:

- Avoiding idle operation of equipment by electrical interlock
- Ensure optimum loading of chippers
- Avoiding fresh water for pulpers and beaters and use back water
- Interlock agitators with pumps at storage chedis
- Providing timer control for agitators for sequential operation
- Use standby effect in multiple effect evaporators and improve steam economy

Medium term:

- Mechanical unloading system in chipper house
- Belt conveyor for conveying wood chips instead of pneumatic conveyors.
- Auto slip power recovery systems for chipper motors
- Install two stage preheating in digesters (combination of MP steam and LP steam)
- Replace steam doctor by high pressure shower in brown stock washers
- Installation of water ring vacuum pumps instead of steam ejectors in evaporators, depending on the cost of steam

Long-term:

- Installation of high capacity chippers with mechanized feeding
- Extended delignification cooking process
- Oxygen delignification

- Install medium consistency pumping
- Replace brown stock washing with double wire press system
- Install high capacity washing system such as flat belt wire washer double wire press

b. Stock preparation and paper machine

Short-term:

- Optimise loading of refiners and beaters
- Interlock agitators with pumps at storage chests
- Minimize recirculation in receiving chest and machine chest
- Optimising excess capacity /head in pump by change of impeller or trimming of impeller size
- Avoiding pump operation by utilization of gravity head
- Optimise capacity of vacuum pumps by RPM reduction
- Install level indicating controllers for couch pit pumps
- Optimising pressure of high pressure pump use for wire cleaning and deck showers

Medium term:

- New high efficiency pumps, fans and blowers in boiler
- VSD for displacement pump discharge pump hot fill pump and warm fill pump of washing and screening plant
- VFD for centrifugal pumps and fans
- Replace eddy current drive with VFD for washing and bleaching
- Pre separators for water ring vacuum pumps
- Introduce double dilution system
- Double disc refiners instead of conical refiners
- VFD for process pumps and avoid valve control

- Dual speed motors for couch pit agitator and press pit agitator
- Install VSD for MG machine/ MF machine hood fans
- Replace steam ejector with water ring vacuum pump in evaporator section
- Cascade condensate system in paper machine area
- Flash steam recovery system for paper machines
- Reel pulper operation optimized by effective utilization of winder pulper
- Optimizing operation of hydraulic system of calendar
- Automatic operation of hood and ventilation system

Long-term:

- Replace conical refiners with double disc refiners
- Conical port high efficiency vacuum pumps in place of flat port vacuum pumps
- Replace centrifugal screens with pressure screen
- Segregate high vacuum and lo vacuum sections of the paper machine and connect to dedicated systems
- Segregation of high head and low head users in cooling towers and process areas
- Trip nip press section in paper machine to reduce drying load
- Computerized automatic moisture control system for paper machines
- Paper machine hood heat recovery system



- Convert small steam turbines in paper machine area to DC or AC drive so as to enhance cogeneration

c. Co generation Steam and Condensate Systems

Short-term:

- Monitor excess air levels in boilers and soda recovery boilers
- Arrest air infiltration in boiler flue gas path, particularly economizer and air preheater section
- Plug steam leakages, however small they may be
- Always avoid steam pressure reduction through PRVs instead, pass the steam through turbine so as to improve cogeneration
- Insulate all steam and condensate lines
- Monitor and replace defective steam traps on a regular basis
- In case coal has higher percentage of fines ensure wetting is done
- Monitor boiler blow down, use Eloguard for optimizing boiler blow down
- Installation of flash vessels for heat recovery from hot condensate vapours
- Monitor the blow down quantity of water in cooling towers and the quality of water
- Install chlorine dosing and HC1 dosing for circulating water

Medium term:

- Automatic combustion control system/ oxygen trim control system in steam boilers and soda recovery boilers
- Economizer/air preheater for boilers
- User of cheaper fuels, like bamboo dust wood barks pith etc
- High temperature deaerator (120 C to 140 C) with suitable boiler feed water pump to enhance cogeneration
- Heat recovery from boiler blow down
- Convert medium pressure steam users to LP steam users to increase co generation

- Reducing moisture content of wet pith using screw presses for burning in boilers
- Condensate recovery systems in digesters paper machines evaporators and air heaters
- Automatic blow down system for boilers ‘
- Install sonic soot blowers in place of steam operated soot blowing system

Long-term:

- Convert chain grate / spreader stoker boilers to Fluidized Bed Combustion (FBC)
- Co generation system for medium sized paper plants
- Vapour absorption system to utilize LP steam and enhance cogeneration
- Cascade condensate recovery plant
- Maximizing solids concentration in recovery boiler
- Rotary feeder for lime kiln feeding system
- Steam generating system from DG exhaust, if DG is run on a continuous basis
- Scoop type siphons in the dryer cylinders of paper machines instead of conventional steam and condensate system with rotary joints
- Hood recovery systems in paper machines to minimize steam consumption



d. Electrical areas

Short term:

- Install delta star converters for lightly loaded motors
- Use translucent sheets to make use of day lighting
- Grouping of lighting circuits for better control
- Operate at maximum power factor say 0.96 and above
- Switching off of transformers based on loading
- Optimizing TD/DG sets operating frequency and voltage

Medium term:

- Maximum demand controller to optimize maximum demand
- Capacitor banks to improve power factor
- Installation thyristorised rectifiers
- Replace rewound motors with energy efficient motors
- Replace 40 watts fluorescent lamps with 36 watts fluorescent lamps
- Replace conventional ballast with high efficiency electronic ballasts in all discharge lamps
- Install LED lamps for panel indication instead of filament lamps
- Install CFLs for lighting in non critical areas, such as toilets corridors, canteens etc
- Optimize voltage in lighting circuits by installing servo stabilizers
- Minimizing overall distribution losses by proper cable sizing and addition or capacitor banks

e. Air Compressors

- Ensure air compressors are loaded to a level of 90%



- Set compressor delivery pressure as low as possible
- Monitor pressure drop across suction filter and after filter
- Demand side controller for compressed air system
- Segregate high pressure and low pressure users
- Replace heater purge type air dryer with heat of compression dryer for capacities above 500 cfm
- Replace old and inefficient compressors with screw or centrifugal compressors

f. Twin Roll Press

- VSD for primary secondary and tertiary centricleaners pumps of unbleached and bleached pulp
- Introduce ClO_2 and H_2O_2 bleaching stages
- Pressure screens in pulp mill and avoid centri-cleaners
- 7-effect evaporator instead of conventional triple effect evaporator
- Falling film evaporator
- 2 stage steam heating in black liquor pre heater
- Soda recovery plant in medium sized paper plants
- Causticiser and rotary lime kiln



9.2.1.6. Co-generation Steam and Condensate Systems

Technological improvements that can increase energy efficiency and reduce carbon emissions in cogeneration steam and condensate systems in the short-, medium- and long terms are as follows:

Short-term:

- Monitor excess air levels in boilers and soda recovery boilers
- Arrest air infiltration in boiler flue gas path
- Insulate all steam and condensate lines
- Monitor and replace defective steam traps on a regular basis
- In case coal has higher percentage of fines ensure wetting is done
- Monitor boiler blow down
- Installation of flash vessels for heat recovery from hot condensate vapours

Medium-term:

- Automatic combustion control system/ oxygen trim control system in steam boilers and soda recovery boilers
- Economiser/air preheater for boilers
- Boiler air preheater based on steam to enhance cogeneration
- Install high temperature deaerator (120 C to 140 C)




- Heat recovery from boiler blow down
- Convert medium pressure steam users to LP steam users to increase co generation
- Automatic blow down system for boilers '
- Install sonic soot blowers in place of steam operated soot-blowing system

Long-term:

- Convert chain grate / spreader stoker boilers to FBC boilers
- Co generation system for medium sized paper plants
- Vapour absorption system to utilize LP steam and enhance cogeneration
- Cascade condensate recovery plant
- Maximising solids concentration in recovery boiler
- Rotary feeder for limekiln feeding system
- Steam-generating system from DG exhaust, if DG is run on a continuous basis
- Install scoop type siphons in the dryer cylinders of paper machines




9.2.1.7. Sugar

The following technological improvements that can increase energy efficiency and reduce carbon emissions can be adopted in the short/medium/long terms in the sugar industry:

a. Cane preparation and juice extraction

Short term:

- Avoid recirculation in the filtrate by installing next lower size impeller

Medium term:

- Correct size pump for crusher and imbition water pump
- Lower capacity pump for juice transfer at III mill and minimize recirculation
- VFD for imbibition water pump, weighed juice pump, process pumps and cane carrier drives

Long-term:

- Installation DC drives / hydraulic for mill drives and shredder
- Electronic mass flow meters for all three mills

b. Juice heating sulphitation, clarification and crystallization

Short-term:

- Reduce rpm of existing reciprocating compressors (centrifugal house) by 20%
- Utilize LP steam for sugar dryer and sugar melting

Medium term:

- Avoid condensate water pumps at juice heaters and evaporators
- Commission load unload mechanisms for sulphur air compressors
- Improve flash steam utilization for SK



condensate and quad 1

- VFD for super heated wash water pump and process pumps
- Installation of correct head and capacity pump
- Segregate high vacuum and low vacuum requirements of Oliver filter

Long-term:

- Modify new injection pumping system and avoid use of cooling tower pumps

c. Cogeneration

Short-term:

- Monitor and arrest air infiltration on continuous basis
- Arrest identified steam leaks and improve the working of steam traps in identified areas
- Avoid recirculation of boiler feed water pump in WIL boiler
- Down size impeller of SA fan
- Improve insulation in identified areas
- Rationalize condensate collection system
- Reduce rpm of power plants air compressor
- Replace feed water make up pump with low duty pump
- Use exhaust steam for deaerator water heating

Medium term:

- Convert identified MP steam users to LP steam users
- Install a flash vessel to recover the flash from the boiler continuous blow down and HP steam header traps drain and connect to exhaust header
- LP steam heater in delivery of boiler feed water pump
- Install steam jet ejectors in place of vacuum pumps for vacuum filters



- Install variable fluid coupling for boiler ID fans
- Install variable speed drives for boiler fans
- VFD for auxiliary cooling water pump and condenser water pump

Long-term:

- Commission de aerator and utilize LP steam for heating condensate water in de aerator
- Heat exchanger to preheat boiler feed water
- Small turbine for utilizing 43/8 ata stem

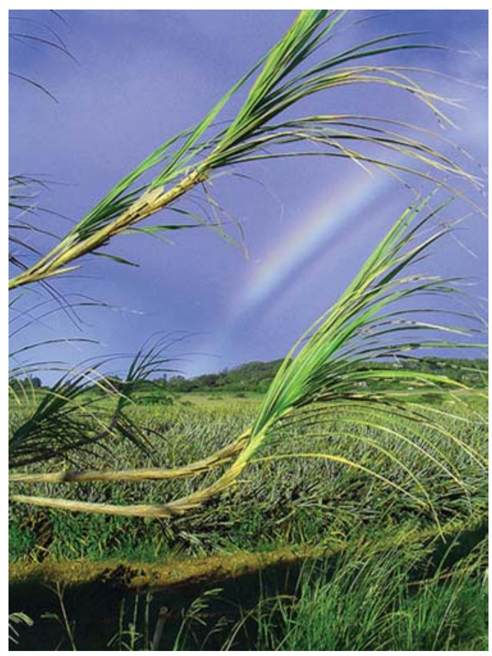
d. Distillery

Short-term:

- Increase the temperature of fermented wash from 83 degree c to 90 degree c by installing additional plates
- Install additional standby PHE for fermented wash heating

Long-term:

- Install steam ejector and utilize LP steam for distilleries



e. Auxiliary areas

Short-term:

- Avoiding over flow of cold water OH tank by installing next lower size impeller for pump
- Install level based on off control for service water pumps
- LIC for service tank install correct size pump for service tank
- Temperature cut off switch for cooling tower fans

Medium term:

- Arrest compressed air leakages at packing section
- Convert V belt to flat belt drive at the identified equipment



- Correct size pumps for hot water pumping at cooling tower
- FRP blades for process cooling tower fans
- Provide cooling tower for identified equipments and stop use of fresh water
- Segregate the low vacuum and high vacuum of Oliver filter

f. Energy Efficient Equipment

Medium term:

- Replace eddy current drive with variable frequency drives in cane carriers
- Replace old rewound motors with energy efficient motors

Long-term:

- Installation of commercial cogeneration system
- Capturing methane from distilleries and generating power
- Installation of biogas plants based on algae, utilizing sugar mill waste water as feedstock




9.2.1.8. Textile

The sector is quite diverse and a wide range of processes and technologies exist in the industry for energy efficiency improvements and reduction of carbon emissions;

- Installation of inverters on supply air fan and on spray pumps of folding chiller
- Energy efficient motors for ring frame machines
- VFD for supply air fan and on spray pumps of air handling section
- High efficiency centrifugal fans and motor blowers for spinning air washer
- Replacement of conventional spray nozzles by energy efficient atomizer
- Automation of dyeing machines
- Install variable speed drives for circulation pumps of dyeing machines
- Heat recovery from hot effluent to generate hot water for boiler
- Convert cotton tapes to synthetic tapes
- Use synthetic spindle oil in spindles
- Optimize the spindle oil level
- Install UPS system for ring frame motors
- Use synthetic plastic tubes instead of paper tubes
- Install temperature and humidification controller in all humidification plants
- Energy efficient washers in humidification plant
- Nylon belts in place of leather belts
- Light weight spindle in ring frames
- Optimization of picking mechanism in looms
- Minimizing heat from building windows
- Seasonal control of fans pumps

Long-term:

- VFD for ring frame machines
- Installation of air-ambiators and optimizing chiller loads
- Energy efficient stenters
- Use of energy efficient washers in humidification plant
- Heat recovery form stenter exhaust



9.2.1.9. Foundry

Proposals beneficial for climate change in the foundry industry include the following:

Short-term:

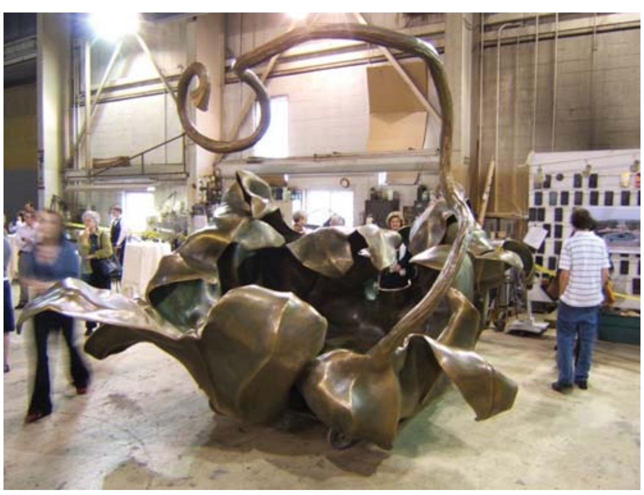
- Insulate and provide insulated lid for the ladle to minimize heat loss during metal transfer
- Suitably size the ladle to match with the molten metal requirement for the casting process
- Optimize the operating pressure of the compressor to match with requirement

Medium Term:

- Reducing the tapping temperature of the molten metal from the furnace to match with the requirement
- Improving combustion efficiency of cupola furnaces
- Practicing oxygen enrichment in cupola furnaces
- Installation of monitoring and control system for induction furnaces
- Matching the moulding time and melting time to minimize the holding time of the molten metal
- Monitoring temperature of molten metal continuously using online infrared thermometer and avoiding overshoot in temperature
- Bundling and increasing the bulk density of the input raw material
- Use of ceramic coating on the inner walls of heat treatment furnace for improving insulation
- Replace pneumatic operated tools with electrical tools
- Installation of low thermal mass insulation for both electrical and thermal furnaces
- Optimize combustion air supply to the oil fired heat treatment furnace

Long term:

- Charge hoper and furnace on load cells to achieve right composition at the first check
- Spectrometer for molten metal analysis and minimize testing time
- Automatic vibratory feeder for faster and continuous feeding of material
- Converting cold blast cupola furnace to divided blast cupola furnace
- Replacing electrical hearing with thermic fluid heating for core baking oven
- Installation of air pre heater for preheating the combustion air supply to the heat treatment furnaces
- Dual track medium frequency induction furnace in place of main frequency furnace Replace electrical arc furnace with medium frequency furnace

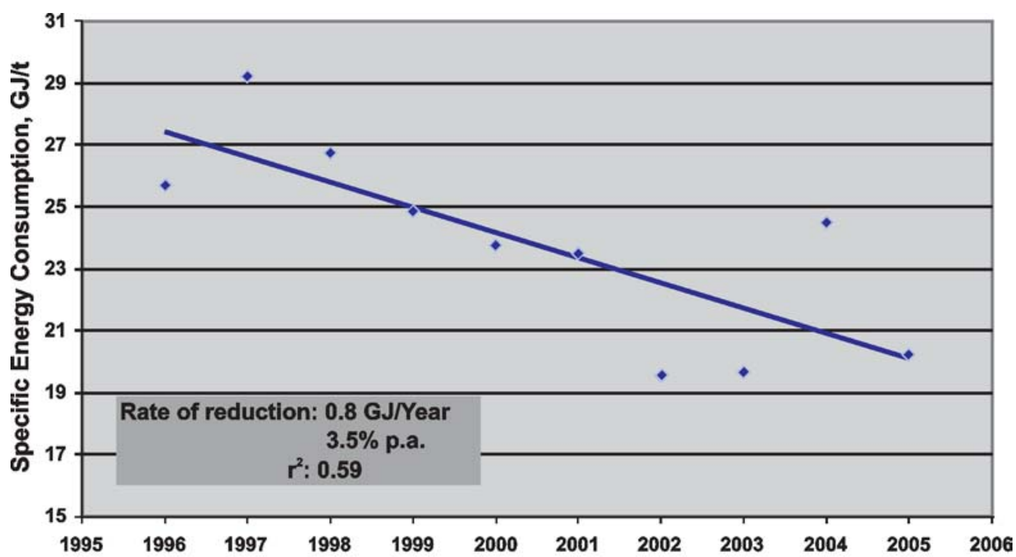


9.2.1.10. Iron and Steel

Average specific energy consumption in the Indian iron and steel sector has also been declining over the last few years (figure 6).

In this industry industry, technological improvements at different stages of the manufacturing process that can further increase energy efficiency and reduce carbon emissions include the following:

Figure 6: Trends in thermal specific energy consumption in the Indian iron and steel sector



Source: Bureau of Energy Efficiency

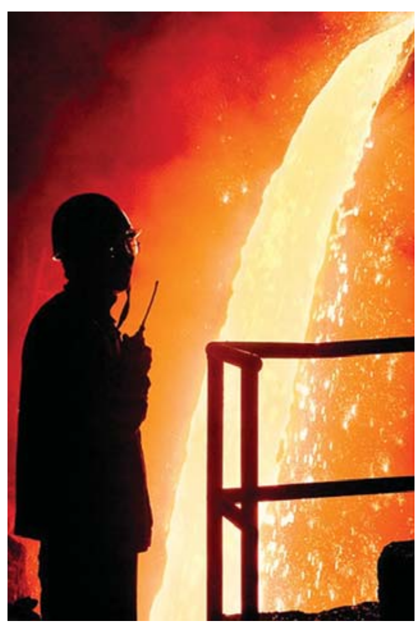
a. General

- Replacement of open-hearth furnaces with basic oxygen furnaces
- Use blast gas for generation of power
- Hot charging of cast steel for manufacturing rails and universal beam
- Injection of blast furnace gas in kiln to reduce coal consumption
- Increase the charging area of hearth furnace by replacing the insulating bricks with ceramic lining

- Reduce fuel gas consumption by controlling furnace pressure and increase the calorific value of mixed gas
- Optimize tapping temperature of molten metal
- Segregate high temp and low temp molten metal requirement
- Provide baffles for the furnace openings to minimize the heat escape
- Optimize the weight of trays in the ovens
- Load the oven optimally
- Avoid heat escape fresh air infiltration in ovens

b. Reheating Furnace

- Use of oxygen lancing in the furnace during the melting stage to hasten the process of melting
- Installation of continuous billet casting m/c
- Automatic door closing mechanism to avoid heat losses
- Installation of VFD to centrifugal pumps and fans
- Adequate refractory material to minimize heat loss
- Computerized control system for re rolling mills
- Charge preheating with exhaust flue gas like Energy Optimization Furnace (EOF)



c. Induction Furnace

- Minimise the tapping time
- Introduce electrical energy monitoring systems like kWHr indicators
- Select suitable size density and condition of charge material



- Ensure efficient design and operation of charge material and molten metal handling system
- Reduce holding periods to minimum
- Use correct size and shape of pouring and gating system
- Replace mains frequency furnace with medium frequency furnace (long term)
- Introduce electrical energy monitoring systems (simple measure)
- Optimize molten metal pouring time by proper scheduling of melting furnaces and casting section (simple measure)
- Use cleaned recirculated rejects to minimize stay formulation (medium term)
- Minimize radiation losses (medium term)
- Scrap segregation and compacting

d. Arc Furnace

- Utilise Oxygen lancing
- Bottom purging system for quicker melting and for homogeneous temperature
- Computerised control for power feeding
- Installation of Oxy fuel burners
- Utilise waste heat and preheat scrap
- Conversion of vertical ladle preheating to horizontal ladle preheating


- Utilization of slide gate method of liquid metal pouring rather than the conventional method
- Providing insulated hood to ladle
- Reducing the temperature drop of molten metal by covering with lid caps
- Scrap segregation to reduce refining time
- Secondary refining in a separate furnace
- Installation of High power or ultra high power transformers
- Automation at electric furnaces
- Eccentric bottom tapping

e. Foundry

- Installation of thermocouples at different zones to avoid overheating.
- Improve furnace insulation by providing ceramic fibre veneering
- Install burner plate and other auxiliary equipment

f. Heat Treatment Furnaces

- Waste heat recovery system for thermal fire furnace
- Installation of low thermal mass insulation for both electrical and thermal furnaces
- Improving combustion efficiency of thermal fire furnaces
- Installation of automatic temperature controllers in furnace

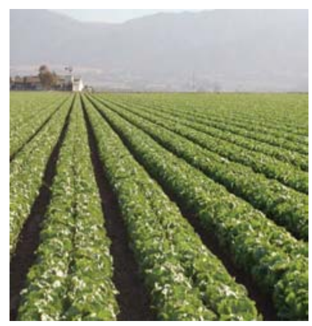


9.2.1.11. Fertilizer

In the fertilizer industry, technological improvements that can increase energy efficiency and reduce carbon emissions include the following:

General

1. Replacing inefficient steam driven pumps and fans with motor driven
2. Collection and reuse of process return condensate
3. Use of improved catalysts for key types of chemical reaction
4. Improvements in distillation equipment & gas turbine efficiency
5. Expanded process integration to conserve heat generated during reactions
6. Use of membrane technologies for separation of reactants
7. Installation of micro steam turbines in place of PRDS and PRV
8. Thermo compressors / vacuum pumps in place of ejectors
9. Improving cooling tower performance



Ammonia plant

1. Installation of superior materials for reformer tubes
2. Installation of adiabatic pre reformer
3. Optimization of steam/carbon ratio for increased performance
4. Use hydraulic turbine
5. Use for stage flash vessel
6. Change of tower packing
7. Installation of purge gas recovery unit
8. Make up gas chiller at suction
9. Synthesis converter revamp

Urea plant

1. Use of urea hydrolyser stripper
2. Incorporation of additional trays inside the reactor for improving the per-pass conversion
3. Use of coil to feed the reactants from top of reactor
4. Use of internal heat recovery system
5. Installation of vacuum pre concentrator in urea plant



9.2.1.12. Engineering

In the engineering industry, various technological improvements that can increase energy efficiency and reduce carbon emissions are listed below:

Boiler

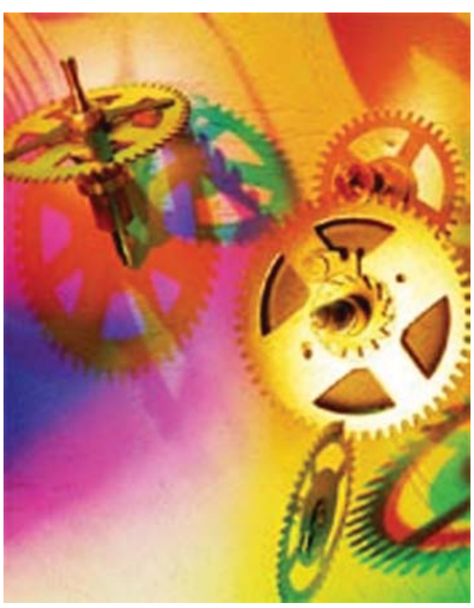
Short and medium term:

- Improving combustion efficiency of boilers by optimizing the combustion air supply
- Installation of condensate recovery system for the boiler

Compressors

Short and medium term:

- Continuous monitoring of compressed air leakage and avoiding leakage level
- Optimizing overall operating pressure of compressors based on the system requirement
- Replacing compressed air with blower air for agitation in effluent treatment plants phosphating tanks and in similar applications
- Use of transvector nozzle for cleaning applications involving compressed air




- Replace pneumatic tools with electrical tools

Long-term:

- Replace old compressors with new energy efficient compressors
- VFD for screw compressors catering to varying demands of compressed air
- Segregating high pressure and low pressure compressed air users
- Installation of demand side and supply side controllers for compressed air system
- Replace heater purge type air dryer with heat of compression dryer for capacities above 500 cfm
- Replacing desiccant type air dryer with heat of compression type air dryers

Cooling tower chilled water

Short and medium term:

- Installation of temperature indicator control for cooling tower fans
- Replacing aluminium blades with FRP blades in cooling tower fans
- Converting 2 well system to a single well system in the chilled water system, where ever possible
- Improving the insulation levels of the chilled water distribution system
- Optimizing the operation of chilled water pumps based on the head capacity requirements of the system

Dust Collection systems

Short and medium term:

- Clean scrubber regularly and optimize the operation of san dust collection blower
- Replacing inefficient dust collection systems and improving the dust collection system

Electrical

Short and medium term:

- Switching-off the primary of idle transformers

- Relocate capacitors to the load end and minimize loss in cables
- Improve overall power factor and reduce maximum demand charges & distribution losses
- Installation of automatic voltage stabilizers for lighting circuits and operating at optimum voltage
- Optimizing the operating voltage and frequency in DG sets based on the capacity loading of the equipment
- Replacing conventional copper ballasts with electronic ballast
- Use of energy efficient lamps like CFL, T-5, Metal Halide, sodium vapour and LED lamps
- Replacing filament indication lamps in control panels and with LED lamps
- Install translucent sheet to avoid day time lighting wherever feasible
- Neutral compensator at unbalanced lighting feeders
- Installation of automatic star delta star converter in the lightly loaded motors which handle fluctuating loads
- Replacing old inefficient motors with energy efficient motors

Long-term:

- Replacing motor-generator sets with static inverters
- Replace high pressure mercury vapour lamps with high pressure sodium vapour lamps Electroplating

Furnaces

Short and medium term:

- Optimizing the over all loading of furnaces by better planning of jobs
- Improving the combustion efficiency of furnaces, by optimising the combustion air supply
- Installation of pneumatic operated door for push type furnaces

- Air curtains at exit entry of drying ovens to reduce heat loss
- Replacing refractory bricks with ceramic fibre in furnaces
- Improving the overall insulation levels and close the openings in furnaces so as to minimize heat losses
- Use of ceramic coating for achieving improved insulation levels
- Installation of kwh integrator & controller for induction furnaces
- Recover waste heat from the flue gas of furnaces and preheat the charge material

Long-term:

- Use of ceramic fibre insulation for batch operated furnaces
- Installation of radiant tube recuperative burners in place of electrical heaters for applications involving temperatures less than 1000 deg c

Pumps

Short and medium term:

- Installation of correct size pumps based the actual head and flow requirement
- Avoiding operation of hydraulic pumps during idle operation
- Level Indicator Controller (LIC) for water over head tank pump to avoid recirculation & over flow

Long-term:

- Installation VFD for hydraulic power pack and avoiding recirculation of hydraulic oil

Refrigeration and air conditioning

Short and medium term:

- Installation of micro processor based temperature indicator controller for window air conditioners
- Use polyester sun film controls in the areas exposed to direct sunlight and optimize the temperature settings of the cooling system

- Optimizing temperature settings of AHUs and install thermostat control for chiller compressor
- Replacing air cooled condensers with water cooled condensers.
- Installation of evaporative condensers for higher capacity chillers

Thermopacs

Short and medium term:

- Improving the combustion efficiency of the thermopac by reducing the excess airflow
- Replace inefficient burners in the theropacs with energy efficient burners
- VFD for thermic fluid pumps catering to multiple users

Vapour Absorption machine

Short and medium term:

- Optimize combustion air supply for direct fired vapour absorption machines

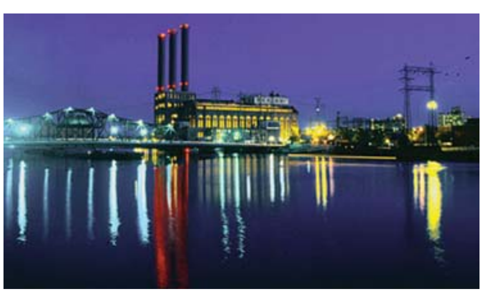


9.2.1.13. Enhancing efficiency of power plants

Coal is the mainstay of India's energy economy. Coal-based power plants account for about two-thirds of the total electricity-generation installed capacity of about 135,000 MW. While power plant efficiency is being addressed, the Electricity Regulatory Commissions are also linking tariffs to efficiency enhancement, thus providing an incentive for renovation and modernization. New plants are being encouraged to adopt more efficient and clean coal technologies, and four new plants under construction have adopted the more-efficient super-critical technology for power generation.

The list of possible energy efficiency improvement measures are given below:

- Heat rate improvement of Coal fired Thermal power plants
  - Condenser performance improvement - Online condenser cleaning system
  - Performance improvement of turbines by incorporating high efficiency seals
  - Performance improvement of Heaters
  - Air preheater performance improvement and improved flexible seals for arresting the leakages
  - Installation of plasma burners for firing
- Super critical technology for thermal power plant
- Heat rate improvement in Gas turbine combined cycle power plants
  - Gas turbine inlet air cooling - Fogging / Chilled water cooling
  - Installation of online washing system
- Integrated Gasification and combined cycle






9.2.1.4. Electrical Systems

Short Term:

- Installation of delta star converters for lightly loaded motors
- Use of translucent sheets to make use of day lighting
- Timers for automatic switching on off of lights
- Grouping of lighting circuits for better control
- Operating electrical system at maximum power factor say 0.96 and above
- Optimising the loading of transformers and improving operating efficiency of transformers
- Optimizing TG / DG set operating frequency and voltage based on the capacity margin available in equipment (Only for island mode operation)

Medium/Long term:

- Installation of maximum demand controller to optimize maximum demand
- Minimising overall distribution losses by proper cable sizing and addition or capacitor banks
- Installation thyristorised rectifiers
- Replace rewound motors with energy efficient motors
- Install energy efficient motors as a replacement policy
- Installation of amorphous core transformers
- Replacing HRC fuses with HN type fuses
- Replacing conventional ballast with high efficiency electronic ballasts in all discharge lamps
- Install LED lamps for panel indication instead of filament lamps
- Use of energy efficient lamps like CFL, T-5, Metal Halide, sodium vapour and LED lamps
- Installation of neutral compensator in lighting circuit
- Optimize voltage in lighting circuits by installing servo stabilizers
- Replacing motor-generator sets with DC drives



9.2.2. Energy Efficiency in the Transport Sector

The Transport sector, particularly road transport is dependent on fossil fuels and is the second largest consumer of energy after industry. Rapid economic growth, increased urbanisation, rising income levels and increased motorization coupled with shortage of reliable public transportation system may lead to exponential growth in number of vehicles and consequent increase in carbon emissions. The road network, both urban and inter-city, has been growing, but needs to keep pace with demand. Government policies, therefore, have an important role to play by providing adequate infrastructure and effective traffic management while also strongly supporting the development of public transport. However, India is steadily gaining reputation as the global hub of small and fuel-efficient cars. Therefore, while vehicle ownership may increase, there can be a reduction in the average vehicle-kilometres driven if suitable multi-modal alternatives are available.

The best way to develop these infrastructure facilities is through public-private partnership, for which several successful models and case studies are available in India.

In terms of long-distance freight and passenger transport, it is desirable to have an optimum inter-modal transportation system where the railways carry the major share of long-distance freight and passenger traffic and roadways catering to the short haul and providing feeder services.

The automobile industry has also been steadily aligning itself with global standards of emission and safety norms. Government policies can help moderate energy demand further by increasing energy efficiency through setting gradually tougher fuel efficiency standards for vehicles.

Key Strategies for climate change mitigation in transport sector include the following:

- Improve technology (scooters, cars, advanced technologies e.g. battery operated vehicles, fuel cell)
- Manage growth in vehicle use (with “carrots” and “sticks”)
- Enhance/improve travel alternatives to serve diversity of needs and desires
    - High quality, affordable mass transit system critical (e.g. Delhi Metro)
- Organize and emphasize on Freight transportation by waterways
- Coordinate government strategies and activities (transport and land use, infrastructure investments, industrial policy and transport, etc)

9.2.2.1. Fuel Efficiency

Promoting fuel efficiency for vehicles by setting-up fuel economy norms, is proving to be quite successful in the United States. The programme, popularly known as Corporate Average Fuel Economy (CAFÉ) standards show that the strategy could be useful in ensuring compliance by vehicle manufacturers. Similar approaches have also been adopted in Japan and European Union. Regulation has been implemented in Japan, with a 138g $CO2$/km weight-based target to be met by 2008 and 125-g co2/km by 2012. In Europe, European Commission has made proposals to decrease cars $CO2$ emission to 120 g/km. India, with its ever increasing appetite for newer vehicles may need to take similar steps (summarised as below):

Key Steps

- Formulate and implement fuel economy standards for HMVs, LMVs at the maximum rate possible by applying economics and available technology.
- Update/increase the standards on a regular basis.
- Improve fuel efficiency by reducing vehicle weight, horsepower or non-critical amenities, or by developing step-out technologies.

9.2.3. Building Codes

As discussed above in section 7, an Energy Conservation Building Code (ECBC) was launched in May, 2007, which addresses the design of new, large commercial buildings to optimize the building's energy demand. Although nearly one hundred buildings are already following the Code, and compliance with it has been incorporated into the Environmental Impact Assessment requirements for large buildings. However, the scope of energy conservation building codes is not limited to large commercial buildings only. The country is building-up numerous software parks, special economy zones, shopping malls and large housing complexes. This provides opportunity for further energy conservation in these establishments. India can leap forward by developing codes for;

- Data centres
- Special Economy Zones (SEZs)
- Malls / Shopping Centres
- Large housing projects

9.2.4. Appliance and Equipment Standards

An energy labelling programme for appliances was launched in 2006, and comparative star-based labelling has been introduced for fluorescent tube lights, air conditioners, and distribution transformers. The labels provide information about the energy consumption of an appliance, and thus enable consumers to make informed decisions. Almost all fluorescent tube lights sold in India, and about two-thirds of the refrigerators and air conditioners, are now covered by the labelling programme.

The Bureau of Energy Efficiency's Energy Labelling and Certification Programme covers the following equipment:

- Refrigerators with or without low temperature compartment
- Room air conditioner (unitary)
- Stationary storage type electric water heaters
- Electric motors up to 100 KW
- Agricultural pump sets including horizontal centrifugal pumps, mono set pumps and submersible pump set up to 15 KW
- Electric light sources, control gears and luminaries including tubular fluorescent lamps, inductive type ballasts, electronic ballasts, luminaries and compact fluorescent lamps
- Distribution Transformers
- Industrial fans and blowers up to 100 KW
- Air compressors up to 100 KW

To further enlarge the scope of appliance and equipment standards, energy efficiency standards should also apply to other increasingly common products, including those based on expanded digital technologies. These standards should be updated on a regular basis depending upon the technology and economics of the equipment.

9.3. Cleaner Conventional Energy Technologies

As indicated in section 4, fossil fuels are likely to be predominant energy sources in the short to medium term. According to the IEA reference scenario, by the year 2030, almost 50% (620



Mtoe out of 1299 Mtoe) of India's total primary energy demand is likely to be met by coal. Even under alternate policy scenario, which presupposes implementation of all desirable policies, share of coal would be over 37% in India's energy mix by 2030. Other fossil fuels are also likely to maintain their prominence for some time to come. Naturally, any climate change mitigation strategy for India is not complete without finding the cleaner and more efficient ways of exploiting fossil fuels. Many such technologies are available today. Some of them are claimed to be ripe for commercialisation. While some other are at various stages of Research and Development. These technologies include Super-Critical & Ultra Super-Critical Boilers, and both of these are eligible for CDM funds.

- Current supercritical coal fired power plants have efficiencies above 45%
    - Carbon emission much lower than sub-critical plants for a given power output
- Ultra super-critical boilers promise even higher efficiency and lower emission
    - Several companies keen on introducing the technology in India

Other technologies that are not yet commercially available but can soon be commercialized with R&D inputs include:

A. Integrated Gas Combined Cycle (IGCC)

- Integrated Gasification Combined Cycle (IGCC) is rapidly emerging as one of the most promising technologies in power generation that utilizes low-quality solid and liquid fuels and is able to meet the most stringent emissions requirements.
- IGCCs can be outfitted for carbon capture much more easily and cheaply than conventional coal plants.
- High capital cost of the technology is a concern. But in India high incremental cost can be partly covered under the CDM mechanism.

B. In-Situ Coal Gasification

Underground coal gasification (UCG) is a cost-effective environmental solution for resource recovery in areas beyond the technical and economic confines of conventional mining

- Environmental foot-prints are relatively low compared to conventional mining.
- Mining, transport, reclamation, and management of combustion residues not required.
- Carbon capture and sequestration are quite easy.



C. Nuclear Energy

As indicated in section 3, Government of India views nuclear as a desirable option to ensure India's energy security in the medium and long term. The technology is also viewed favourably from climate change standpoint. International Energy Agency has recognised nuclear as an option for climate change mitigation. However, other multilateral agencies haven't revealed their considered opinion on the technology. Though nuclear has to be treaded carefully due to safety, waste disposal and fuel issues, there is little doubt that the technology has to play an increasingly important role in India's energy mix.

Besides the fact that nuclear power is emission-free, India's huge thorium reserves can be gainfully utilized for nuclear power once fast breeder reactor technology is operationalised. To enable this, continuing support to the three–stage development of India's nuclear potential is essential.

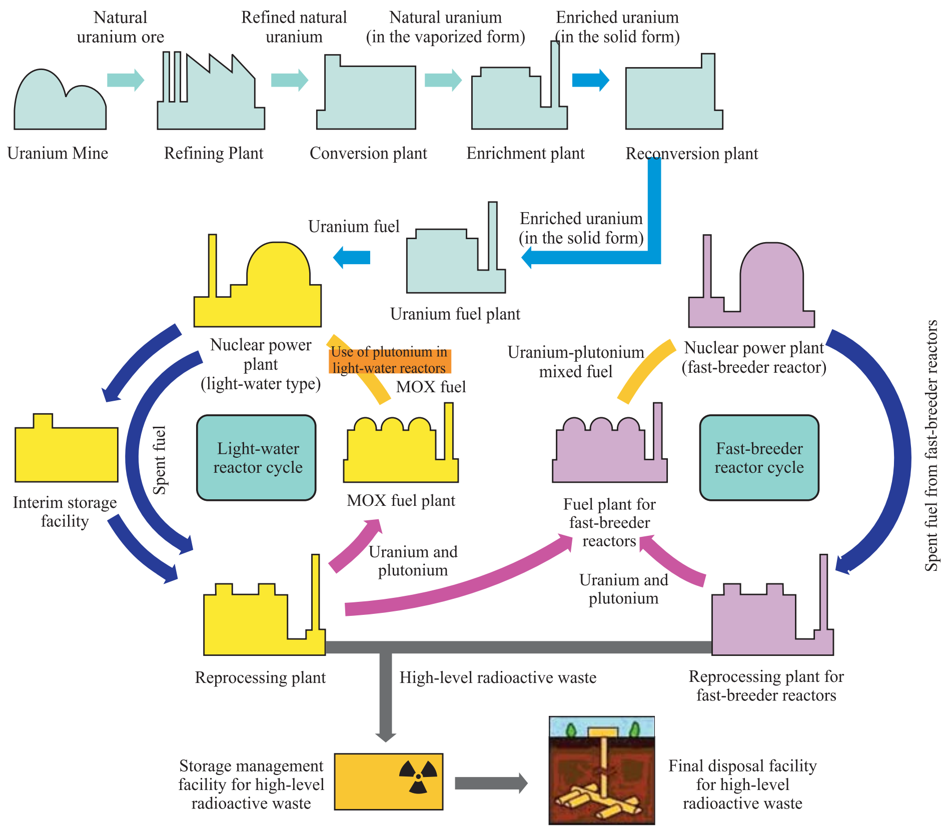
Nuclear fuel & Reprocessing: With technology denials and no access to nuclear fuel, India had been extracting low-grade uranium ores with low uranium content of 0.1 per cent compared to those abroad with a content of 12-14 per cent. This also made the Indian nuclear fuel two-three times more expensive. Conventional Nuclear reactors convert barely 1-2 % energy from the fuel; reprocessing entails conversion of over 95%. Thus, reprocessing builds energy security and reduces the amount of radioactive waste and significantly reduces the waste disposal concerns (refer to figure 7).

9.4. Hydrogen/Fuel cell

Other promising technologies that have the potential for commercialization, after R&D inputs, in the long-term are Hydrogen and Fuel Cell. At present, issues related to cost, infrastructure, safety and production of hydrogen has been impeding the commercialisation of this technology. However, as a result of global R&D initiatives (e.g. IPHE), these issues are likely to get addressed gradually. Some of the merits of hydrogen/fuel cell technology are;

- Can be used for transportation as well as stationary applications.
- Hydrogen is a clean carrier of energy. Can be made totally emission free if production based on renewable energy sources.
- Fuel cells are more energy efficient. Fuel cells utilise 40-60% of fuel's energy compared to 20% in case of internal combustion engine.
- Lot of research capability exists world-over as well as in India.

Figure 7: Nuclear Fuel Cycle Diagram



9.5. Free and Open Markets

India needs a well-instituted market mechanism, where energy prices are based on the interaction of demand and supply. Subsidies in certain energy segments, particularly in fossil fuels, have distorted the market and have perpetuated inefficient use of energy:

- Free/subsidized electricity to farmers has resulted into over drawing of water, use of in-efficient pumps etc.
- Subsidy on kerosene has caused adulteration of gasoline with kerosene
- Subsidy on cooking gas has perpetuated inefficient cooking practices

These subsidies have serious repercussions for climate change. The subsidy to fossil fuels is slowing the rise of renewable energy technologies and energy efficiency measures; by impairing



the government's ability to invest in these alternate energy technologies and by reducing stakeholders' willingness to adopt these solutions.

9.5.1. Carbon/CDM Market

For India, CDM and other types of carbon markets such as voluntary emission reduction (VER) are proving to be effective tools for technology transfer and capacity building to cope with climate change. India affords a variety of opportunities for CDM and its project range is very diverse, both in terms of technology type and scale.

The strength of India's CDM programme is:

- The country has the highest number (over 747) of CDM projects approved by any national government.
- World's largest number of registered CDM projects are hosted by India (289 out of 844).
- 34.69% of the total CERs issued by host parties are from India as of November 2007.
- CDM can pave the way for around 18,500 crores (3.5 bn Euros) of investment by 2012 in India.

Sources: Planning Commission, India; UNFCCC

Furthermore, the Indian CDM programme is acclaimed as a more broad-based programme compared to the present CDM initiatives of countries such as China. The CDM portfolio in India constitutes a balanced mix of renewable energy, energy efficiency and other industrial projects, while the Chinese CDM portfolio is dominated by large HFC projects.

India has a large pool of domestic and foreign consultants, validators and verifiers that has kept CDM markets competitive in the country. Some of the consultants have started charging a part of the proceeds from CER sell instead of an up-front consultancy fee from project developers. This has further improved comfort and confidence of project developers, particularly, small and medium ones. On the demand side, several buyers already operate in India. Some of the well-known buyers of emissions reductions from India include the World Bank Prototype Carbon Fund and institutions from the Netherlands, Austria, Finland and Sweden.

However, the success of the Indian CDM programme should not mask certain deficiencies, which have impeded the full-scale exploitation of carbon opportunities by the country. These shortcomings (listed below) may require immediate attention of Government and other stakeholders:

1. Lack of an organised domestic carbon market in India
2. Lack of clarity on the taxation of CER income
3. Lack of mitigation mechanisms for risks prevailing during the trade of carbon credits in the pre-certification period

9.5.1.1. Organised Domestic Carbon Market in India

The present carbon market in India appears to be fragmented and devoid of sophisticated tools for hedging and risk mitigation. Currently, most of the carbon trade takes place through bilateral deals. These deals do not provide a clear signal on market clearing prices due to absence of an advanced market tracking and monitoring mechanism. The wide range of carbon prices prevailing in the Indian market today does not provide a clear signal to the investors and project developers.

Most of the CDM projects in India are unilateral projects, and project developers have to invest considerable time and energy to find-out and negotiate with suitable buyers. The present carbon market in the country is also fraught with lack of sophisticated risk mitigation tools that can encourage the trading of pre-certification instruments such as verified emission reduction (VERs) and tranche certificates generated from the pool of CDM projects. Clearly, there is a need to set-up an organised domestic carbon market in the country, which can address the above-mentioned issues and augment the scale of CDM project development. The features of this market could be:

- Trade in all instruments: Certified Emission Reduction (CERs), Verified Emission Reduction (VERs) and Voluntary Emission Reduction.
- Provide for advance risk management instruments in carbon markets such as forward, futures, options and trading in carbon tranche.
- Provide for both exchange-based trading and over-the-counter trading with adequate linkages between them.
- Provide for clearing, settlement and guarantee facilities of a typical modern market.
- Link with global carbon markets such as EU ETS, UK ETS etc.
- Encourage and facilitate the participation of international stakeholders and financial institutions.



9.5.2. Dynamic Cap and Trade Market in India: A Case for Contemplation

India and similar other developing countries are facing increasing pressure from the rest of the world to sign for mandatory emission reduction. Some experts have also called for India's unconditional participation in Global Green House Gas mitigation targets, and espoused the idea of economic and trade sanctions to force the country into mandatory targets during the second commitment period of Kyoto Protocol (post 2012). This has been opposed by government and other stakeholders in India due to concerns that mandatory targets would undermine India's right for economic development and its capacity to meet millennium development goals.

Unlike developed countries, India is facing continued shortages of energy and energy prices are not market determined. The consumers are yet to have control over energy choices and energy markets are likely to evolve and mature over a period of time. Hence, commitments to carbon reduction need to be phased out to a later period (viz. 2020).

A balanced way forward can be worked out in the form of committing to a dynamic carbon reduction programme (may be for post 2020), where the permissible limit of carbon emission is dynamically adjusted every year depending upon forecasts of underlying factors such as GDP growth rate, industrial growth rate, population growth rate, increase in per-capita energy consumption and rate of energy-GDP decoupling. The carbon emission quota can be worked out after fitting forecast of these variables in a dynamic programming model, which takes into account technological changes and changes in lifestyle pattern. For example, in the long-term, technological breakthroughs, e.g. in hydrogen/fuel cell, CCS, industrial processes and nuclear fusion are expected to dramatically reduce the energy and carbon intensity of the Indian economy, thereby requiring less carbon emission for the same level of GDP growth.

The next step after committing to a dynamic carbon reduction target could be to establish a dynamic cap and trade scheme in the country. After capping the aggregate greenhouse gas emissions (GHGs), the cap can be sub-divided into smaller parts (or emissions allowances similar to rationing coupons), and can be distributed on a no-cost basis to businesses that emit greenhouse gases. The sectoral allowances/coupons may also be adjusted annually, depending upon the increase in total GHG allowances and technological changes in specific sectors.

However, significant research and analysis is required before such an idea can be presented for implementation. Proper investigation of merits/demerits of dynamic cap and trade scheme



vis-à-vis carbon tax, sectoral impacts of cap-trade, preparedness and ability of Indian businesses to participate in such a mechanism is required. Also rigorous modelling would need to be done to determine forecasts of underlying variables, total and sectoral carbon emission allowances and also to establish trading methodologies. The trade-off/linkages of Indian 'cap and trade' market with present CDM market would also need to be studied. To start with, the total carbon allowances can be set liberally and Indian cap and trade market can be linked with other global carbon markets such as EU ETS to allow Indian parties to take advantage of surplus allowances.

9.5.3. Carbon Tax: an Alternate to 'Cap and Trade'

Carbon tax is an instrument to increase the relative price of carbon. Carbon tax is a price-based policy, which leaves the market to determine the optimum volume of carbon emission. On the other hand, 'cap and trade' scheme fixes the volume and leaves the market to determine the price of carbon. In a world of perfect information, the two instruments would be equivalent. The social cost of carbon would determine optimal abatement level and vice-versa. However, information is not perfect and uncertainties are considerable. Therefore, the final outcome of these two instruments may differ significantly from each other. Carbon taxes may generate additional tax revenue for the exchequer but its volume consequences are uncertain.

Further, energy is priced very high in India. In the electricity sector, industrial and commercial segments have been cross-subsidising domestic and agriculture segments. Several taxes are imposed on the electricity generated by industry for in-house consumption (e.g. self-generation tax, electricity duty etc.) or on electricity bought through trade. In the hydrocarbon sector, high rates of taxes are imposed at every step of the value chain. These include, custom duty (5% on crude, 10% on petrol and diesel), excise tax, local sales tax/VAT, Octroi etc (Rangarajan Committee Report, 2006). Due to the ad-valorem nature of these taxes, the effective quantum of taxes on petroleum sector has increased along with the increase in international crude prices.

Apparently, the relative price of carbon is already high in India. Therefore, before imposing any further tax (e.g. carbon tax), the marginal benefit of such taxation and its impact on competitiveness of Indian Industry needs to be clearly understood. This would require rigorous analysis and debate within the country.



9.6. Green Buildings

Buildings make up to approximately 40% of total energy consumption in developed countries such as United States. They are also responsible for 40% of all material flows and produce upto 15%– 40% of the waste in landfills. (Rocky Mountain Institute, 2007). Clearly, large-scale improvements in resource productivity in buildings would have a profound effect on national resource consumption.

In India, the construction sector is growing at 13% and real estate at a staggering 30%. The growing demand for office space requires office stock to increase to the tune of 20 million sf/ year in New Delhi, Mumbai and Banglore (BEE, 2007). The demand for office space in other cities is also increasing proportionately. This would undoubtedly burden the already stressed urban infrastructure. If this kind of a growth rate is to be sustainable, there is an imminent need to look at construction options, which are environment - friendly.

Worldwide, green buildings have emerged as a popular solution. Since the past 5 years, it is increasingly adopted by several stakeholders of the construction industry for a variety of reasons such as:

- 40% to 50% reduction in energy cost
- 30% to 40% reduction in water consumption
- Green corporate image
- Health of building occupants
- Imbibe best operational practices right from day one

There are various rating and verification systems available to qualify a building as a green building, notably, Leadership in Energy and Environmental Design (LEED). Buildings are rated based on the features such as water efficiency, energy efficiency, material/resources consumption, indoor environmental quality and sustainable selection of site.

Indian private sector led by CII has achieved leadership in Green Buildings. Launch of CII Sohrabji Godrej GBC Platinum rated building (refer to box 6) in Hyderabad inspired many Indian companies to opt for such construction. Presently, approximately 19 Buildings have already accomplished green building ratings, out of which 5 buildings achieved prestigious Platinum rating. Further, 110 more buildings have registered for Green Building rating, Equivalent to 20 million Sq. ft of building area.



Today a variety of green building projects are coming up in the country - residential complexes, exhibition centres, hospitals, educational institutions, laboratories, IT parks, airports, government buildings and corporate offices. A strategy should be worked out to increase the penetration of Green Buildings' concept in these upcoming establishments. This could be done by:

- Increasing awareness on green buildings amongst architects, building industry community
- Conducting workshops, training programs and conferences on green buildings
- Involvement of state & central governments in policy related to green buildings
- Promoting and creating market for green building materials
- Launching of Indian rating systems (LEED India) for green building

Box 6 : CII-Sohrabji Godrej GBC Platinum Building

The CII Godrej GBC platinum building is located in an area of five acres near HITEC City in Hyderabad, India. The building was the first LEED certified platinum rated building outside the United States. 80 per cent of the material used in the construction of the building was recycled material. The building discharges zero water as all of its used water is recycled. It consumes about 40 % less water than a conventional building due to low water consuming fixtures like Waterless Urinals. It has a huge capacity for the collection of rain water. The GBC building consumes only 1,30,000 kwh electricity per year compared to around 2,50,000 kwh of power consumption by a conventional building of the same size. Other notable features of the building include;

- Minimum site disturbance
- 55% reduction in energy consumption
- 100% Day lighting
- 15 % Power-Solar PV
- 60% recycled materials
- Roof garden - 60% area
- Non toxic paints
- Fly-ash based blocks
- Building management system



9.6.1. Green Overhaul of Existing Buildings

Along with promoting the green building concept in new and upcoming establishments, it is also important to encourage greening of existing buildings. This would involve diagnostic testing, benchmarking and retrofitting of existing buildings. Buildings with lower benchmarking scores would be targeted under this strategy. Retrofitting would be the next step after benchmarking, with a view of formulating low-cost upgrades to building operations and replacement of failed components.

World-over, several initiatives are going on for the green overhaul of existing buildings; notably, Clinton Climate Initiative (CCI) of Clinton Foundation; EuroACE activities in Europe etc. India has already developed remarkable capabilities in green buildings and this capacity can be easily utilised in greening of existing establishments. Also, retrofits and upgrades are being contemplated for adoption by Indian architects and builders.

9.7.Addressing Energy Efficiency and Climate Change in the Aviation Sector

Aviation contributed about 2 per cent of global fossil fuel carbon dioxide emissions in 2005. However, the impact of aviation on global warming is increasing rapidly. According to the Stern Review, "aviation emissions could account for... 5 per cent of the total warming effect (of all global CO_2 emissions) in 2050." Since the expansion of air transport in India is among the fastest in the world, India needs to take steps to;

- Set emission targets for airlines operating in India, as has been done by The Advisory Council for Aerospace Research in Europe, which has set a target to emit 50 per cent less CO_2 for European aircraft, or by NASA, which has set similar targets for US airlines
- Explore possibility of carbon credits for Indian civil aviation sector, as has been done in Europe.
- Formulate policies to encourage shift from aviation to high-speed rail.
- Use advanced aircraft scheduling techniques.

Globally, advances are taking place in aircraft technology. Boeing's Greenliners and the Airbus A380 are the best examples of commercial response to the emerging crisis in climate change. Application of lightweight carbon fibre in Boeing, and General Electric's light weight materials in engine and components are examples of the effort. Air traffic management is a crucial factor for the future.

Increasing attention will be needed to:

- Invest in fuel-efficient aircraft and related equipment. For example, twin engine aircraft, which burn less fuel and emit less carbon dioxide than comparable 3 and 4 engine aircraft, can be used.
- Install advanced technology aero blades, reducing emissions and fuel consumption on long range aircraft.
- Equip aircraft with winglets, which are wingtip extensions that lower aircraft drag and result in upto 5% reduction in emissions and noise. Old aircraft can also be retrofitted with winglets.
- Develop more efficient air traffic routes and airspace configurations.
- Enhance flight-planning systems to minimize fuel burn.
- Instead of using aircraft auxiliary power units when parked at gate, alternative, energy - saving methods to be used.
- Reduce the use of fuel-driven thrust reversers on landing.
- Routinely wash aircraft and engines, which reduce emissions by reducing drag.
- Change from steel to lighter carbon brakes, which reduce aircraft weight.

9.8. Water Efficiency

Water use is directly linked to energy supply, availability and price. Water pumping takes up 25-30% of electrical energy consumption in India. Water tariffs and power tariff are directly linked. Low power tariffs or free supply of power, especially at unregulated times and frequency leads to wastage of water. Supply of water to urban and municipal areas at potable purity is a huge drain on the limited financing resources of urban and municipal bodies.

Numerous ways and examples which show how water can be used more efficiently include:

- Efficient water pumping systems: efficient pumps, high-efficiency electric motors, Diesel Engines, foot relief valves and pipelines and fittings with least number of bends.
- Demand side management: pumping water during "off-peak" electricity consumption period.
- Community involvement in water management as shown by the numerous instances of



water user associations throughout the country. These helped avoid misuse and excessive use of water.

- Community involvement in restoration of water bodies and water harvesting and conservation, as shown by the work of Rajendra Singh/Tarun Bharat Sangh, Alwar in Rajasthan and Anna Hazare at Ralegaon Sidhi in Maharashtra.
- Rain water harvesting by large buildings and artificial groundwater recharge in cities.
- Water trading and informal urban water supply markets.
- True water pricing which leads effectively to cutting down on wastage by consumers.

9.9. Agriculture

Agricultural production in India is largely determined by the weather – rainfall and temperature. Climate change can have extreme impacts on agricultural production, slashing crop yields and forcing farmers to adopt new agricultural practices in response to altered conditions. Climate change thus has an impact on food security and can be a matter of serious concern even in short to medium term.

A number of improvements in agricultural practices are needed to make agriculture more sustainable, climate friendly as well as to adapt to climate change. Some of the key action points include:

a) Improve and develop efficient crop varieties compatible to climate change

Development of crops better suited to changing environmental conditions will need to be prioritized by national and international breeding and genetic modification programmes. For example, food grain varieties that are less water intensive and are resistant to extreme weather would be of great use. Research should also go into developing rice varieties that emit less methane.

b) Efficient utilisation of biotechnology for breeding

Agricultural scientists should prioritise developing new generation of crop varieties adapted to changes induced by global warming. The advancement of biotechnology would definitely help to speed up the process. Many of the expected future conditions due to climate change are already problems for marginal areas today: drought, heat stress, salinity, pests and pathogens. This provides a good testing ground for research in this area. In order to have successful new products, the breeding has to be environment-specific like breeding



for drought, cold, heat, increased productivity in flood-prone areas, etc.

c) Use of biological/ecological resources in a sustainable manner by promoting organic farming, which uses animal dung, wastes, bio-fertilizers and bio-pesticides

Agriculture is not only a victim of global warming. At present, it is also a contributory factor, and in the future, it could make a major contribution to reduction of global climate change. Some 25 per cent of carbon dioxide emissions come from land use change (mainly deforestation in the tropics), and fertilizer use is one of the main sources of nitrous oxides. Therefore, switch-over to sustainable modes of farming (e.g. reducing excessive is of nitrogenous fertilisers) would go a long way in tackling the problem of climate change. Similarly, agriculture sector's emissions of methane can be reduced by changing cultivation methods in paddy fields.

d) Use of animal dung, crop residues, other non-farm activity based organic residues, etc. for energy production

Generation of methane from the livestock can be curbed by using feed additives that increase livestock digestion efficiency. Also, animal dung, crop residues and other organic residues can be gainfully utilised for energy production through Biogas plants.

e) Promotion of Agro-forestry

Agro-forestry combines agriculture and forestry technologies to create more integrated, diverse, productive, profitable, healthy and sustainable land-use systems. It can increase the presence of trees in arable land and pasture, increasing carbon uptake. It is now recognized globally as having high potential for sequestering carbon as part of a short-to-medium term mitigation strategy.

f) Install Advance Monitoring and Early Warning System

To minimise the threat of extreme weather events and breakouts of plant diseases due to climate change, setting-up of advanced monitoring and early warning system is quite critical. The Food and Agriculture Organisation (FAO) is encouraging several national decision-makers and the scientific community for the following:

- Monitoring agricultural production for planning and early warning purposes (GIEWS), using satellite technology (ARTEMIS) and agro-meteorological tools;
- Establishing effective early warning systems for animal and plant diseases (EMPRES);



- Monitoring environmental conditions and climatic changes (GTOS, AFRICOVER, SD Dimensions Global Climate Maps).

9.10. Afforestation and Land Restoration

The basic components of India's forest conservation efforts include protecting existing forests, putting a check on the diversion of forest land for non-forestry purposes, encouraging farm forestry/private area plantations, expanding the protected area network and controlling forest fires. The significance of afforestation activities and the thrust given at present is reflected from the following points:

- Forests cover 19.4% of the country's landmass. Forests with a crown cover of more than 40% have been increasing.
- The National Forestry Action Programme has been formulated for sustainable forest development and to bring one-third of the country's geographical area under forest/ tree cover as mandated in the National Forest Policy, 1988. A major programme of afforestation is being implemented with the people's participation under Joint Forest Management.
- The National Forest Policy envisages the participation of people in the development of degraded forests to meet their requirements of fuel wood, fodder and timber.
- The protected area network comprises 88 national parks, 490 wildlife sanctuaries and is spread over 15.3 million hectares.
- Twelve biosphere reserves have been set up to protect representative ecosystems. Management plans are being implemented for 20 wetlands with coral reefs and mangroves being given a priority.
- The National Wasteland Development Board is responsible for regenerating private, non-forest and degraded land.
- The National Afforestation and Eco-development Board is responsible for regenerating degraded forestland, land adjoining forests and ecologically fragile areas.

9.11. Research and Development

Focused Research and Development is critical for improving the understanding of drivers of climate change and finding options to reduce its impact. India, having a large pool of research professionals, is expected to contribute significantly to the R&D efforts pertaining to climate



change. These R&D activities can be carried out both domestically and in sync with global R&D efforts of similar nature.

9.11.1. Participation in Global R&D Consortia

India can combine its strength of abundant scientific manpower and low-cost innovation with the already existing research infrastructure and resources of the world to bring about optimum results. Several opportunities exist where Indian R&D stakeholders can be part of Global R&D consortia. Some work has been done in this direction. India is already participating in several global R&D consortia project for example;

- International Thermonuclear Experimental Reactor (ITER): ITER is a joint international research and development project that aims to demonstrate the scientific and technical feasibility of fusion power. The long-term objective of fusion research is to harness nuclear energy for mankind's future energy needs. ITER is the first fusion experiment to produce net power and will test a number of key technologies, including the heating, control, diagnostic and remote maintenance that will be needed for a real fusion power station.

- International Partnership for the Hydrogen Economy (IPHE): IPHE is a global partnership to help organize and implement effective, efficient, and focused international research, development, demonstration and commercial utilization activities related to hydrogen and fuel cell technologies. It also provides a forum for advancing policies, and common codes and standards that can accelerate the cost-effective transition to a global hydrogen economy to enhance energy security and environmental protection.

- FuturGen: This is an initiative to build the world's first integrated sequestration and hydrogen production research power plant. The $1.5 billion project is intended to create the world's first zero-emissions fossil fuel plant. When operational, the prototype will be the cleanest fossil fuel fired power plant in the world. The prototype plant will establish the technical and economic feasibility of producing electricity and hydrogen from coal, while capturing and sequestering the carbon dioxide generated in the process.

- Carbon Sequestration Leadership Forum (CSLF): CSLF is a framework for international cooperation in research and development for the separation, capture, transportation and storage of carbon dioxide. The CSLF seek to realize the promise of carbon capture and storage over the coming decades, making it commercially competitive and environmentally safe.



9.11.2. Public-private partnership (PPP) approach for R&D

An effective R&D strategy for climate change would require combining government financing, social responsibility and public accountability of the public sector, with the finance, technology, managerial efficiency and entrepreneurial spirit of the private sector. Various R&D projects with the objective of finding-out effective solutions for climate change can be taken up under Public-Private Partnership (PPP) mode. To enable the same, a dedicated fund on 'Climate-Friendly Technologies' may be created by the government that could be further leveraged with both international and private funds to promote research, development, demonstration and deployment of clean technologies. Various projects can be started for commercialisation and use depending upon time frame. Short-term and medium-term projects may be taken up mainly with the view of improving existing technologies. However, many promising solutions can be worked out in long run. Some of these options for R&D are summarised in the table below (table 12):

Table 12: Options for Emissions Reductions beyond 2030

Power generation	■ Solar PV and concentrating solar power in combination with long distance electricity transportation ■ Ocean energy ■ Deep water wind turbines ■ Hot dry rock geothermal ■ Generation IV nuclear reactors ■ Large scale storage systems for intermittent power sources ■ Advanced network design ■ Low cost CCS for gas fired power plants ■ Distributed generation ■ Low cost unconventional gas
Transport	■ Hydrogen fuel cell vehicles ■ Plug in hybrids ■ Trans modal transportation systems ■ Intermodal shifts
Industry	■ CCS ■ Biomass feedstocks /bio refineries
Buildings	■ Advanced urban planning ■ Zero energy buildings

Source: World Energy Outlook, 2006



9.11.3. Carbon Capture and Sequestration (CCS)

CCS is an opportunity for reducing carbon emission from coal based thermal by trapping, compressing and storing CO_2 for a long term. Coal combustion is the largest source of CO_2 emission from energy use in India. Carbon emission from burning of coal can be significantly arrested by developing certain carbon capture and sequestration methods. In India, these CCS activities need to be implemented on a large scale.

According to an estimate, total sequestration potential of geological formations in India is around 572 Gt of CO_2. Of this 360 Gt would come from on-shore and off-shore deep saline aquifers. Around 200 Gt from the Basalt formations in the Deccan and Rajmahal traps. Approximately 5 Gt is likely to come from unminable coal seams and 7 Gt in depleted oil and gas reservoirs.

India can take a lead in developing the roadmap towards commercialisation of CCS by:

- Enabling a legal and regulatory framework conducive to CCS
- Providing regulatory clarity for land use and liability policies
- Undertaking a national CO_2 sequestration capacity assessment
- Enabling a full scale CCS and clean coal technology demonstration
- Organising communication between CCS technology developers and oil & gas/coal project developers
- Continuing R&D to work out low-cost CCS options for India

9.12. Financing Solutions

According to recent UNFCCC estimate, approximately 0.3 to 0.5% of global domestic product and about 1.1 - 1.7% of global investment would be required to address climate change by 2030. Developing countries like India would require significant amount of resources to combat climate change, given their need for large-scale adaptation measures.

National, state and local government would be required to largely meet the financing needs of various adaptation projects from their development budget and also to implement such projects. The augmented coffer of Adaptation Fund Board – to be set-up as per Bali agreement – would provide a good opportunity to Indian stakeholders to access funds for high cost adaptation projects.

The financing need for research, development, demonstration and deployment of clean technologies in India is also quite evident. Clean technology R&D projects would require substantial amount of funds both from international and domestic sources.

Some of possible domestic sources for these projects include;

- An exclusive climate-friendly technologies fund can be created in India; funded by government, and subsequently leveraged by industry
- Indian venture funds, angel investors can be encouraged to invest in commercially promising clean technologies
- Pension funds/provident funds can be utilised to provide long term capital for clean technologies research/implementation
- Technology Up-gradation Funds (TUFs) can be redefined to emphasise more on deployment of clean technologies

Some of the possible International financing sources are:

- CDM Funds
- Funds from other carbon reduction options (e.g. voluntary markets)
- International Clean Technology R&D fund (e.g. R&D endowments of various APP countries)
- Commercial participation of global R&D funds, angel investors, venture capitalists, other high-risk funds
- Long-term participation of global pension funds in commercially viable projects



10. Adaptation

Adapting to climate change will entail adjustments and changes at every level – from community-based to national and international. The range of practices that can be used to adapt to climate change is diverse, and includes changes in behaviour (e.g. in water use or farming practices), structural changes (e.g. in the design specification of bridges and roads), policy based responses (e.g. integrating risk management and adaptation into development policy), technological responses (e.g. increased sea defences, improved forecasting) or managerial responses (e.g. improved forest management and biodiversity conservation).

Given the fact that many areas in India are highly disaster prone and the increasing incidence of disasters, which is ascribed to climate change, adaptation activities In India are extremely important. Suitable adaptation strategies for India and existing initiatives are summarised below:

- **Breeding new plant species and crops which are more tolerant to changed climate:** GOI has initiated programmes to address technical issues, such as development of arid-land crops and pest management, as well as capacity building of extension workers and NGOs to support better and vulnerability-reducing practices.
- **Afforestation:** As discussed in section 9.10, significant thrust is being given on the afforestation programme in India. The National Forestry Action Programme has been formulated for sustainable forest development and to bring one-third of the country's geographical area under forests. Government is also contemplating plans to undertake a major afforestation programme called "Green India" for greening six million hectares of degraded forest land.
- **Effective Disaster Management:** The existing National Disaster Management programme provides grants-in-aid to victims of disasters, and manages disaster relief operations. It also supports proactive disaster prevention programmes, including dissemination of information and training of disaster-management staff.
- **Livelihood Preservation:** Programmes support income diversification, as well as minimum employment guarantees in order to enable sustainability of livelihoods, including in response to loss of livelihoods due to the adverse impacts of climate.
- **Risk Financing/Insurance:** Presently, two risk-financing programmes support adaptation to climate impacts. The Crop Insurance scheme supports the insurance of farmers against climate risks, and the Credit Support Mechanism facilitates the extension of credit to farmers, especially in instances such as crop failure due to climate variability.



- **Health:** The prime objective of these programmes is the surveillance and control of vector borne diseases such as Malaria, Kala-azar, Japanese Encephalitis, Filaria and Dengue. Programmes also provide for emergency medical relief in the case of natural calamities, and train and develop human resources for these tasks.

- **Irrigation:** Irrigation is considered to be one of the most effective drought proofing strategies. The ultimate irrigation potential in India is estimated to be around 139 mha (Ministry of Water Resources, GOI). Several central and state schemes have been implemented to enlarge irrigation facilities.

- **Coastal management including rehabilitation of displaced people due to soil erosion:** strategies available for coastal adaptation to climate change impacts include protection from flooding/erosion through massive engineered sea defences, such as high sea walls and embankments, or large-scale beach nourishment. This would also include measures to cope with regular inundation such as extensive flood-proofing or elevation of property, modification of urban drainage systems and raising of roads. Coastal management may also include changes in land use and the distribution of homes away from vulnerable sites, involving perhaps acquisition of land and property by public authorities, planning set-back zones or subsidies to coastal dwellers to relocate inland.

- **Changes to building and infrastructure design standards to protect against extreme weather events:** One of the starkest impacts of climate change would be in the form of increased frequency of extreme weather events. The impact of these events on buildings and physical infrastructure could be minimised by adopting advanced designs developed in view of climate change.



11. Mainstreaming Climate Change in Sustainable Development

Building a low-carbon Indian economy is in itself a part of the larger sustainable development approach. In other words, climate change is a part of the larger sustainable development challenge.

The most effective way to address climate change is to adopt a sustainable development pathway by shifting to environmentally sustainable technologies and promotion of energy efficiency, renewable energy, forest conservation, reforestation, water conservation, etc. The issue of highest importance to India is reducing the vulnerability of its natural and socio-economic systems to the projected change in climate. India will face the challenge of promoting mitigation and adaptation strategies, bearing the cost of such an effort and its implications for economic development.

The climate change issue is part of the larger challenge of sustainable development. As a result, climate policies can be more effective when consistently embedded within broader strategies designed to make national development paths more sustainable. The impact of climate variability and change, climate policy responses, and associated socio-economic development will affect the ability of countries to achieve sustainable development goals. The pursuit of these goals will in turn affect the opportunities for, and success of, climate policies. In particular, the socio-economic and technological characteristics of different development paths will strongly affect emissions, the rate and magnitude of climate change, climate change impacts, the capability to adapt, and the capacity to mitigate.

Addressing climate change mitigation and adaptation involves many stakeholders, cuts across short and long timeframes, and requires that all development projects be assessed for their sensitivity to climate concerns. The integration of climate concerns in the development process has been mainstreamed in India through the involvement of all stakeholders, which include government, industry, civil society and citizens and consumers.

11.1. Mainstreaming through Government Initiatives

Government initiatives for the diffusion of renewable energy and energy-efficient technologies, joint forest management, water resources management, agricultural extension services, web-enabled services for farmers and rural areas, and environmental education in schools and colleges represent a broad spectrum of efforts to integrate climate change concerns in sustainable development. This integration is institutionalized through specialized institutions, such as the Ministry of New & Renewable Energy, the Ministry of Environment & Forests, the Bureau



of Energy Efficiency, and the Technology Information, Forecasting & Assessment Council, with specific mandates to promote climate friendly technologies.

The National Environment Policy, 2006, provides the basis for the integration of environmental considerations in the policies of various sectors. So much so, that the government may well be advised to re-phrase it to read as the “National Sustainability Policy”. The Policy Statement for Abatement of Pollution, 1992, stresses the prevention of pollution at the source based on the “polluter pays” principle. The Forest Policy, 1988, highlights environmental protection through preservation and restoration of the ecological balance. The policy seeks to substantially increase the forest cover in the country through afforestation programmes.

The statutory framework for the environment and energy efficiency includes the Indian Forests Act, 1927, the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Forest (Conservation) Act, 1980, and the Environment (Protection) Act, 1986. Other enactments include the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995, the National Environment Appellate Authority Act, 1997, the Energy Conservation Act, 2001, and the Electricity Act, 2003. The courts have also elaborated on the concepts relating to sustainable development, and ‘precautionary’ principles. In India, matters of public interest, particularly pertaining to the environment, are articulated effectively through a vigilant media, an active NGO community, and through the judicial process which has recognized the citizen’s right to a clean environment as a component of the right to life and liberty.

11.2. Civil Society Initiatives

Several Indian economic and social habits promote a lower resource and energy intensive lifestyle. Indian food habits (e.g. emphasis on vegetarian food and minimal processing) and recycling processes have mitigated growth in energy demand and GHG emissions. The specific GHG emissions from food production and processing are much lower in India than in developed countries. The high ratio of recycling in India, compared to that of other major economies has also limited the growth in energy use, and GHG emissions, because of the lower demand for virgin material such as steel, aluminium and copper.

Technology Transfer and Grassroots innovations: Due to a strong technological knowledge and skill-base India can leap forward through innovation in several critical areas. India is also a vast storehouse of indigenous knowledge and appropriate technology innovations.

Indigenous knowledge can be put to commercial use both nationally and internationally.



This would address the goal of 'inclusive growth' where the intellectual and technical (appropriate technology) skills of the poorest are tapped and rewarded and can vastly improve their income earning capacity.

Though the energy linkage is only indirect, one of the good examples of innovative systems to meet a daily need is the indigenous Dabbawala Lunch distribution system of Mumbai which handles around 200,000 deliveries a day and the margin of error is 1 in 6 million deliveries.

There are a number of civil society initiatives that lead to the adoption of environmentally beneficial and climate-friendly activities. For instance, the decision of the Self Employed Women's Association (SEWA), Ahmedabad to switch from using kerosene to using solar lamps. Development Alternatives- a Delhi based NGO- promoting sustainable national development through the use of appropriate technologies, effective institutional systems and environmental and resource management method (refer to box 7).

Box 7 : Development Alternatives Group, India

The mission of the Development Alternatives Group is to promote sustainable national development. Other objectives of the group are to innovate and disseminate the means for creating sustainable livelihoods on a large scale, and thus to mobilise widespread action to eradicate poverty and regenerate the environment.

To enable the above, the group's strategy include;

- Innovation, through design, development and dissemination of appropriate technologies, effective institutional systems and environmental and resource management methods
- Sustainability, through commercially viable approaches
- Scalability, through partner organizations and networks

The activities of Development Alternatives cover a broad array of development issues. And these issues are complex, requiring sophisticated, trans-disciplinary responses.

To be able to provide such responses successfully, the Group has built up a strong capacity to identify the priority issues confronting the nation and devise effective ways to solve them. It has therefore brought together a cadre of professional staff members with a wide range of skills and backgrounds but a common, solid commitment to excellence and teamwork.

Source: Development Alternatives



11.3. Tapping the Indian diaspora

Today the Indian diaspora numbers over 20 million spread far and wide. In recent years there is recognition of the important role of the diaspora in India's technological, sociological and economic transformation. Several Indians are occupying top positions in big multinationals (Indira Nooyi, Pepsico; Shantanu Narayen, Adobe; Arun Sarin, Vodafone). There is a manifested willingness that the Indian Diaspora has shown to plough back and invest in developing national skills and resources. NRI venture capitalists and angel investors (e.g. Vinod Khosla, Kanwal Reikhi, Promod Haque) are investing in clean energy in India. This vast resource can be tapped to boost our developmental pace, as well as to address the challenges thrown up by climate change.

12. The Way Forward

The Bali roadmap[3] has established a clear-cut agenda of action on key issues such as adaptation, mitigation and transfer of climate friendly technologies in the coming two-three years. The next two years are going to see intense negotiations on actualising the Bali roadmap. Indian stakeholders are expected to play a key role in these negotiations and demonstrate leadership in adapting climate friendly solutions.

For India, the way forward is to identify common ground between climate change policy and economic growth and pursue measures to achieve both. The country needs to consistently move towards a low-emission growth trajectory, though the carbon emission in absolute number may grow for some time to come. India need to pay equal attention on both adaptation and mitigation strategies to deal with climate change.

Addressing climate change will entail participation of all stakeholders – from national and state governments to industry and civil society. As discussed in this paper, Indian government, business and civil society have already made significant contribution in responding to climate change. These efforts by Indian stakeholders need to further up-scaled, and aligned to global developments.

12.1. Government:

Indian government can intensify its efforts by better co-ordination and cohesion at various levels in the government. Some key issues for the government in the area of climate change planning, policy development and implementation include:

a) Collection/collation of targeted information and development of appropriate methodologies

Decision makers must have a clear understanding of climate risks, implications andresponse options. The delivery mechanism for this would depend upon quality of relevant information. Government needs to formulate appropriate strategies and methodologies to collect targeted information regularly such as sector-wise statistics on energy intensity and carbon intensity. This would help in industry efforts of benchmarking and adoption of best practices.

[3] NFCCC Conference of Parties (COP) 13th meeting was recently concluded at Bali, Indonesia. Several important decisions were taken in the meeting, popularly known as Bali roadmap. The decisions include a clear agenda for the key issues to be negotiated up to 2009. These are: action for adapting to the negative consequences of climate change, such as droughts and floods; ways to reduce greenhouse gas emissions; ways to widely deploy climate-friendly technologies and financing both adaptation and mitigation measures.



b) Enhanced understanding of climate change impacts on India and response options

Information on the threat to Indian ecosystems and other impacts on India is widely seen as piecemeal and inadequate. Similarly, there has been little comprehensive analysis of feasible options for enhancing the capability of vulnerable areas and systems to cope with climate change. An India specific study, similar to the Stern Review, should be commissioned to study the climate change impacts on India and the response options.

c) Greater Government involvement and facilitation

Climate change issues are interrelated with each other and are also closely linked with various developmental and business issues. Climate affects virtually every aspect of society and business. In view of this, it is important to build awareness and understanding of climate change impacts and various generic adaptation and mitigation strategies among a wide-range of government departments and agencies at the grass-root level. For example, agencies/departments dealing with health, agriculture, disaster management, irrigation, forestry, among various others should fully understand implications of climate change and the role they can play in minimising its impacts.

d) Focus on Adaptation

Much of the implementation of the adaptation strategy would be the responsibility of the national, state and local governments reflecting their key roles in public infrastructure, safety, health and land use planning and control. Key adaptation issues span virtually all portfolios of the government. Building on existing effort to integrate planning and management for climate change will be important. The most effective way would be to integrate climate change adaptation strategies in country's development policy. India can draw additional resources from the 'Adaptation Fund Board' – which will be operationalised shortly as per the Bali agreement.

e) Supporting and Leveraging Private Actions:

Governments can catalyse the effectiveness of private actions and helping ensure that individual efforts are consistent with national goals on climate change. The first step towards this would be documentation of country's goal on climate change and disseminating it to a wider audience in the country including industry and civil society. Government can also identify civil society initiatives, desirable from climate change standpoint and support them for large-scale replication.

f) **Climate friendly technologies fund:**

The financing requirement to undertake R&D on climate-change solutions and to enable acquisition of clean technologies has to be met with both public and private funds. Government can set-up a climate friendly technologies fund to invest, on long-term basis, on projects such as;

- Clean technologies R&D
- Acquisition of clean technologies
- Research on innovative approaches and technologies for adaptation
- Research, development and demonstration of clean alternate energy technologies

g) **Policy and Regulation:**

Setting-up of an appropriate policy and regulatory framework is the sole responsibility of the government. As discussed earlier, the present policy framework of incentivising renewable energy and energy efficiency has shown productive results. However, a larger pool of policy instruments may be needed to cover a vast range of climate change mitigation opportunities present in various other sectors. An indicative list of such instruments may include tax incentives based on vehicle fuel efficiency in the automobile sector, tax breaks for modern and efficient transport systems, soft loans for renovation and modernisation projects and incentives for cleaner conventional energy technologies among others.

Indian government may soon need to further strengthen the regulatory framework. At the national level, this may be in the form of implementing either a dynamic cap and trade mechanism or a carbon tax. At the sectoral level, various sector-specific norms would need to be established and legislation would need to be enacted.

12.2. Industry:

Many companies in India are using entrepreneurial innovation to adapt their business models and develop strategic approaches to reduce GHG emissions. The lead taken by the pioneers in the Indian industry needs to be enlarged and intensified.

(a) Adoption of "Best practices" to achieve global benchmarks

Indian companies can adopt voluntary charters, codes of conduct or practice internally to confirm to sectoral and international best practices and performance viz;



- Good housekeeping, retrofitting and process changes in existing industries.
- Best technology options/access for green field /brown field ventures.

(b) Industry associations to focus on small scale industries

Industry associations along with other stakeholders should focus on small and medium size enterprises to enable the latter to employ and derive benefits of new technologies, IT enablement with professional inputs and networking with financial institutions and government agencies.

(c) Leverage "climate-friendly technology fund" to accelerate deployment of clean technologies.

Industry can leverage the envisaged 'climate-friendly technology fund' with its own resources to undertake high cost R&D and technology acquisition projects.

(d) Partner R&D efforts to develop low/no carbon technologies.

As discussed in section 9.11.2, private players have to play an extremely important role in collaborative research and development on clean technologies. Industry has to contribute with its strength of finance, technology, managerial efficiency and entrepreneurial spirit to R&D projects undertaken in public-private partnership mode and partner in such projects with proportionate sharing of IPRs.

(e) Country-wide boosting of awareness and incentives for consumers across all market segments toward low-carbon products, services and lifestyles.

Industry should make conscious efforts to shift towards offering low-carbon product and services. To offer such products, it is important to begin at the design stage where about 70 per cent of the costs of product development and manufacture are invested, and life-cycle impact for a product is determined. This should be done along with providing reliable information to the customers about climate-friendly features of the products. Low-carbon products and services could be an entirely new business opportunity for Indian companies. A country-wide campaign for such products and services would make this market deeper and more broad-based. A beginning has already been made in India with successful launch of voluntary energy efficiency labelling programme and the upcoming fuel-efficient TATA car.

(f) Measure its carbon footprint, and develop reporting systems

Measurement of carbon footprints is the first step towards addressing climate change at the company level. By measuring its carbon footprint, a company will understand where to focus its efforts on reducing its emissions as cost-effectively as possible. This would include measuring reliable GHG inventories, incorporating GHG considerations in business strategies, implementing in-house emission reduction projects and buying/banking external offsets. A robust GHG inventory also will provide a baseline for the company to measure its progress annually in reducing its climate impact. The reporting system should be rigorously developed and made available to all functional levels within the company. Indian industry can take advantage of widely accepted CDP[4] standards, or can also develop their own methodology.

12.3. Civil Society:

As discussed in section 11.2, lifestyle pattern and habits of majority of Indians ensures efficient utilisation of energy and resources. Some of these practices include food habits (e.g. vegetarian food and minimal processing) and emphasis on recycling. Several independent civil society initiatives such as by SEWA, Development Alternatives, Centre for Environment Education etc have been promoting resource conservation and sustainable livelihood practices. Civil society can further contribute to address climate change in various ways such as;

1. **Promote awareness about impacts of climate change and options for mitigation and adaptation that can be pursued by individuals**

   Civil society has an important role to play in spreading awareness about climate change to all sections of the society. Knowledge of various adaptation and mitigation options will help individuals in making conscious efforts towards addressing climate change.

2. **Campaign to effect behavioural change**

   Civil society can stimulate behavioural change by using "high profile environmental problems such as drought, heatwaves or flooding". Further, gradual shift towards low carbon product and services would create a demand for such products and compel companies to shift their businesses towards such products.

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[4] The CDP was launched in India in May 2007 as a joint effort of the CII-ITC Centre of Excellence for Sustainable Development, WWF-India and the CDP.



3. **Work with government and other role players as partners in sustainable development**

Several examples such as CII-UNDP project for rural electrification show that community led participatory approaches of development can be very successful in providing sustainable livelihoods to people. Community involvement in solar and biomass initiatives has helped in several communities shift to renewable based energy sources. Involvement of civil society in forest management has helped curb over-exploitation of forests. Civil society can be involved in sustainable development initiatives in variety of innovative ways.



13. Conclusion

Climate change is one of the most serious and urgent challenges that humanity faces today. Global and national level decisions at present and in the next few years are crucial in determining how effectively we will be able to meet the challenge. Both developed countries and the fast growing developing countries such as China, India, Brazil and South Africa need to work together to synchronize their energy and developmental policies addressing both energy needs and climate concerns.

There are clear signs and directions, however, that industry in India has adopted an approach that can help us leapfrog to a low carbon economy. India has already achieved some success in de-coupling the energy-GDP link at a much earlier stage of development. Energy intensity of the Indian economy now compares favourably with those of other major economies. This goal can be further achieved by adopting suitable policies to promote non-carbon intensive fuels, renewables and state-of-the-art technologies and processes to promote energy efficiency in industries, power generation and in the transport, residential and commercial sectors.

A number of new initiatives are being taken by Indian government and industry. These include energy labelling, energy conservation in buildings, energy audits, energy efficient and low carbon emission transport systems and vehicles, further improvements in energy efficiency in industries and power plants, and active participation in CDM projects. In the future there is also a need to develop new technological solutions for clean energy through research and development within India as well as in collaboration with other global efforts. Indian industry stays committed to work towards finding new and innovative solutions and approaches to deal with climate change; and to imbibe these approaches in an accelerated manner.

India needs to focus both on adaptation and mitigation strategies to deal with challenges posed by climate change. The climate change issue is part of the larger challenge of sustainable development. The most effective way to address climate change, therefore, is to adopt a sustainable development pathway by shifting to environmentally sustainable technologies and promotion of energy efficiency, renewable energy, forest conservation, reforestation, water conservation, etc. The issue of highest importance to India is reducing the vulnerability of its natural and socio-economic systems to the projected change in climate.

Addressing climate change mitigation and adaptation involves many stakeholders and cuts across short and long timeframes. The integration of climate concerns in the development process in India has been mainstreamed through the involvement of all stakeholders, which include government, industry, civil society, citizens and consumers and even the Indian diaspora, but continued and more vigorous efforts are needed in this direction. With a concerted, timely and focussed effort India can take leadership in building a low-carbon economy.



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