सत्यमेव जयते






INDIA

First Biennial Update Report to the United Nations Framework Convention on Climate Change

Ministry of Environment, Forest and Climate Change

Government of India

December 2015

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Secretary
Ministry of Environment, Forest and Climate Change, Government of India
and Chairman, National Steering Committee
Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi-110003
Phone: +91 11-24695262 / 24695265
Fax: +91-11-24695270

National Project Director
India's Third National Communication and other New Information to the UNFCCC
and Member Secretary, National Steering Committee
Scientist-G, Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhawan
Jor Bagh Road, New Delhi-110003
Telefax: 011-24695293
E-mail: jrbhatt@nic.in

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Minister of State (Independent Charge)
Government of India
Ministry of Environment, Forest and Climate Change

Message

I have great pleasure in presenting India's first Biennial Update Report (BUR) in fulfilment of reporting obligations under the United Nations Framework Convention on Climate Change (UNFCCC). This gives us an opportunity to communicate our low carbon development efforts in a transparent manner.

The BUR has been prepared through a participatory process at the national level. The BUR has undergone a rigorous process through several technical studies, collaborative activities, consultation meetings and workshops during various stages of its preparation. The process has met standards of scientific rigour of transparent and complete reporting together with intense peer review.

The BUR has been prepared by a group of scientists, who have been involved in the national communication process. As an effort to further expand the network of scientists, new institutions and researchers have also been involved in this exercise. A multi-tier consultative process was undertaken, led by the Ministry of Environment, Forest and Climate Change, involving acclaimed national institutions and sectoral experts, guided by inter-ministerial inputs and with financial support from the Global Environment Facility.

Apart from complying with the requirements of the Convention, India has also voluntarily initiated several measures to abate and alleviate climate change. National Action Plan on Climate Change comprising eight national missions was launched in 2008 and the missions are being implemented for addressing challenges of climate change.

The emission intensity of GDP has reduced by 12% from 2005 to 2010, on course to meeting the voluntary target of 20-25% reduction in emission intensity of GDP by 2020.

India has been an active participant in the consultation, negotiations and initiatives on climate change. We have wrestled with the challenge of meeting climate change expectations without sacrificing our development goals. We have set up two dedicated funds at the national level: the National Clean Energy Fund financed by a carbon tax of ₹ 200 (US$ 3.2) on each tonne of coal, and the National Adaptation Fund with an initial allocation of ₹ 3,500 million (US$ 55.6 million) to address the cost of adopting cleaner technology in sectors such as agriculture, fisheries, water and forestry.

We have also announced more than five times increase in the installed capacity of renewable energy generation from 35 GW (up to March 2015) to 175 GW by 2022. To ensure rational consumption of fossil fuels, we have cut petroleum subsidy by about 26 per cent. We have also introduced an implicit carbon tax of US$ 140 per tonne of CO_2 on petrol and US$ 64 per tonne of CO_2 on diesel, which is higher than the initial tax on CO_2 emissions of US$ 25 - 35 per tonne. To increase energy generation through

cleaner sources and to fund renewable energy projects, we have introduced tax-free infrastructure bonds of ₹ 50 billion (US$ 794 million) for the year 2015-16. Moreover, in our efforts to lower carbon emissions, we have put in place a balanced and comprehensive plan named Intended Nationally Determined Contribution (INDC), under which we propose to create a carbon sink of 2.5 to 3 billion tonnes of CO_2 by 2030 through additional forest and tree cover. Thus, India, despite being confronted with development challenges and pressure of inclusive and high economic growth, has made serious interventions to address climate change and is consciously taking a path towards decoupling of economic development and greenhouse gas emissions. However, we are aware of the constraints and gaps that still exist and have identified them in our report. This will enable us to further improve upon the efforts in future so as to ensure continuous reporting on a consistent basis. I congratulate all those who were involved directly or indirectly in this national effort.

Prakash Javadekar
Minister of State (Independent Charge)
Environment, Forest and Climate Change
Government of India

Dated: 10 December 2015

अशोक लवासा
Ashok Lavasa, IAS

सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Secretary
Government of India
Ministry of Environment, Forest and Climate Change

Foreword

Climate Change has emerged as a global challenge requiring an integrated global response along the principles of common but differentiated responsibilities and respective capabilities (CBDR-RC). India has the second largest human population of the world. India also has largest proportion of global poor with around 30% of the population without access to electricity. India's per capita energy consumption is around one-third of world's average. With a Human Development Index of 0.586 and global rank of 135, India's development imperatives are driven by its unique national circumstances and priorities.

India is contributing its best to address climate change. India's National Action Plan on Climate Change enshrines eight national missions that represent multipronged, long-term and integrated strategies for achieving key goals in the context of climate change. The national missions are on Solar Energy, Enhanced Energy Efficiency, Sustainable Habitat, Water, Green India, Sustainable Agriculture and Strategic Knowledge for Climate Change. India has also revisited these missions in the light of new scientific information and technological advances and identified new missions or programs on wind energy, health, waste to energy, and coastal areas. It is also redesigning the National Water Mission and National Mission on Sustainable Agriculture. As a result of domestic efforts, India's emission intensity of GDP has decreased by 12% between 2005 and 2010. Energy intensity of economy has also decreased at an annual rate of over 2.5% between 2005 and 2012.

India's economic growth is guided by a key concern for balancing overall holistic development with sustainability. As the world is seriously concerned about its new investments to be climate friendly, it must seize the opportunity of supporting a country like India where economic growth could be achieved with minimum levels of emissions by providing new and additional resources including finance, technology and capacity for achieving low carbon growth.

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC). Towards fulfilment of reporting obligation under the UNFCCC, India presented Initial National Communication (INC) to the UNFCCC on 22 June 2004 and Second National Communication (SNC) to the UNFCCC on 4 May 2012. Both the submissions were acclaimed by scientists all over the world.

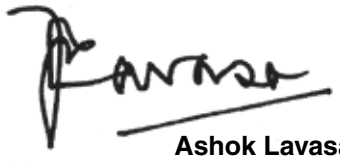
In addition to National Communications, India is now required to submit Biennial Update Report (BUR) every two years to the UNFCCC as per Paragraph 60 (c) of Decision 1/CP.16, the reporting guidelines for preparation of which are provided in Annex III of Decision 2/CP.17. Submission of the BUR is an additional reporting requirement for developing countries consistent with their capabilities and the level of support provided for reporting.

This enhanced reporting requirement calls for additional efforts as compared to the national communication process. Our system of national reporting is adapting to this change.

The scope of BUR is to provide an update to the most recently submitted national communication. India's first BUR has five major components viz. (I) National Circumstances, (II) National Greenhouse Gas Inventory, (III) Mitigation Actions, (IV) Constraints, Gaps and related Financial, Technological and Capacity Building needs and support received, and (V) Domestic Monitoring, Reporting and Verification (MRV) arrangements.

The preparation of BUR involved putting together and synthesizing the work from 26 studies carried out by 17 expert institutions involving over 50 scientists. The inputs received from these studies were compiled by an expert group into a draft BUR which was circulated for peer review to independent referees. In the entire preparation process, there have been eleven expert consultations and meetings, one Expert Advisory Committee meeting and a meeting of the National Steering Committee composed of members from several Ministries/Departments of the Government before being approved by the Union Government.

Every effort has been made to ensure transparency and completeness in reporting. There are challenges that lie ahead such as establishment of a National Inventory Management System (NIMS), with improved methods of inventory estimation for all sectors on a continuous basis and implementing a domestic Measurement, Reporting and Verification system. This constitutes major capacity building needs for India's future communications and BURs. India remains committed to urgently and effectively meeting the challenges.



Ashok Lavasa
Secretary
Ministry of Environment, Forest and Climate Change
Government of India

Dated: 10 December 2015

सुशील कुमार
Susheel Kumar, IAS

अपर सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
Additional Secretary
Government of India
Ministry of Environment, Forest and Climate Change

Preface

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC). The Convention requires all Parties to furnish information on implementation of the Convention in the form of periodic National Communications. India furnished its Initial National Communication in 2004 and Second National Communication in 2012 to the UNFCCC.

Conference of Parties to the UNFCCC in its sixteenth session decided that developing countries should also submit Biennial Update Report (BUR) as an update to the most recently submitted national communication. In compliance of this decision, India is now submitting first Biennial Update Report which is an update to its Second National Communication.

This BUR contains information on five major components viz. (I) National Circumstances, (II) National Greenhouse Gas Inventory, (III) Mitigation Actions, (IV) Domestic Monitoring, Reporting and Verification (MRV) arrangement and (V) Finance, Technology and Capacity Building Needs and Support Received.

The latest available data on India's National Circumstances has been presented in the first chapter containing inter alia detailed information on India's climate, land use, forests, economy, energy and demographic information.

The second chapter is on National GHG inventory. The inventory covers six greenhouse gases, viz. Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6) and five source/sink categories, namely Energy, Industrial Processes and Products Use (IPPU), Agriculture, Waste and Land Use Land Use Change and Forestry (LULUCF).

GHG emissions have been estimated for the year 2010 and consistent time series inventory has been presented for 2000-2010 for Energy, IPPU (Industrial Processes and Product Use), Agriculture, Waste and LULUCF (Land Use, Land Use Change and Forestry) sectors.India's gross emissions of Greenhouse Gases were 2.136 billion tonnes CO_2 equivalent in 2010. Out of this, Energy sector contributed 71%, IPPU 8%, Agriculture 18% and Waste sector 3%. About 12% of emissions were offset by carbon sink action of forests and croplands. Therefore, the national GHG net emissions amounted to a total of 1.884 billion tonnes Gg CO_2eq. The forest cover in India has increased from 14% in 1950-51 to 21.23% in 2010-11. This is a remarkable conservation achievement considering high population density and low per capita forest area, high dependence of population on forests and high livestock density. The progressive conservation-oriented forest policies and afforestation programmes are contributing to the stabilization of forest cover in India, through community awareness and participation such as participatory management of forests.

Chapter 3 is on 'Mitigation Actions' which contains information on a range of climate-friendly measures that

the Government is undertaking to address climate change, National Missions under National Action Plan on Climate Change and other programmes such as Integrated Power Development Scheme, Renewable Purchase Obligations, enhancement of cess on coal, Perform Achieve and Trade Scheme and National Program for LED based lighting. The fourth chapter presents constraints and gaps faced during preparation of the BUR as well as technology and finance needs for our efforts related to climate change. Chapter 5 on domestic MRV arrangements provides details of existing mechanisms and highlights the need to develop a robust MRV system in future.

The final chapter 6 titled "Additional Information" contains important policies and programmes that are being implemented in India under the context of sustainable development and have impact on mitigation of climate change. At national level 137, and at state level 286 such policies and measures relevant to climate change have been mapped on an illustrative and non-exhaustive basis.

As per BUR estimates, India's per capita GHG emission in 2010 was 1.56 tCO_2 equivalent which is far below the global average and those of other emerging economies. In recognition of the growing problem of climate change, India had declared a voluntary pledge of reducing the emissions intensity of its GDP by 20-25 % over 2005 levels by 2020. As this first BUR clearly establishes, the emissions intensity of Indian GDP has decreased by 12% between 2005 and 2010 on account of a slew of policy measures launched by the Government of India.

BUR is a transparency arrangement for national reporting from developing countries. India has strived to incorporate all elements of a good GHG inventory in this report, namely completeness, consistency, accuracy and comparability. We have followed all the relevant IPCC guidelines, including 2006 guidelines to the extent possible and as per our extant capabilities. There are data and information gaps in some sectors and we are making efforts to address them in our future reports in a gradual manner.

We are committed to enhance accuracy of our GHG inventory estimations by "riding the tier ladder" for key categories. We are in the process of setting up a National Inventory Management System (NIMS) which will improve the quality of our BURs and NATCOMs in future. I compliment all the scientists, institutions, departments and ministries involved in this national effort.

Susheel Kumar
Additional Secretary
Ministry of Environment, Forest and Climate Change
Government of India

Dated: 10 December 2015

Executive Summary

Executive Summary

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC) and the Government of India attaches great importance to issues related to climate change. The government recognizes the urgency and importance of the actions that need to be taken collectively to meet the ultimate objective of the Convention i.e. stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. India had submitted Initial National Communication in 2004, and Second National Communication in 2012. Government of India has prepared the first Biennial Update Report (BUR) for submission to the United Nations Framework Convention on Climate Change as an update to the most recently submitted National Communication i.e. the Second National Communication.

The Government of India has taken several steps and made concerted efforts towards creating a sustainable institutional structure and arrangements relevant to the preparation of the National Communications and BURs on a continuous basis. Preparation of the BUR required a comprehensive study, as well as technical and administrative arrangement, in addition to stakeholders' participation in various tasks and activities. A National Steering Committee under the chairmanship of the Secretary, Ministry of Environment, Forest and Climate Change (MoEFCC) was constituted to prepare and implement the work programme of the Biennial Update Report. The National Steering Committee has members from those ministries and departments which are concerned with the various elements of information in the report. A schematic representation of the implementation arrangement is provided in Figure 1.

Multiple technical consultations on multidisciplinary aspects of information relating to green house gas (GHG) inventory and mitigation actions were held during the process. Considering the range of requirements, it was found practical to have exclusive committees to oversee preparation of the Biennial Update Report. These committees have members from government, academia and society:

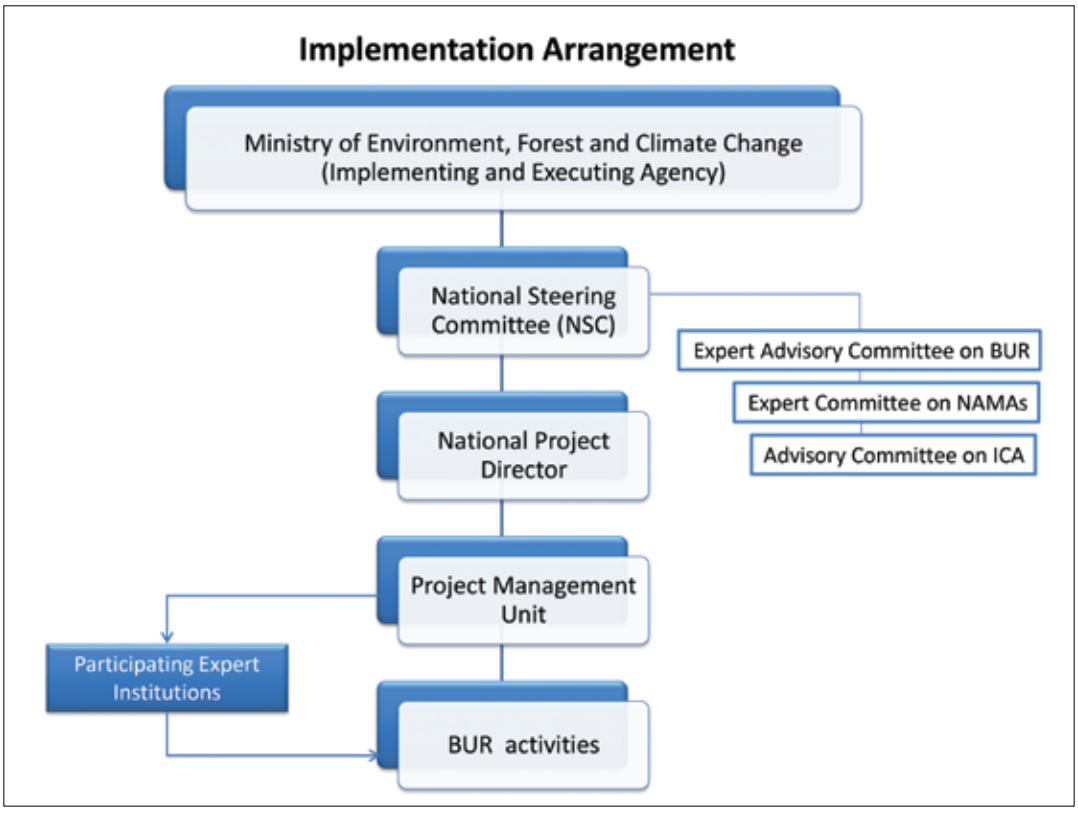


Figure 1: Implementation Arrangement

- Expert Advisory Committee on Biennial Update Report (EAC-BUR)
- Expert Committee on Nationally Appropriate Mitigation Actions (EC-NAMAs)
- Advisory Committee on International Consultation and Analysis (AC-ICA)

A National Project Director supported by a Project Management Unit is responsible for the proper implementation of the work programme and coordination of various activities.

National Circumstances

India has great geographic diversity, and a variety of **climate** regimes and regional and local weather conditions. The climate of the country is greatly influenced by the presence of the Himalaya and the Thar Desert. The Himalaya helps in keeping the Indian subcontinent warmer than other regions at similar latitudes by acting as a barrier to the cold winds flowing from Central Asia. The northern region of the country possesses a continental climate with alternating seasons of severe summer and cold winter. The coastal regions of the country receive frequent rains and have nearly uniform warmth through the year.

The Indian monsoon with its summer (South-west) and winter (North-east) phases is the dominant climatic influence on the subcontinent. South-west monsoon is the most important feature of India's climate as nearly 75% of the annual rainfall of the country is received during this season (June-September). North-east monsoon brings rain mainly to the southeast parts of the country. The rainfall in India shows great variation, uneven seasonal and geographical distribution and frequent departure from normal. Variation in the onset, withdrawal and amount of rainfall during the monsoon season affects the water resources, agriculture, power generation, and ecosystems of the country. Temperature variations are also notable in the country. Due to the influence of continental winds over most of the country, the winter is severe in the North, but the temperature becomes moderate as one moves towards the South.

The total utilizable **water resources** in India are approximately 1123 billion cubic meters (BCM), out of which the proportion of surface water is 61.4%, the rest being ground water. There are twelve major river systems in the country with a total catchment area of 252.8 million hectare (Mha). These are broadly classified as Himalayan rivers, peninsular rivers, coastal rivers, and inland drainage basins. Wetlands in India cover an estimated 4.63% of the geographical area of the country and support about a fifth of the recorded biodiversity.

The **land use pattern** of India shows that net sown area in the country is approximately 46% and area under forests and tree cover is 24%; about 23% of the area is not available for cultivation while the remaining 7% is fallow land. India's land use pattern is influenced by demographic needs, industrial growth, urbanization, livestock grazing, forest land diversion for development purposes, creation of irrigation facilities, and natural calamities such as flood and drought.

Forest is the second-largest land use in India after agriculture. Roughly, 275 million rural people in India depend on forests for at least part of their subsistence and livelihood. From tropical wet evergreen forests in the North East and the South West India to the tropical dry thorn forests in the central and western parts of the country, India is endowed with diverse types of forests. As per the State of Forest Report 2013, the forest cover of the country stood at 697,898 km^2, while it was 692,027 km^2 in 2011, recording an increase of 5,871 km^2 within two years.

With its vast area, large population and unique geo-climatic conditions, the Indian sub-continent is exposed to **natural catastrophes**: 59% of the land is vulnerable to earthquakes, 8.5% to cyclones and 5% is prone to river basin floods.

With a **population** of 1210 million in 2011, India is the second most populous country in the world with a density of 382 persons/km^2. India's performance on critical demographic parameters is constantly improving. Total fertility rate has declined to 2.4 in 2011 from 3.1 in 2001. Crude birth rate per thousand population has also declined to 21.8 in 2011 from 25.4 in 2001. Urbanization in India has been relatively slow as compared to other developing countries, a process that is set to accelerate with ongoing economic growth. Urban population has increased to 31% of the total population in 2011 as compared to 28% in 2001. Growth of population in various states during the period 2001-2011 is represented in Figure 2.

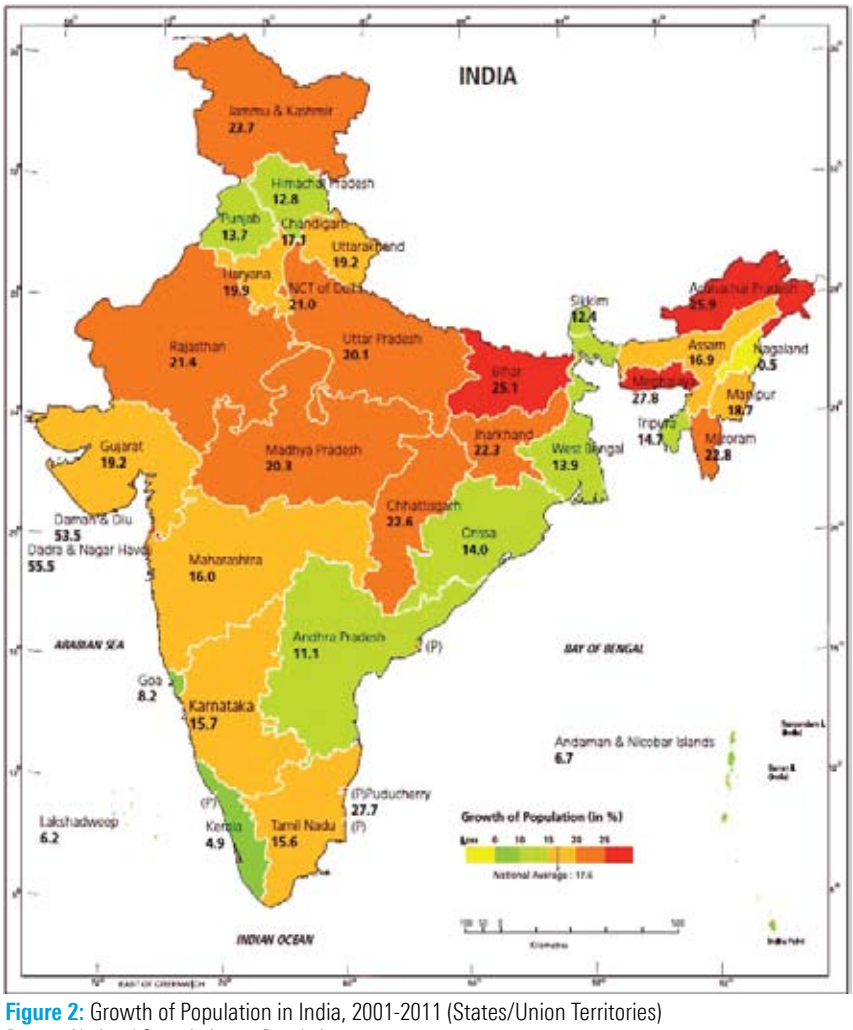


Figure 2: Growth of Population in India, 2001-2011 (States/Union Territories)
Source: National Commission on Population

Urbanization and robust **economic growth** are expected to lead to increase in use of energy-intensive household appliances which is at present extremely low in comparison to the developed and even many other developing countries. The rising energy cost, and awareness among the people about climate change, is driving penetration of star-rated appliances with higher energy efficiency. There is a shortage of about 18.78 million houses in India, and thus a large number is homeless. Demand for houses, especially in the urban areas, will rise in the years to come which will be further driven by rural to urban migration.

Based on the new growth estimates by Central Statistical Organisation (CSO), during the last 12 quarters preceding March 2013, economic growth averaged 6.7% per annum. Since 2013-14 growth has accelerated. GDP in the year 2014-15 showed a growth rate of 7.3% over GDP for 2013-14. Because of the improvement in rate of growth, India's macroeconomic position now compares favourably.

Despite the rapid economic growth, poverty remains an issue of considerable concern for India. Although India has initiated various poverty alleviation schemes, it has not been able to eradicate poverty and 29.5% of its population still lives below the poverty line. The basic statistics of the national circumstances are provided in Table 1.

Indian **agriculture** is primarily rain-fed, with majority of farmers dependent on monsoon for irrigating their crops. Over-reliance on the monsoon poses uncertainties for food production and rural incomes as droughts, floods and variation in rainfall pattern greatly affect the agricultural sector. The sector's contribution to the overall Gross Domestic Product (GDP) is declining and was 17.6% in 2014-15 as compared to 18.9% in 2011-12. But for the climatic uncertainties affecting specific crops in different years, India is self-reliant in food production. The country ranks first in the world's total **livestock** population.

Energy is one of the important aspects of the modern economy which makes the energy policy inseparable from the overall national developmental strategy. India's per capita energy consumption is around one-fourth of world's average, and around 33% households do not

Table 1: National Circumstances	
Criteria	**Measure**
Total area (million square kilometer)	3.28
Land area used for agricultural purposes (million square kilometer of gross cropped area)	1.95
Forest and tree cover (million square kilometer)	0.79
Population (million, 2011 census)	1210
Urban population as percentage of total population (2011)	31
Population below poverty line (percentage) (2009-10) (Indian poverty line)	29.5
Life expectancy at birth (years) (2006-10)	66.1
Literacy rate (percentage 2011)	74.04
GDP at constant (2011-12) prices, ₹ trillion- 2014-15	106.44
GDP at constant (2011-12) prices, ₹ trillion -2013-14 (New Series)	99.21
Share of industry (manufacturing and construction) in GVA (percentage)#	29.7
Share of services in GVA (percentage)#	52.7
Share of agriculture, forestry and fishing in GVA (percentage)#	17.6
Livestock population excluding poultry (million), year 2012	512.05
Households without access to electricity	33%
Households with *kuchha* (mud huts) and semi-*pucca* (semi-concrete) houses	55%
Source: Census, 2011, CSO advance estimates 2013-14, 19th Livestock Census- 2012, India State of Forest Report 2013, Economic Survey 2013-14, Economic Survey 2014-15, Report of Rangarajan Committee, 2014 # Percentage share of sectors in Gross Value Added (GVA) at factor cost current prices- 2014-15 (2011-12 series)	

have access to electricity. India has launched its Perform, Achieve and Trade (PAT) Mechanism, a first of its kind market-based mechanism to promote energy efficiency among large energy-intensive industries in India.

The Indian power sector is driven by state, central and private players. The total installed capacity in the country is 271,722 MW as on 31st March 2015, with state sector generation plants accounting for 35%, central sector 26.7% and private producers 38.3%. Targeted improvements in transmission and distribution (T&D) have led to reduction in losses from around 24% of generated electricity in the year 2010-11 to about 23% in 2012-13.

Fossil energy source based power plants (*i.e.* coal and natural gas) have installed capacity of about 187,698 MW as on 31st March 2015. Coal being the primary energy source for power generation in the country, large coal based capacity shall need to be installed in future. Such capacity addition will be based on super-critical coal technology. It is pertinent to mention here that such technology platforms used in coal-based power plants have been obtained through technical licensing from developed countries. It may also be mentioned that these basic energy conversion technologies, as used in power plants, were all developed in these countries much before the advent of climate concerns. Major technology approaches which merit adoption to further improve thermal efficiency are variants of pressurized coal combustion, gasification combined cycle and advanced ultra-supercritical technology.

Development of clean coal energy technologies is capital intensive research and development undertaking. Voluntary domestic efforts by India for mitigating GHG emissions through efficiency enhancement for coal based power plants need to be supplemented by collaborative R&D from developed countries in line with the provisions of the Convention for further development and deployment.

Transport is a critical infrastructure for development. Adequate transport provisions in terms of quality, quantity and resource-efficiency are essential. The total number of registered road vehicles grew at a Compound Annual Growth Rate (CAGR) of 10.1%, public vehicles (buses and goods carriers) grew at 9.6%, whereas growth rate for private vehicles (two wheelers, car, jeep and taxis) stood at 10.3% between 2005 and 2012. To reduce emissions from the transport sector, the Government of India has implemented Bharat Stage III norms (Euro 3 equivalent) for new vehicles except for two- and three-wheelers for the entire country, and Bharat Stage IV (Euro 4 equivalent) norms for all private vehicles, city public service vehicles and city commercial vehicles in respect of 11 major cities

of India with effect from 1st April, 2010. It has also been decided that these norms will be extended across the entire country by 1st April, 2017 in phases.

Environmental concerns are integral to the governance of the country. India has pioneered legislation to incorporate provisions to protect its environment. India is actively implementing **reforms** in sectors such as energy, including electricity, hydrocarbons, and coal, and in activities that emit GHGs as well as other pollutants. The Energy Conservation (Amendment) Act, 2010 was introduced by making amendments to The Energy Conservation Act, 2001 to address all matters related to the efficient use of energy and its conservation. To improve energy efficiency of the coal-based power plants, and to reduce the GHG emissions, it was decided that new thermal power plants should be based on supercritical technology. A total capacity of 27,485 MW has been installed using this technology. Large number of supercritical units is under construction and about 50% of coal-based capacity addition in the ongoing Twelfth Plan is expected to be based on supercritical technology.

The Government of India is committed to welfare of its people for poverty eradication, food security and improvement in living standards. Sustainable development activities and programmes are at the core of economic development of India.

Greenhouse Gas Inventory Information

As a part of the first BUR, GHG inventory has been provided for the year 2010. The estimation has been done as per the relevant guidelines of Intergovernmental Panel on Climate Change (IPCC), including Revised 1996 Guidelines, Good Practice Guidance 2000 and also by adopting elements from 2006 IPCC Guidelines for National Greenhouse Gas Inventories and Good Practice Guidance for LULUCF 2003 to the extent possible. A consistent time series inventory of GHG emissions has been created for the period of 2000-2010. A description of the greenhouse gas (GHG) inventory of the emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) by sources and their removal by sinks, for the year 2010 has been provided. The sectors covered include Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use-Land Use Change and Forestry (LULUCF) and Waste. The overall reporting is in accordance with the revised guidelines 17/CP.8 meant for reporting National Communications (NC) from Non-Annex-I Parties to the United Nations Framework Convention on Climate Change (UNFCCC). While reporting the GHG inventory, an account of the methodology used and the quality assurance/quality control (QA/QC) measures adopted has also been included.

In 2010, India emitted 2,136,841.24 Gg CO_2 equivalent (2,136.8 million tonnes of CO_2eq.) from the energy, industrial processes and product use, agriculture, and waste sectors (excluding LULUCF). The summary of the GHG emissions by each sector is presented in Table 2. The land use, land-use change, and forestry (LULUCF) sector was a net sink in 2010. With the inclusion of LULUCF, the net emissions in 2010 were 1,884,309.46 Gg of CO_2 equivalent. Figure 3 provides inventory estimates according to sectors and gases, and Figure 4 presents emission distribution of GHGs in CO_2 eq., excluding LULUCF sector, in 2010.

The total amounts of CO_2, CH_4 and N_2O emitted (Table 2) were 1,574,362.14 Gg, 19,623.15 Gg, and 368.92 Gg, respectively, together equaling an emission of 2,100,813.72 Gg CO_2eq (excluding LULUCF). Further, the industrial process and product use sector emitted 1.43 Gg of fluoroform (HFC-23), 2.13 Gg of tetrafluoromethane (CF_4), 0.58 Gg of hexafluoroethane (C_2F_6) and 0.0042 Gg of sulphur hexafluoride (SF_6) which together amount to 36,027.53 Gg CO_2eq emissions. The energy sector emitted 1,510,120.76 Gg of CO_2eq, contributing 70.7% of the total GHG emissions in 2010. The agriculture sector emitted 390,165.14 Gg CO_2eq, which was 18.3% of the total GHG emissions. The industrial processes and product use sector emitted 171,502.87 Gg CO_2eq, or 8.0% of the total. The waste sector emitted 65,052.47 Gg CO_2eq in 2010, which was 3.0% of the total GHG emissions. Acting as a net sink, the LULUCF sector offset 12% of the total GHG emissions.

The relative contribution of CO_2 from the energy sector to the total GHG emissions (excluding LULUCF) was by far the largest in 2010. CO_2 accounted for 95.5% of the total emissions from the energy sector. Emissions of CH_4 and N_2O originated mainly from the agriculture sector.

Trends in GHG emissions during 2000 and 2010

Trends in GHG emissions for the period 2000 to 2010 are presented year-wise in Figure 5. GHG emissions (including LULUCF) increased from 1,301.2 Mt in 2000 to 1,884.3 Mt during 2010, an increase of 583.1 Mt during the 10-year period. LULUCF sector remained a

Table 2: India's national greenhouse gas inventories (in gigagram) of anthropogenic emissions by sources and removals by sinks of GHGs not controlled by the Montreal Protocol for the year 2010

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
TOTAL without LULUCF (Gg)	**1574362.14**	**0.00**	**19623.15**	**368.92**	**0.00**	**1.43**	**2.13**	**0.58**	**0.0042**	**2136841.24**
TOTAL with LULUCF (Gg)	**1632623.84**	**314586.77**	**19776.18**	**370.79**	**0.00**	**1.43**	**2.13**	**0.58**	**0.0042**	**1884309.46**
1. ENERGY	**1441882.67**	**0.00**	**2534.30**	**48.44**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1510120.76**
A. Fuel Combustion Activities	1441882.67	0.00	204.36	48.44	0.00	0.00	0.00	0.00	0.00	1461192.10
B. Fugitive Emission from fuels	0.00	0.00	2329.94	0.00	0.00	0.00	0.00	0.00	0.00	48928.66
2. Industrial Processes and Product Use	**132479.47**	**0.00**	**22.97**	**8.11**	**0.00**	**1.43**	**2.13**	**0.58**	**0.0042**	**171502.87**
A. Minerals	104545.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	104545.23
B. Chemicals	19506.71	0.00	21.46	8.11	0.00	0.00	0.00	0.00	0.00	22470.76
C Metal Production	6824.27	0.00	1.52	0.00	0.00	0.00	2.13	0.58	0.0042	26171.33
D. Other Production	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.00	16712.28
E. Non energy product use	1603.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1603.27
3. AGRICULTURE	**0.00**	**0.00**	**14612.78**	**268.70**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**390165.14**
A. Enteric Fermentation			10811.12							227033.52
B. Manure Management			130.60	0.08						2768.11
C. Rice Cultivation			3398.47							71367.95
D. Agricultural Soils				261.55						81080.50
F. Field Burning of Agricultural Residues			272.59	7.07						7915.06
4. LULUCF	**58261.70**	**314586.77**	**153.02**	**1.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**-252531.78**
A. Forestland		203829.60	153.02	1.87						-200036.31
B. Cropland		110757.17								-110757.17
C.Grassland	55646.16									55646.16
D. Settlement	2615.54									2615.54
5. WASTE	**0.00000**	**0.0000**	**2453.10**	**43.67**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**65052.47**
A. Solid Waste Disposal on Land	0.00	0.00	664.94	0.00	0.00	0.00	0.00	0.00	0.00	13963.74
B. Waste-water Handling	0.00	0.00	1788.16	43.67	0.00	0.00	0.00	0.00	0.00	51088.73
Memo Item (not accounted in total emissions)	**589760.13**	**0.00**	**0.05**	**0.10**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**589793.42**
International Bunkers	3627.13	0.00	0.05	0.10	0.00	0.00	0.00	0.00	0.00	3660.42
CO_2 from Biomass	586,133.00									586,133.00

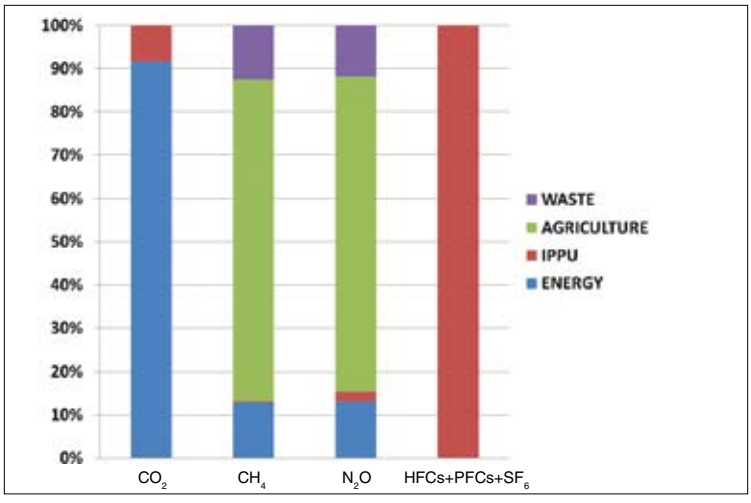


Figure 3: Distribution of GHG emissions, by sectors, in 2010

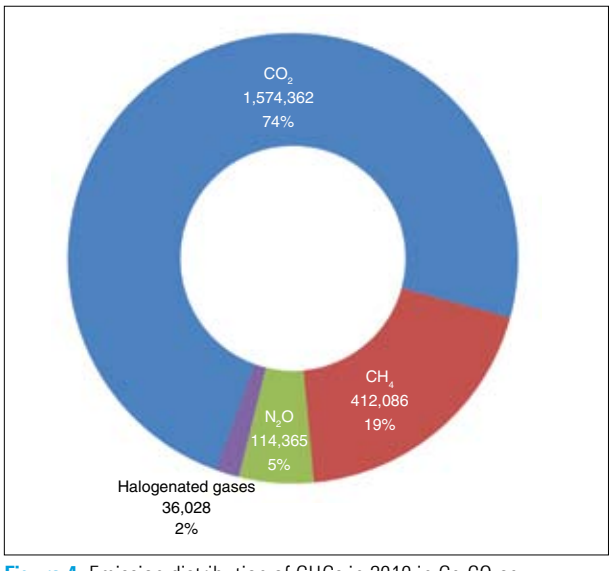


Figure 4: Emission distribution of GHGs in 2010 in Gg CO_2eq, excluding LULUCF sector

sink of GHG emissions over this period. GDP of the country roughly doubled during this period and the population increased by about 18%. It is estimated that the GHG emission intensity of GDP decreased by 12% during 2005 to 2010.

Mitigation Actions and Sustainable Development

India is committed to address the challenges of climate change through its National Action Plan on Climate Change (NAPCC), with the underlying framework of sustainable development. Appreciating the link between sustainable development and climate change in the Indian context, a range of climate-friendly measures has been initiated in all sectors. Government of India has taken a voluntary pledge to reduce the greenhouse gas (GHG) emission intensity of Gross Domestic Product (GDP) by 20-25%, with the exception of the agriculture sector, over the period 2005 to 2020. India has also stated that the proposed domestic actions are voluntary in nature and will not have a legally binding character. These actions are being implemented in accordance with the provisions of relevant national legislation and policies.

Energy and Power Sectors

Planned economic development envisions a low carbon economy for India. Since India is an emerging economy, there is a continuously rising demand for energy and fuel. This has pushed policy makers to keep sustainable development at the core of energy and climate change policies in India.

The Energy Conservation Act, 2001 was enacted with the objective of energy security through conservation and efficient use of energy. Some of the major provisions of the Act include Standard and Labelling of Appliances, Energy Conservation Building Codes, setting up of Bureau of Energy Efficiency (BEE), and Establishment of Energy Conservation Fund.

The National Electricity Policy, 2005 stipulates that progressively the share of electricity from non-conventional sources needs to be increased.

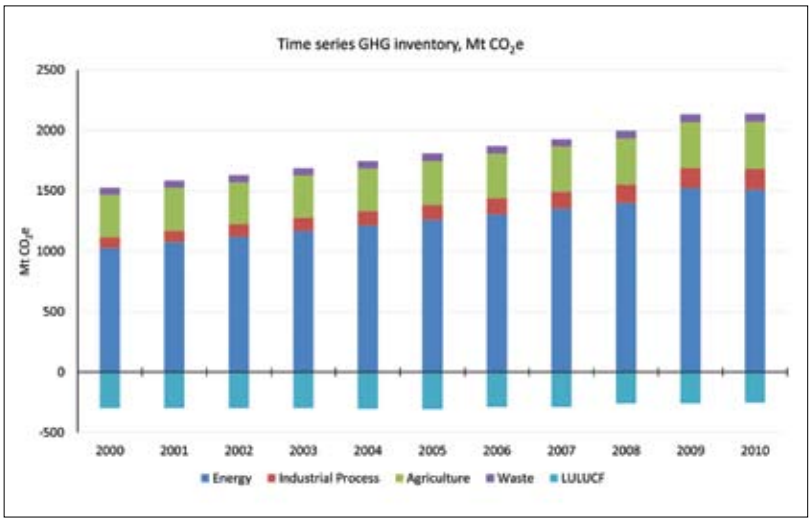


Figure 5: Time series GHG Inventory (2000-2010)

India adopted **Integrated Energy Policy in 2008**, aiming to reliably meet the demand for energy services of all sectors including the energy needs of vulnerable households with safe, clean and convenient energy at least-cost. **Deen Dayal Upadhyaya Gram Jyoti Yojana** aims at providing electricity to rural households. It has a provision for decentralized distribution and generation through use of renewable energy sources. The scheme aims at separate agriculture and non-agriculture feeders, and use of Information and Communication Technologies (ICT) enabled smart grids. The scheme will enhance energy efficiency that will contribute eventually to GHG emission reductions.

The Government of India has set up a **National Clean Energy Fund (NCEF)** in 2010 by imposing a cess on coal, lignite and peat at an effective rate of ₹50 per tonne of coal, both, produced domestically and imported into India. This rate was increased in 2015 to ₹200 per tonne of coal. The NCEF supports projects, programmes and policies that promote clean energy technologies.

Integrated Power Development Scheme (IPDS), notified in December 2014, covers urban areas under distribution utilities in India. The scheme aims at strengthening of sub-transmission and distribution networks in urban areas, including provisioning of solar panels and metering of feeders / distribution transformers / consumers including prepaid / smart meters. This scheme subsumes Accelerated Power Development and Reform Programme (APDRP) which was launched in 2003 and Re-structured APDRP (R-APDRP) of 2008.

The Twelfth Five Year Plan (2012-2017) has laid down a detailed agenda for sustainable development. The plan emphasizes on a bouquet of intervention in governance/ planning/technologies e.g. Ultra Mega Power Projects, Supercritical technology, Super-Efficient Equipment Programme (SEEP) for superefficient fans, LED bulbs and tube lights.

Renewable Purchase Obligations (RPO): Pursuant to the section 86 (1) (e) of the Electricity Act, the State Electricity Regulatory Commissions (SERCs) have issued RPO regulations specifying share of renewable energy in the electricity mix. Further, in order to assist in meeting RPO, the Central Electricity Regulatory Commission (CERC) has notified the Renewable Energy Certificates (RECs) mechanism. Almost all SERCs have notified follow up regulations enabling the Obligated Entities to purchase RECs to meet their RPO. These regulations have provisions for regulatory compliance, reporting and penal provisions for non-compliance by the Obligated Entities, which are primarily Distribution Companies (DISCOMs).

All states, except for Sikkim, have specified overall RPO targets with separate RPO for solar power. The RPO specified by SERCs is not uniform across the states, varying from one per cent in the case of Meghalaya to 10.25 per cent in the case of Himachal Pradesh and Karnataka for the year 2013-14. Similarly, the solar RPO varies from 0.05 per cent in the case of Uttarakhand to one per cent in the case of Gujarat, Rajasthan and Uttar Pradesh.

As on 31st March 2015, installed capacity of renewable energy based grid-interactive power generating units was 35,777 MW. In addition, installed capacity of captive power (off-grid) was 1,174 MWeq. Cumulative achievement target for renewable energy based power generation set by the government is 175,000 MW by the year 2022, comprising 100,000 MW Solar, 60,000 MW Wind, 10,000 MW Biomass and 5,000 MW Small Hydro.

Buildings and Infrastructure sectors

The **Energy Conservation Building Code (ECBC)**, developed by the Bureau of Energy Efficiency (BEE), prescribes a minimum standard for energy use in new buildings and major retrofits. The code is voluntary at the national level, and the Ministry of Urban Development and state governments are responsible for its implementation and enforcement. Several states have announced plans to make ECBC operational for new construction and major retrofits. Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) have adopted ECBC as a minimum compliance requirement.

The **National Building Code (NBC)** of India provides comprehensive guidelines for regulating construction activities. The Bureau of Indian Standards is in an advanced stage of revising the code to incorporate sustainability and ECBC references.

BEE has a star rating programme called the **BEE Buildings Star Rating System** based on the actual performance of a building in terms of its specific energy usage in kWh/sq.m/year. The programme rates buildings on a one to five-star scale, with five stars being the most efficient.

BEE is also undertaking **Bachat Lamp Yojana (BLY)** which promotes the use of compact fluorescent lamps

(CFL). A CFL can provide the same level of light as an incandescent lamp (IL) at a much lower consumption of electricity. BEE is also undertaking an **Appliances Labelling/Rating Scheme**. The appliances are rated in the range of one to five stars — five stars referring to most energy efficient model.

National Programme for LED-based Home and Street Lighting has been launched in January 2015. LED bulbs are being distributed in a phased manner from March 2015 onwards. The entire project of installing LED bulbs for domestic and street-lighting in 100 cities is targeted for completion by March 2016. A web-based system to enable consumers in Delhi to register requests for procuring LED bulbs under "Domestic Efficient Lighting Programme" (DELP) has already been launched.

The Telecom Regulatory Authority of India (TRAI) has released a consultation paper on **"green telecom" in 2010** which offers guidance for the use of eco-friendly equipment in the Information and Communication Technology sector.

Transport sector

A major initiative in the transportation sector has been the upgradation of vehicular emission norms. '**Bharat 2000**', similar to Euro-I norms, was implemented throughout the country on 1st April, 2000 for all categories of vehicles manufactured in India. Bharat Stage IV emission norms have been effective from 1st April, 2010 in 11 mega cities and Bharat Stage III emission norms for the rest of the country from the same date, as notified on 9th March, 2009.

To encourage production of bio-diesel in the country, the Ministry of Petroleum and Natural Gas announced a **Bio-diesel Purchase Policy** in October, 2005, which became effective from 1st January, 2006. Under this scheme Oil Marketing Companies (OMCs) will purchase bio-diesel for blending with High Speed Diesel to the extent of 5% at identified purchase centers across the country.

Dedicated Freight Corridor Project is designed to alleviate congestion on the rail routes between Delhi and Mumbai, and Delhi and Kolkata. Furthermore, **electrification of Indian Railways** is an important step towards not only enhancing the efficiency of the system but also mitigating GHGs from its operation.

After successful implementation in the National Capital Region, the Government of India had approved the implementation of Mass Rapid Transit System (MRTS) in other parts of the country. In order to give proper legal

Source: MMRDA

cover to metro projects, the Metro Railways Amendment Act 2009 was brought into effect, providing an umbrella 'statutory' safety cover for metro rail work in all the metro cities of India. Further, the Mumbai Monorail that opened on 2nd February 2014 is the first operational monorail in India.

According to the **Aviation Environment Circular 2 of 2013** on Climate Change Initiatives in Civil Aviation, the DGCA shall operate a Climate Change Task Force, while airlines and airports shall submit fuel and electricity consumption data on a regular basis and assess their own carbon footprint.

Agriculture Sector

The Ministry of Agriculture, Government of India has adopted a mega project called the **National Initiative on Climate Resilient Agriculture (NICRA)** in 2011 with four main modules – natural resource management, improving soil health, improving crop production and livestock to make the farmers self-reliant for adaptation under changing climate.

System of Rice Intensification that results in reduced emission of methane is being promoted in 199 districts which have been selected for paddy interventions in National Food Security Mission.

Crop diversification from transplanted paddy to other food crops is another recent initiative announced for 2013-14 wherein an amount of ₹ 500 crore was sanctioned for diverting a part of area under paddy to other crops and to agro forestry. Improvement in energy efficiency through **micro irrigation** is also being promoted.

Government of India has approved **National Agroforestry Policy** to encourage and expand tree plantation in an integrated manner with crops and livestock to improve productivity, employment, income and livelihoods of rural households, to protect and stabilize ecosystems,

and promote resilient cropping and farming systems to minimize risks during extreme climatic events. The policy also envisages meeting the raw material requirements of wood-based industries, augmenting the availability of agroforestry products (AFPs) such as fuelwood, fodder, non-timber forest produce and small timber for the rural and tribal populations, and reducing the pressure on forests.

Forestry Sector

Government of India is promoting afforestation, forest conservation and restoration throughout the country. Afforestation and drought-related programmes are being promoted through schemes such as Mahatma Gandhi National Rural Employment Guarantee Scheme **(MGNREGA)** and **National Afforestation Programme.** Under **Green India Mission (GIM),** forest restoration, afforestation, agroforestry and urban forestry are being promoted. In addition, plantation forestry on farmlands is also being practiced by various private players in the country. Green India Mission has issued Convergence Guidelines of GIM with MGNREGA.

Government of India is in the process of developing its **National REDD+ strategy**. Ministry of Environment, Forest and Climate Change has prepared a draft national REDD+ policy and strategy. A REDD+ reference document has also been prepared. A **REDD+ Cell** has been established in MoEFCC which has the task of coordinating and guiding REDD+ related actions at the national level, and discharging the role of guiding and collaborating with the State Forest Departments to collect, process and manage all relevant information and data relating to forest carbon accounting.

National Action Plan on Climate Change

The National Action Plan on Climate Change (NAPCC) was launched in 2008 in order to address climate change concerns and promote sustainable development. The NAPCC identifies measures that promote development objectives while addressing climate change. There are eight **National Missions**, which form the core of the NAPCC, representing "multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change". This underscores the fact that several of the programmes enumerated under NAPCC are already being undertaken under various schemes/programmes of Government of India (GoI), but in the present context would require a change in "direction, enhancement of scope and accelerated implementation".

As a second step, after the National Action Plan on Climate Change was announced, all states were asked to prepare their state-level action plans to deal with the challenges of climate change. State Action Plans for several states have been endorsed by National Steering Committee on Climate Change.

Domestic Measurement, Reporting and Verification Arrangements

Most of the programmes and projects have some kind of monitoring mechanism within the government and its agencies. A multi-tier approach is common where monitoring is undertaken at various levels. The physical and financial targets, outputs and outcomes are monitored in terms of their initial objectives and design. These ground level measures are aggregated in a manner so as to be consistent with the overall objective of the project. Many such projects being part of a state-level programme (for example, distribution network upgrade and rural electrification), a state-level monitoring is also undertaken. For national-level programmes, regular monitoring is done at the national level to ensure that the outputs and outcomes are met. Finally, there is a mechanism for review of the performance of these programmes at the Parliament level through debates /discussion, and review by Parliamentary Committees, Public Accounts Committee and Standing Committees. In addition, all ministries and agencies of the Government are required to place their Annual Reports before the Parliament.

In the power sector, the in-built Measurement, Reporting and Verification (MRV) mechanisms are operationalized by Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC). CEA receives regular data on generation, and the information obtained from these data is reflected in daily, monthly, annual and wing specific reports. CERC regularly monitors factors that relate to system efficiency of the power plants.

The Ministry of Power and the Bureau of Energy Efficiency are entrusted with the task of preparing the implementation for the National Mission on Enhanced Energy Efficiency (NMEEE) under NAPCC. This mission has a component which deals with the market-based mechanism to improve the energy efficiency in energy intensive large industries and facilities by certification of energy savings which could be traded. The scheme is known as **Perform, Achieve and Trade (PAT)**. Eight industrial sectors, namely Power, Iron and Steel, Fertilizer, Cement, Aluminium, Pulp and Paper, Textile and Chlor-alkali, have been included in

this scheme wherein about 478 industries (known as designated consumers (DCs)) are covered. A robust MRV framework has been in-built in this scheme. Measurement and Verification will be carried out by 'Designated Energy Auditors (DENA)'. PAT is a rule-based mechanism. Therefore, it shall be DENA's responsibility to ensure that these rules are complied with for recognition of any project activity under the PAT scheme.

In the forestry sector, institutions such as Forest Survey of India (FSI), National Remote Sensing Centre (NRSC) and Department of Land Resources have the task of monitoring the forest resources of the country. FSI has been collecting data on forest cover, volume of the stock of forests, and the trends of changes in the stocking of forest lands. This is done by laying out sample plots (done since 1965), and until now approximately 80% of the country's forest area has been inventoried. FSI was mandated in 1986 to carry out India's forest cover assessment. Since then, the forest cover assessment has been made biennially using the Landsat data until 1991. From 1995 to the present, FSI has been using the Indian Remote Sensing (IRS) data (LISS II, LISS III and AWiFS) for assessing forest resources and carbon stocks. Commonly, the satellite images having 23m or 30m resolution have been used to assess the forest cover and forest types in India.

Constraints, Gaps and related Technical, Financial and Capacity Needs

Government of India has put constant efforts to improvise national GHG reporting to the UNFCCC from Initial National Communication to Second National Communication and from Second National Communication to the first Biennial Update Report. To achieve the continuous improvement in national reporting, Government of India made institutional arrangements, specific to the nature and scale of BUR preparation. A key challenge faced during the preparation of BUR was the risk of potential delay in compilation of GHG inventory and other information for the year 2010 due to limited availability of time as the initial funds were received in December 2013. Though a number of Indian institutions were involved in the preparation of GHG inventory and preparation of a database on mitigation actions, the coordination of the efforts and timely delivery was a challenge. Lack of data for some sectors with desired level of precision and accuracy also created delays. Efforts were made to overcome these challenges with enhanced coordination among expert groups. As a part of the BUR preparation, refinement of Net Calorific Values for coking as well as non-coking coal and lignite used for various industries for 2010, was attempted.

Since 1991, India has accessed US$ 327 million as GEF grant and, of this US$ 154 million was accessed during the GEF 4 cycle (July 2006 – June 2010). An allocation of US$ 76 million was made for climate change and US$ 30 million for biodiversity during GEF 4 cycle. However, during the GEF 5 cycle, India has received an allocation of US$ 93.75 million for climate change, US$ 30.58 million for biodiversity and US$ 5.1 million for land degradation.

India has also been receiving multilateral and bilateral funds towards climate change financing. Major part of this finance is mitigation-related, whereas the rest is for adaptation.

Government of India has over 21 development programmes relevant to climate change adaptation, covering areas such as forests, agriculture, water, ecosystems, infrastructure, livelihoods and health. There are many other programmes at state level. Government of India is consistently committing considerable resources through the Union Budget towards these adaptation programmes as well as for other climate change related research and project implementation. According to the UNFCCC, international financial support is to be provided to developing countries to enable them to take voluntary actions for mitigation and adaptation. Even though resources are scarce, India has been making specific budgetary outlays to address the challenge of climate change. It is important to ensure that funds flowing through international sources are indeed 'new and additional resources', and their terms of finance are in accordance with the provisions of UNFCCC.

A chapter titled "**Additional Information**" focuses on reforms related to climate change. Broadly speaking, the policies and measures driving these reforms can be classified into the following types of instruments: Regulatory measures (Acts, Regulations/Notifications/ Rules, Standards and Labels System, Efficiency Measures), Economic and fiscal measures (Tax, Price Directed Financial Incentives/ Subsidy, Emissions Trading, Quotas and Certificates) and Supportive measures (Market Development, Cooperative Measures, Capacity Building, RD&D, Green Procurement, Information, Education and

Public Awareness). As many as 137 national-level and 286 state-level policies and measures have been mapped on a non-exhaustive basis. Thus, it could be seen that despite resource constraints and competing demands, India is fully committed and has invested significantly in addressing all issues related to climate change.

* * *

Background Information and Institutional Arrangement

Background Information and Institutional Arrangement

The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner.

According to the Article 4.1 of the Convention, all Parties, taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall develop, periodically update, publish and make available to the Conference of the Parties (COP), information in accordance with the Article 12 of the Convention and decisions of the Conference of the Parties and related guidelines. According to Article 12 paragraph 1, Parties shall communicate information on: national inventories of greenhouse gases not controlled by the Montreal Protocol, steps taken or envisaged to implement the Convention and any other information that the Party considers relevant to the achievement of the objective of the Convention and suitable for inclusion in its communication. In its decision 1/CP.16 paragraph 60, Conference of the Parties decided to enhance reporting from Parties not included in Annex I to the Convention. Paragraph 60 (c) of this decision states that "Developing countries, consistent with their capabilities and the level of support provided for reporting, should submit biennial update reports containing updates of national greenhouse gas inventories, including a national inventory report and information on mitigation actions, needs and support received". The decision also states the need to consider national capability and financial support required to facilitate the timely preparation of biennial update reports.

India is a Party to the United Nations Framework Convention on Climate Change (UNFCCC). In obligation to its reporting requirements under UNFCCC, India has submitted its Initial National Communication (INC) to the UNFCCC in June 2004 and its Second National Communication (SNC) to the UNFCCC in May 2012. As a fulfilment of the requirement of enhanced reporting, this report is being submitted to the UNFCCC as India's first Biennial Update Report (BUR).

Previous submissions

To briefly recall, India submitted its Initial National Communication (INC) to the UNFCCC in 2004 entailing emissions inventory of 1994. Second National Communication (SNC) was submitted to the UNFCCC in 2012 wherein GHG inventory for the year 2000 was reported (Figure 6). In addition, a summary of GHG inventory of the year 2007 was provided as a proactive measure.

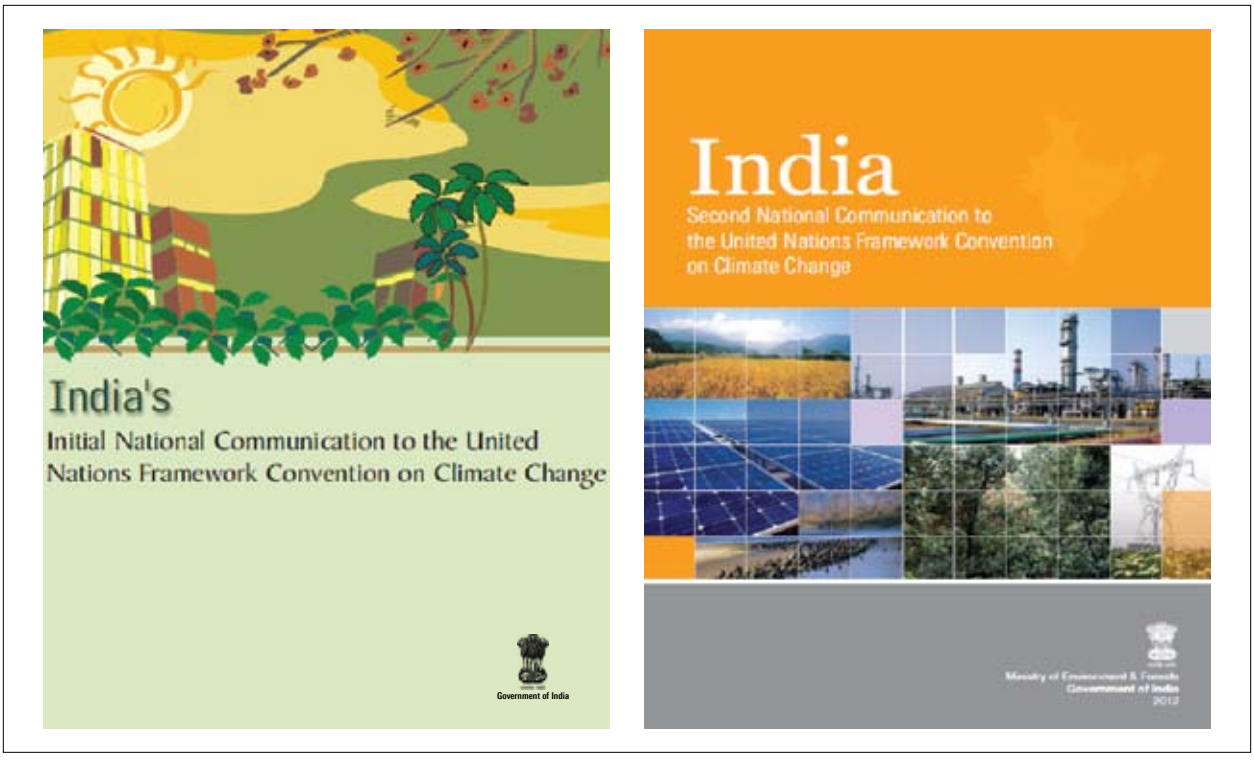


Figure 6: India's Initial and Second National Communications to the UNFCCC

In the Second National Communication, a consistent, comparable, comprehensive and transparent national GHG emission inventory by sources and removals by sinks, for the year 2000 with reduced uncertainties, using guidelines developed by the Intergovernmental Panel on Climate Change (IPCC), was presented. The sectors covered included: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use Land Use Change and Forestry (LULUCF), and Waste. Total emission in 2000 excluding LULUCF was 1,523,777.44 $GgCO_2eq$. Distribution of emissions by gases and sectors is represented in Figure 7.

Information on the government schemes relating to low carbon economic development such as those relating to renewable energy, energy efficiency, transport and power sector were appropriately placed in the SNC.

The first BUR serves as an incremental report to the SNC wherein updated information on status of implementation of the mitigation actions in the country has been included. Studies were carried out following a participatory approach that included consultations with experts of different sectors in order to furnish the required information that is transparent, accurate, complete, consistent and comparable.

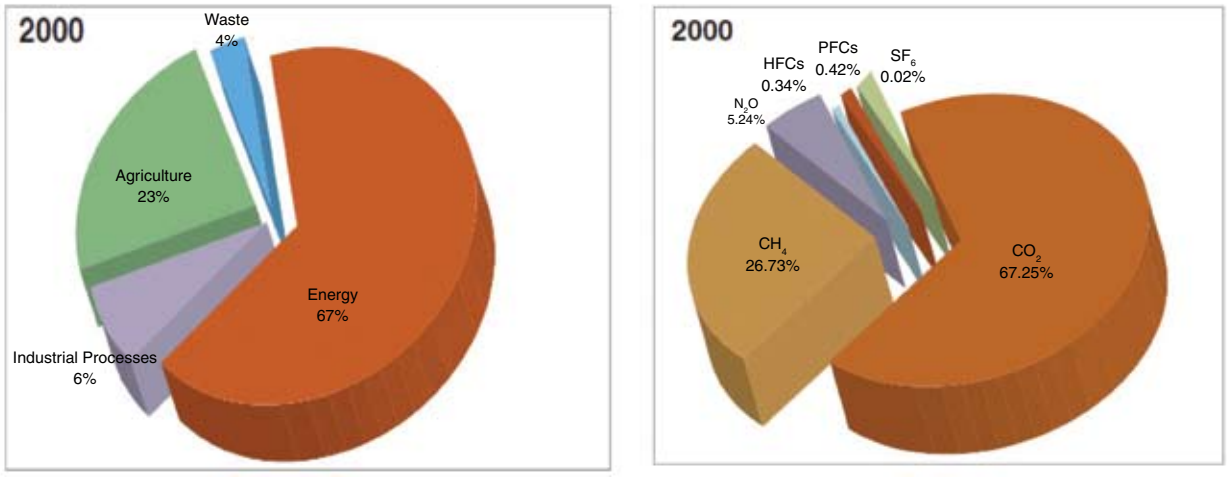


Figure 7: Distribution of emissions, by gases and sectors (figures in Gg CO_2eq), in 2000

Preparation of the BUR

Pursuant to the COP decisions on reporting requirements for Non-Annex I Parties to the UNFCCC, India has prepared its first Biennial Update Report (BUR) as an update to the information provided in India's Second National Communication.

Implementation Arrangement

Consequent upon the submission of the Second National Communication (SNC), the Ministry of Environment, Forest and Climate Change (MoEFCC) launched the preparatory activities for India's Third National Communication (TNC) and other new information to the UNFCCC. Pursuant to this, a facilitation agency (InsPIRE Network for Environment) was hired and the Project Management Unit (PMU) transitioned with the recruitment of a Programme Officer and Project Associates to assist the National Project Director.

The Government of India has taken steps and made efforts towards creating a sustainable institutional structure and institutional arrangements relevant to the preparation of the National Communications on a continuous basis. Preparation of the BUR required a comprehensive study, and technical as well as administrative arrangements, in addition to stakeholder's participation in various tasks and activities. To ensure adequate attention and participation, elaborate implementation arrangements have been devised. A National Steering Committee under the chairmanship of the Secretary, Ministry of Environment, Forest and Climate Change (MoEFCC) was constituted to prepare and implement the work programme of the Biennial Update Report. The National Steering Committee has members from those ministries and government departments which are concerned with the various elements of information in report.

Technical consultations on multiple and multidisciplinary aspects of information relating to GHG inventory and mitigation actions were held during the process. Considering the range of requirements, it was found practical to have exclusive committees to oversee the preparation of BUR. These committees have members from the government, academia and society:

- Expert Advisory Committee on Biennial Update Report (EAC-BUR)
- Expert Committee on Nationally Appropriate Mitigation Actions (EC-NAMAs)

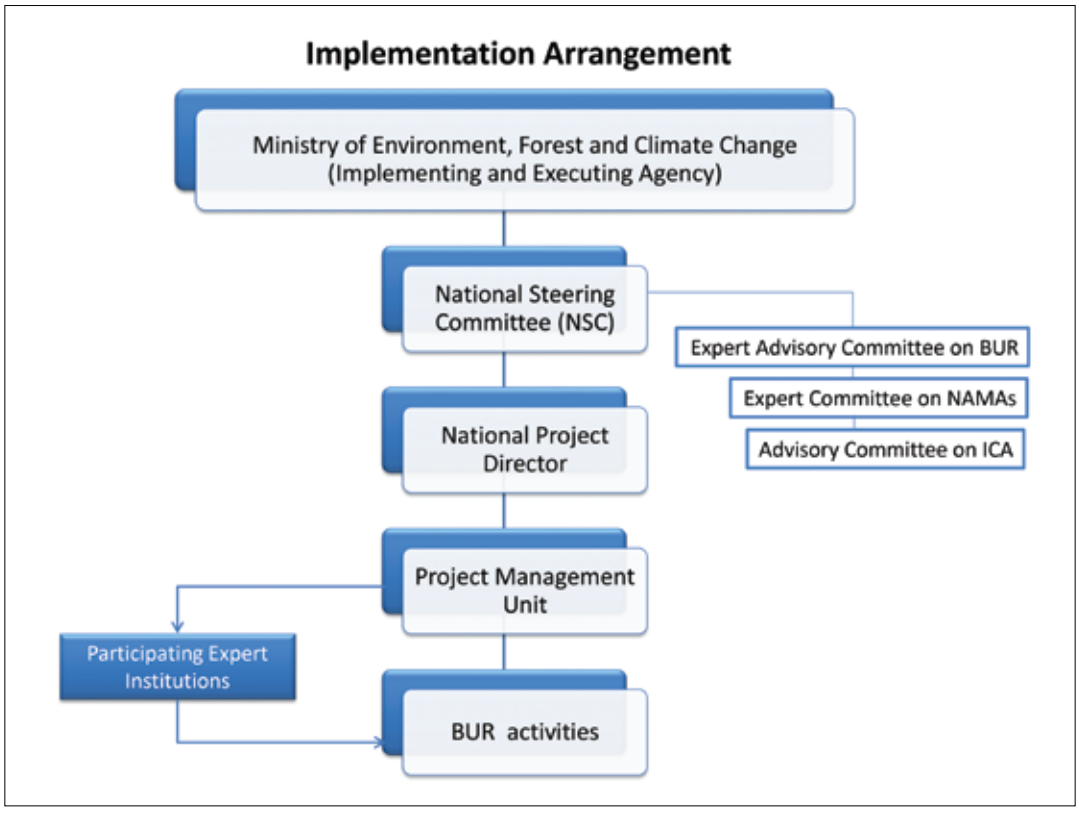


Figure 8: Implementation Arrangement for the First BUR

- Advisory Committee on International Consultant and Analysis (AC-ICA)

This report encompasses information on National Circumstances, GHG Inventory, Mitigation Actions, Analysis of Constraints, Gaps, and related Financial, Technical and Capacity Needs as well as other related information to the extent possible. Several studies were launched to accommodate the requisites of the first BUR. These studies were carried out by institutes having sector-specific expertise. The implementation arrangement is depicted in Figure 8, while the institutional arrangement of the first BUR is depicted in Figure 9.

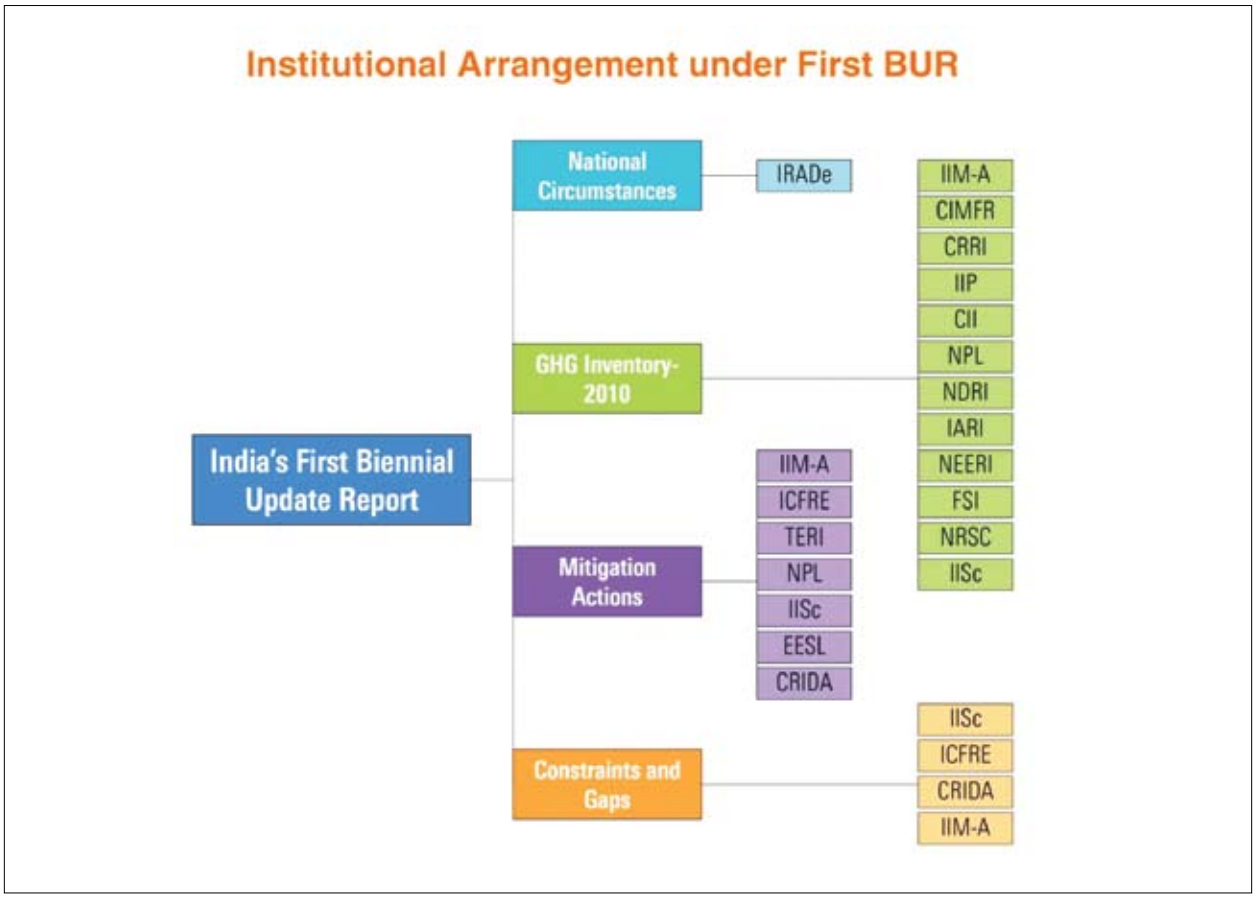


Figure 9: Institutional Arrangement for the first BUR

Acronym:

CIMFR	-	Central Institute of Mining and Fuel Research, Dhanbad
CRIDA	-	Central Research Institute of Dryland Agriculture, Hyderabad
CRRI	-	Central Road Research Institute, New Delhi
CII	-	Confederation of Indian Industry, New Delhi
EESL	-	Energy Efficiency Services Limited, New Delhi
FSI	-	Forest Survey of India, Dehradun
IARI	-	Indian Agricultural Research Institute, New Delhi
ICFRE	-	Indian Council of Forestry Research and Education, Dehradun
IIM-A	-	Indian Institute of Management, Ahmedabad
IIP	-	Indian Institute of Petroleum, Dehradun
IISc	-	Indian Institute of Science, Bengaluru
IRADe	-	Integrated Research for Action and Development, New Delhi
NDRI	-	National Dairy Research Institute, Karnal
NEERI	-	National Environmental Engineering Research Institute, Nagpur
NPL	-	National Physical Laboratory, New Delhi
NRSC	-	National Remote Sensing Centre, Hyderabad
TERI	-	The Energy and Resources Institute, New Delhi

Institutional Network

Executing/Implementing entity for the project is Ministry of Environment, Forest and Climate Change (MoEFCC). MoEFCC assigned various activities and studies for the preparation of BUR to 17 expert institutions through a facilitating agency which also houses the Project Management Unit. Studies for preparation of the GHG inventory was carried out by 12 institutions in their respective sectors of expertise. Reporting of mitigation actions was undertaken by seven expert institutions. Four institutions were engaged to carry out studies pertaining to constraints, gaps and related financial, technical and capacity needs. The network of institutions is shown in Figure 10. Over the years the Government of India has made continued efforts to create sustainable institutional structure to drive the NATCOM process. The network is built upon the existing network of institutions for the previous communications; however, as an effort to strengthen the system of reporting a new institution *i.e.* EESL (Energy Efficiency Services Limited) has been included in the network.

BUR preparation involved estimation of GHG inventory for all the sectors, compilation of mitigation actions, assessment of constrains and gaps and related financial, technical and capacity needs, and information on domestic MRV. Many of the institutions which were involved in the preparation of INC and SNC are also involved in the preparation of BUR. The coordinating institutions and supporting network institutions have developed the required technical capacity, especially for the GHG inventory preparation. In the two National Communications, elements of the mitigation actions were reported as sustainable development and related activities. India is in the process of building institutional arrangement with adequate capacity for sustained reporting of GHG inventory, mitigation actions and other components of BUR and National Communications. The institutional arrangements will be formalized for long term and sustained BUR preparation and submission.

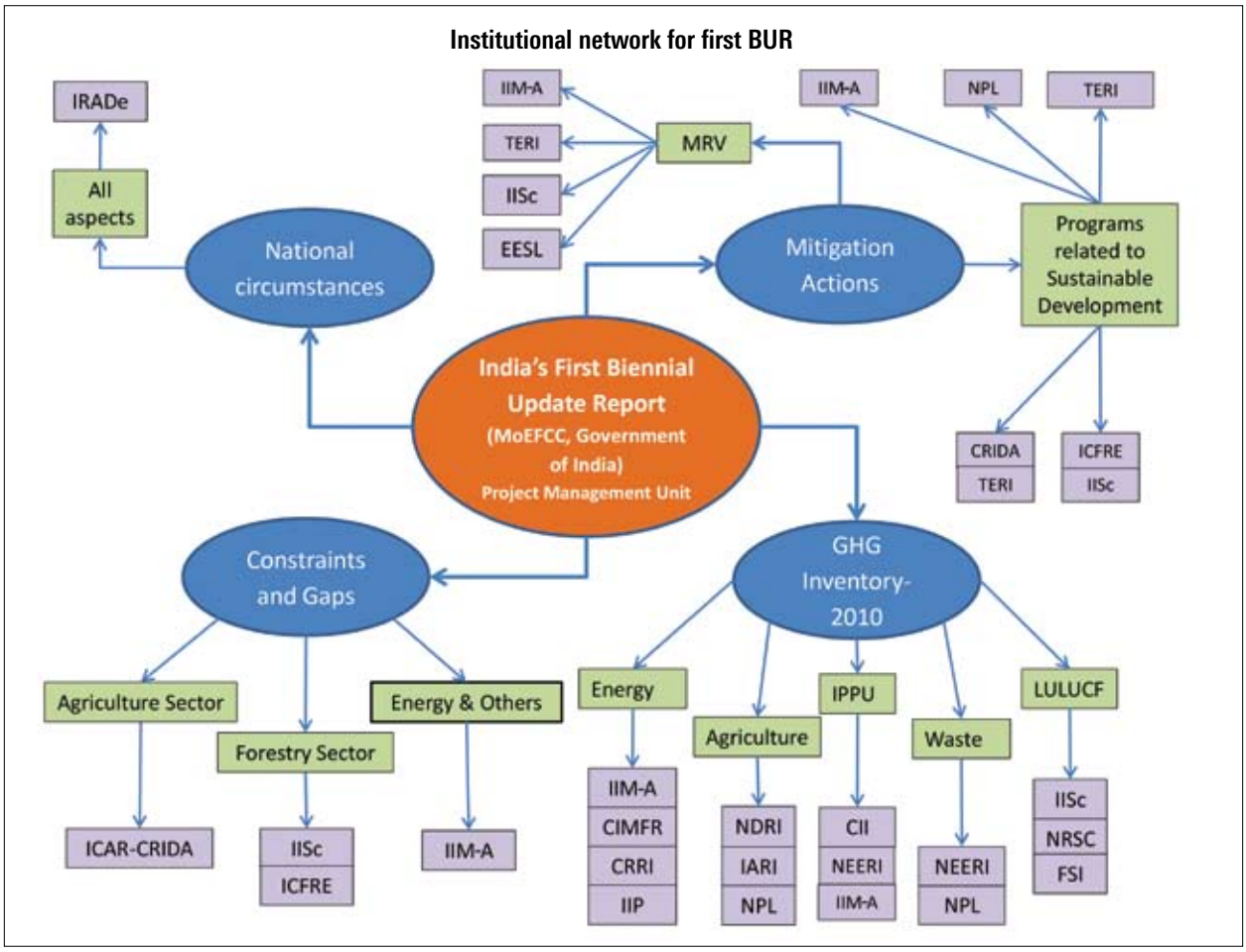


Figure 10: Institutional network for the first BUR

The institutional arrangement involves a 4-tier approach as mentioned below, with a focus on BUR components:

1. **Institutions compiling GHG inventory, mitigation actions and other components of BUR**
   a. Co-coordinating agency for each sector
   b. Network of supporting Institutions for each sector
2. **Institutions providing data and information for BUR components**
   a. Ministries and departments
   b. Research institutions and universities
   c. Industries and associations
   d. Departments involved in generating and compiling data
3. **Institutional arrangement for reviewing the BUR**
   a. Ministries and departments
   b. Independent experts
   c. Expert Advisory Committee
4. **Ministry of Environment, Forest and Climate Change for Co-ordination, Supervision, Approval and Submission of BUR, periodically to UNFCCC**
   a. Steering committee –
      i. Chaired by the Secretary, MoEFCC
      ii. Member Secretary – Adviser/Scientist-G, MoEFCC
      iii. Members are representatives from all relevant ministries and departments.
   b. Endorsement of Minister and approval of the Cabinet

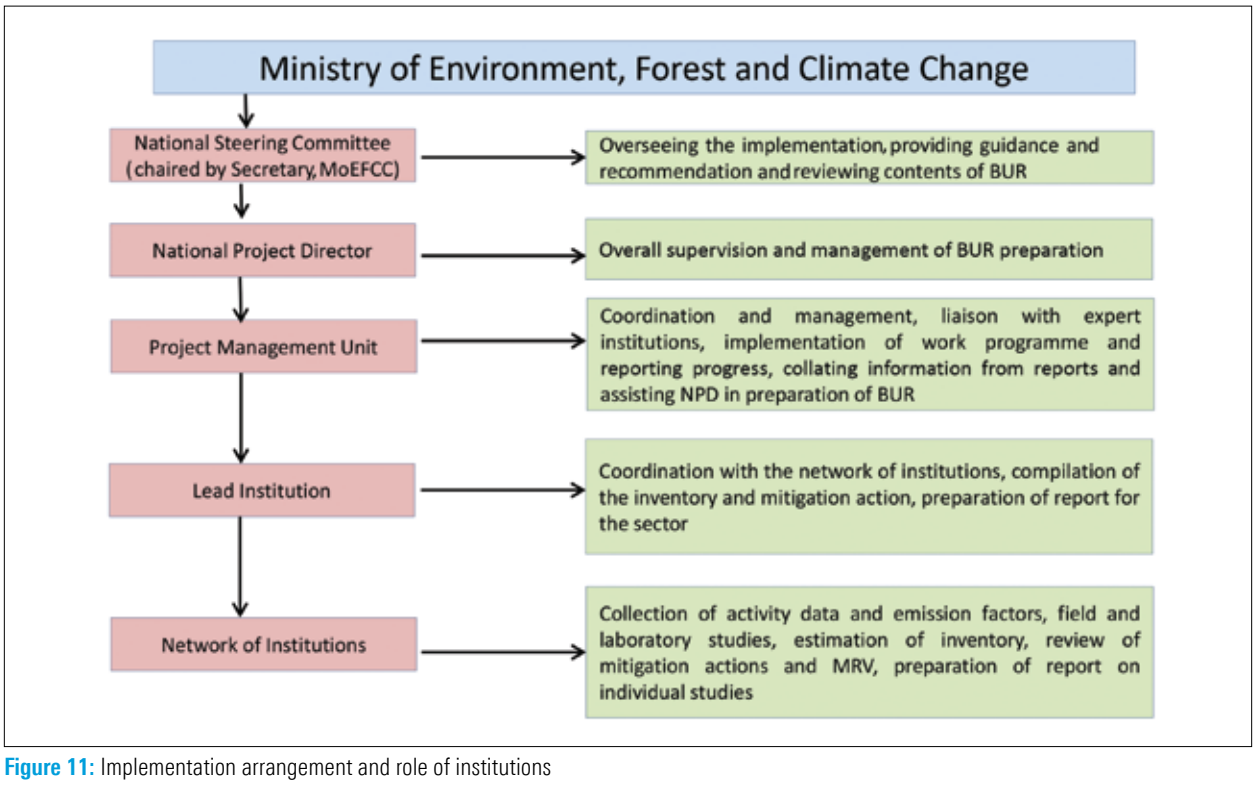


Figure 11: Implementation arrangement and role of institutions

* * *

Chapter 1

National Circumstances

National Circumstances

India is a large and diverse country with an area of 3.287 million km^2 that extends from the snow-covered Himalaya in the north to the shores of the Indian Ocean in the south, and from the arid salt-pans of the west to the tropical rain forests of the east. The Indian sub-continent is separated from the Asian mainland by the Himalaya; the country extends between latitudes 8° 4' and 37° 6' North, longitudes 68° 7' and 97° 25' East and measures about 3,214 km from North to South between the extreme latitudes and about 2,933 km from east to west between the extreme longitudes. India has a land frontier with neighbouring countries of about 15,200 km, and a total coastline length of about 7,500 km. Politically, India is a Union of 29 states (including Telangana formed in the year 2014) and seven union territories, including the Andaman and Nicobar islands toward the south-east, and Lakshadweep Islands in the south-west in Indian ocean. India is neighboured by seven countries namely Afghanistan, Pakistan, Bhutan, Bangladesh, Myanmar, Nepal, China and Sri Lanka. India has the second largest human population of the world with more than 1.21 billion people (in the year 2011) or nearly 17.5% of the world's population with only 2.4% of the global land area. Table 1.1 summarizes the national circumstances of India as of 2014.

1. 1 Climate

India has enormous geographical diversity and a variety of climate regimes and regional and local weather conditions. The climate ranges from continental to coastal, from extremes of heat to extremes of cold, from extreme aridity and negligible rainfall to excessive humidity and torrential rainfall. India's climate is greatly influenced by the presence of the Himalaya and Thar Desert. The Himalaya helps in keeping the Indian-subcontinent warmer than other locations at similar latitudes by acting as a barrier to the cold winds flowing from Central Asia. The northern region of the country possesses continental climate with alternate seasons of severe summer and cold winters. Peninsular India has a more moderate but arid climate. The coastal regions receive abundant rains and have unvarying warmth. The northeast also receives abundant rainfall but has a more contrasting seasonal temperature.

Table 1.1: National circumstances - key features

Criteria	Measure
Total area (million square kilometer)	3.287
Land area used for agricultural purposes (million square kilometers of gross cropped area)	1.95
Forest and tree cover (million square kilometers)	0.79
Population (million, 2011 census)	1210
Urban population as percentage of total population (2011)	31
Population below poverty line (percentage) (2009-10) (Indian poverty line)	29.5
Life expectancy at birth (years) (2006-10)	66.1
Literacy rate (percentage 2011)	74.04
GDP at constant (2011-12) prices, ₹ trillion- 2014-15	106.44
GDP at constant (2011-12) prices, ₹ trillion -2013-14 (New Series)	99.21
Share of industry (manufacturing and construction) in GVA (percentage)#	29.7
Share of services in GVA (percentage)#	52.7
Share of agriculture, forestry and fishing in GVA (percentage)#	17.6
Livestock population excluding poultry (million), year 2012	512.05
Households without access to electricity	33%
Households with kuchha (mud huts) and semi-pucca (semi-concrete) houses	55%

Source: Census, 2011, CSO advanced estimates 2013-14, 19th Livestock Census- 2012, India State of Forest Report 2013, Economic Survey 2013-14, Economic Survey 2014-15, Report of Rangarajan Committee, 2014
Percentage share of sectors in Gross Value Added (GVA) at factor cost current prices – 2014-15 (2011-12 series)

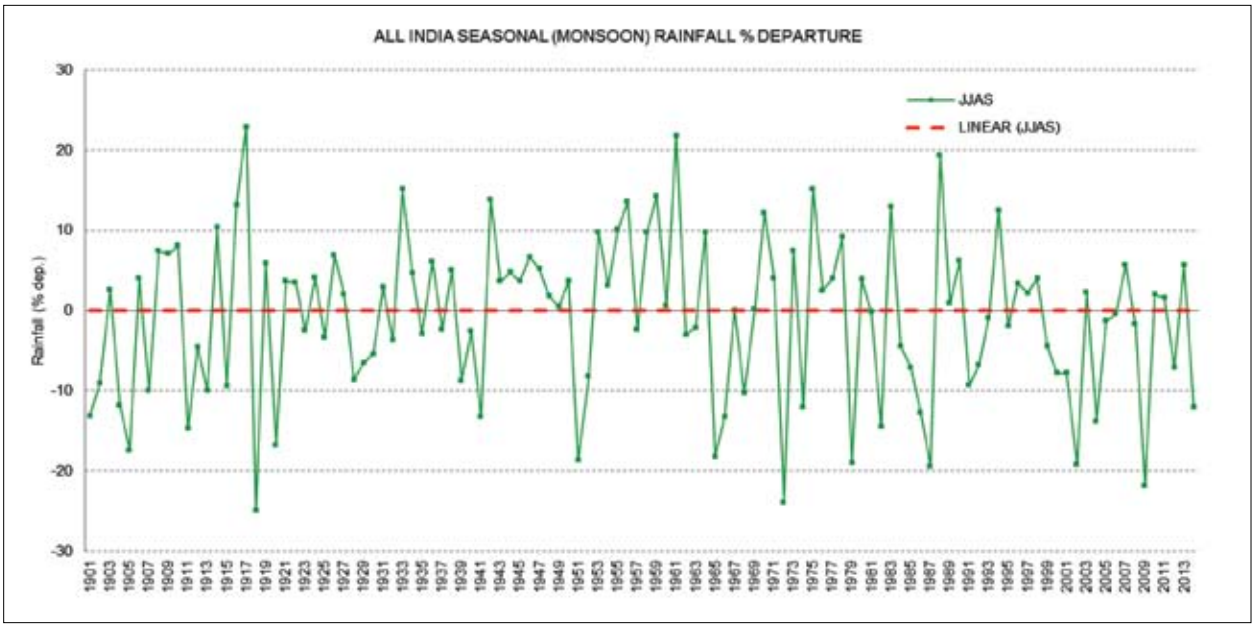


Figure 1.1: Trend in all India monsoon season rainfall over the period 1901-2014

1.1.1 Precipitation

The Indian subcontinent is influenced by two rainy seasons that are accompanied by the seasonal reversal of winds. The south-west (or summer) monsoon is the most important feature of India's climate as it brings nearly 75% of the country's annual rainfall. An average of about 887 mm is received during this principal rainy season (June-September). The pre-monsoon and post-monsoon seasons receive about 11% and 10% of annual rainfall respectively. The inter-annual variability in the monsoon onset, seasonal rainfall distribution and intensity has a great impact on the country, especially its agriculture and water resources. The phase of the El Niño Southern Oscillation (ENSO) often impacts on the rainfall amount and distribution, with the warm phase (El Niño) tending to result in lower rainfall, both during and beyond the monsoon period. Variations in the onset, withdrawal and amount of rainfall during the monsoon season affect the water resources, agriculture, power generation, and ecosystems of the country. As mentioned above the rainfall in India shows great variation, unequal seasonal and geographical distribution and frequent departures from the normal. It generally exceeds 1000 mm annually in areas to the East of longitude 78° and extends to over 2500 mm along almost the entire West Coast and Western Ghats, and over most of Assam and sub-Himalayan West Bengal. On the West of the line joining Porbandar to Delhi and then to Ferozepur in Punjab the rainfall diminishes rapidly from 500 mm to less than 150 mm in the extreme west. The Peninsula has large areas of rainfall below 600 mm with pockets of even less than 500 mm annually. The north-east (winter) monsoon brings rainfall mainly to the southeast part of the Peninsula.

Indian summer monsoon has largely remained stable over the last century (Figure 1.1). India Meteorological Department (2014) concludes that "for the country as a whole, the all-India annual and monsoon rainfall for the period 1901-2014 does not show any significant trend". However, Kulkarni et al. (2012) concluded that though over a century long period (1871–2010) the Indian summer monsoon rainfall (ISMR) series has been stable, it does depict a decreasing tendency during the last three decades of the 20th century. However, there are statistically significant regional variations of precipitation. Eastern parts of central India (Chattisgarh, eastern Madhya Pradesh, Bihar) and Kerala showed decreasing trend in monsoon rainfall, while west coast of India (north of Kerala) and interior parts of Karnataka and Maharashtra showed increasing trend in seasonal monsoon rainfall. Attri and Tyagi (2010) have reported increasing trends in temperature and extreme rainfall events.

Krishnan et al. (2013) too report a decreasing monsoon rainfall trend over the Western Ghats and parts of northern and central India (Figure 1.2).

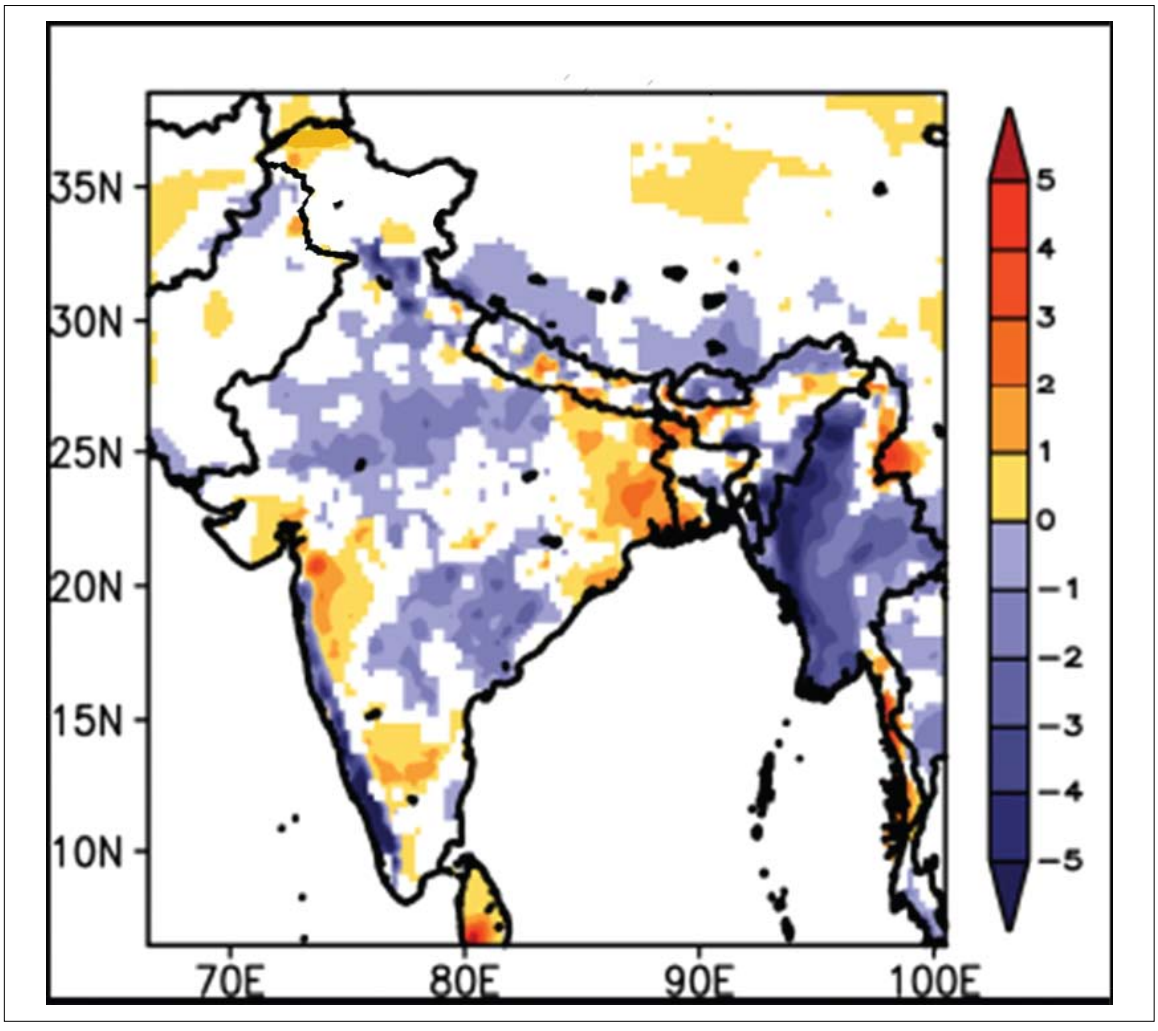


Figure 1.2: Spatial map of linear trend of rainfall rate for JJAS season (June-July-Aug-Sept) based on the APHRODITE daily gridded rainfall dataset for the period 1951 to 2007
The units are mm day^{-1}year^{-1}. Only values exceeding the 95% level of significance have been shaded
Source: Krishnan et al. 2013

1.1.2 Temperature

Temperature variations are also notable in the Indian sub-continent. Due to the influence of continental winds over most of the country, the winter is severe in the North but the temperature becomes moderate as one moves towards the South. During the coldest months of December and January the mean maximum temperatures vary from 29°C in some parts of the country to about 18°C in the north, while the mean minimum temperature varies from about 24°C in the extreme south to below 5°C in the plains of the north. Temperature variations are obviously even more pronounced in mountainous regions such as the Western Ghats in the south and the Himalaya in the north. March to May is usually a period of continuous and rapid rise of temperature. The highest temperature occurs in northern India, particularly in the desert regions of the North-West where the maximum may exceed 48°C. With the advent of south-west Monsoon in June, there is a rapid fall in the maximum temperature in central India. The temperature stays uniform in the areas covering two-third of the country that gets good rain. The temperature falls in August when the monsoon retreats from northern India. The mean maximum temperature is below 38°C, and the mean minimum below 10°C. Temperatures fall below freezing point during winter in the extreme northern parts of the country.

The annual mean, maximum and minimum temperatures for the period 1901-2010 (110 years of data) over India,

show a significant increasing trend of 0.60°C, 1.0°C and 0.18°C per hundred years, respectively. The trend of change in maximum temperatures is much higher than that of minimum temperatures. Further, the rate of rise in the annual mean temperature is much higher since the 1980s, mainly due to sharp rise in the minimum temperatures. For the 1981-2010 period, the mean, maximum and minimum temperatures increased almost at an equal rate of around 0.2°C per decade, which is much higher than the trends for the period 1901-2010 (see Figure 1.3).

On a seasonal scale, the highest increasing trend in the mean temperature was observed in the post-monsoon and winter seasons. Further, rise of the maximum and minimum temperatures, during the past 30 years, is mostly confined to the northern, central and eastern/ north-eastern parts of the country.

The frequency of occurrence of hot days (> 90 percentile) during the pre-monsoon season shows significant increase over the east and west coasts of India and interior peninsula. Likewise, an increasing trend in the frequency of hot nights is seen in the east coast, west coast and north-west India. The frequency and duration of heat waves over northwest India and east coast of India have also increased. The duration of heat wave over central and north-west India has increased by about five days over the past 50 years.

Spatial spread of the warming (mean annual) trends are presented in Figure 1.4. It can be observed that most states in India have warmed at about 0.1°C on a decadal scale, and southern states have warmed at a higher rate than other regions.

1.1.3 Extreme Temperature and Rainfall Events

Extreme rainfall events over India have shown a significant increasing trend over central India. Daily rainfall observations during the period 1901-2004 indicate that the frequency of extreme rainfall events (rain rate > 100 mm day^{-1}) has a significant positive trend of 6% per decade. However, light and moderate rainfall events have shown

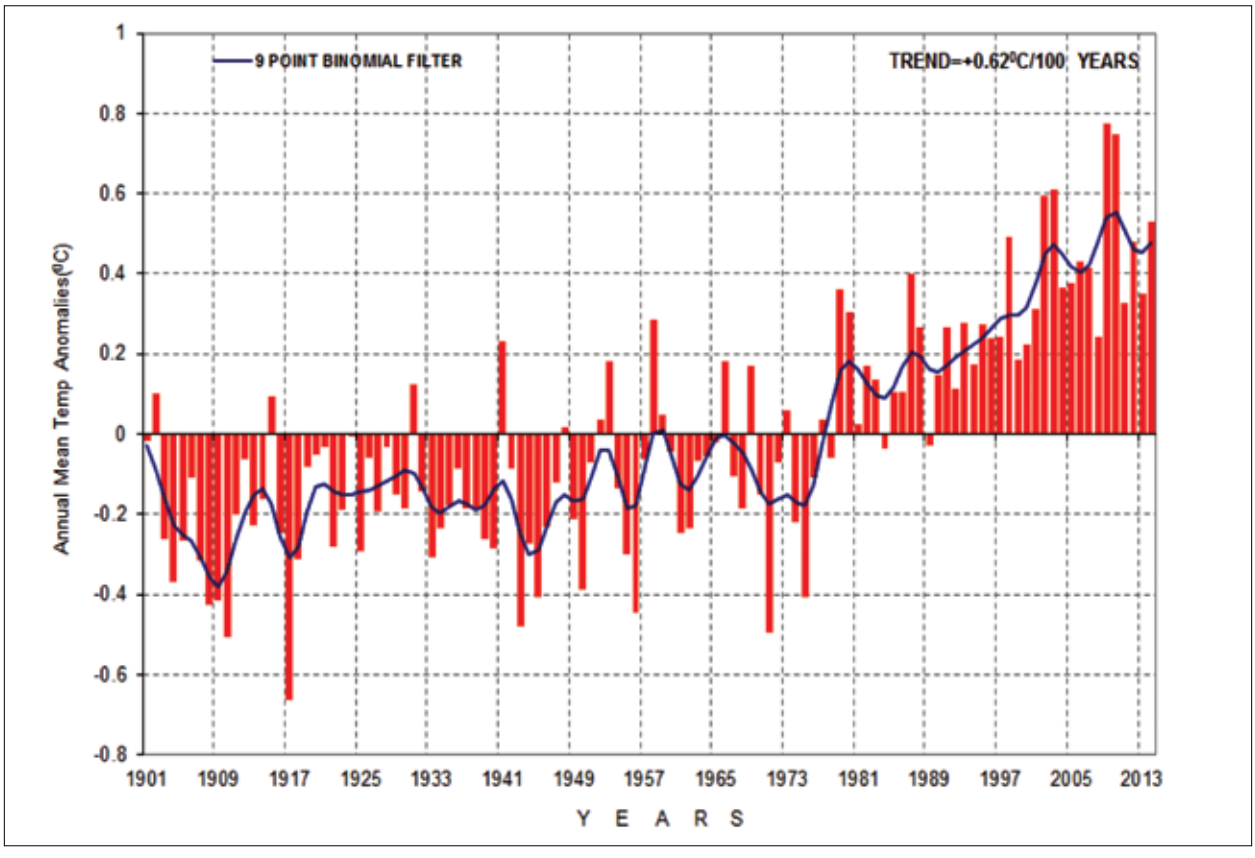


Figure 1.3: Observed temperature trend over India (anomalies are with respect to 50 years mean, 1961-2010)
Source: IMD (2014)

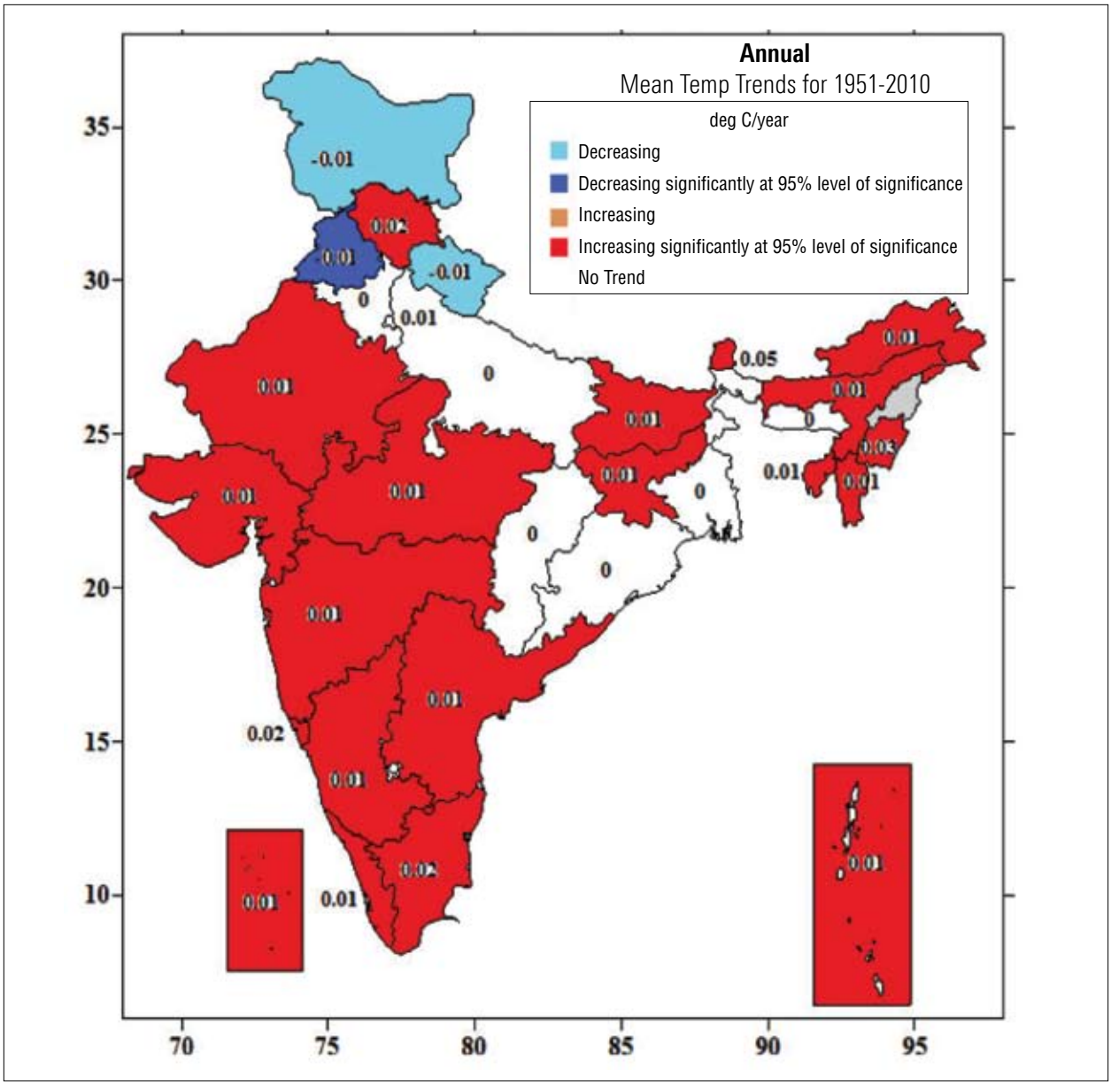


Figure 1.4: State-wise annual trend in temperature increase over 1951-2010
Source: (Rathore et al., 2013)

a decreasing trend over India. Frequency and duration of rainstorms (synoptic weather systems which have potential for causing major floods) have also increased during the past 60 years. A number of studies point to an increasing trend in the observed frequency of heavy precipitation events (Christensen et al. 2013; Rajeevan et al. 2008; Krishnamurthy et al. 2009; Sen Roy 2009; Pattanaik and Rajeevan 2010), and a decreasing trend in light rainfall events (Goswami et al. 2006) and moderate to heavy rainfall events especially over the Western Ghats (Krishnan et al. 2013).

India has witnessed many instances of extremes of temperature, rainfall and tropical cyclones in recent years. A list of the weather extremes in India in the recent years is provided in Table 1.2.

Thus, India is experiencing extreme hazardous weather events resulting in enhanced exposure to multi-hazard vulnerability with adverse impact on ecosystems, natural resources, agriculture and socio-economic profile.

1.2 Water Resources, Land Use and Forests

1.2.1 Water Resources

India has sizable water resources and a vast area of cultivable land. The country has about 17.5% of the

Table 1.2: Weather extremes in India in the recent years (2009-2014)			
Rain Induced Landslide			
Year		**Event**	**Details**
2014 (July)		Landslide	Landslide hit Malin village in Pune district, about 105 people died and 160 were estimated to be trapped under the debris
Temperature			
Year	**Month**	**Event**	**Details**
2009	May	Heat Wave	150 deaths (mainly in Andhra Pradesh)
2010	Jan-Feb	Cold	Northern India: temperature 5-10° Celsius lower than normal. More than 600 lives lost.
2010	May	Heat wave	Northern/Central India: more than 300 lives lost. 2010 warmest year on record.
2011	Jan-Dec	Severe Cold Wave	Northern Plains-maximum temperature was 5 to 10°C below normal, Cold waves claimed about 500 lives (approx 250 alone in Bihar) during January and about 150 during December 2011
2012	Jan-Dec	Severe Cold Wave	Maximum temperature was below normal by over 5°C over most of the parts of the country. Heavy Snowfall led to the closing down of Srinagar-Jammu Highway. The peninsular parts of the country also experienced these conditions during the last week of February. These conditions prevailed across northern, eastern and central parts during last 10 days of December. Cold waves/fog related incidents claimed over 90 lives from Uttar Pradesh.
2012	Apr-Jun	Heat Waves	Heat waves in northern, eastern and peninsular parts of the country claimed 800 lives with over 400 lives from Andhra Pradesh alone
Precipitation			
2009	Summer-Monsoon	Drought	North-western and North-eastern India affected. India's weakest monsoon since 1972
2009	Jul	Floods	Northern parts of west coast, Gujarat receives 500 mm in 24 hours
2009	Sep-Oct	Floods	Andhra Pradesh, Karnataka, Odisha, Kerala, Delhi, Maharashtra, 300 people died
2009	Nov	Floods	Flooding and landslides in Tamil Nadu, 75 fatalities
2010	Aug	Floods	Leh (Jammu and Kashmir); more than 500 missing
2011	Mar-May	Dust Storm/ Thunderstorm/ lightning/heavy rains	Heavy rains during the pre-monsoon season claimed over 100 lives from northern parts of the country, 60 people died in Uttar Pradesh alone.
2011	Jul-Aug	Heavy rains and floods	Death toll due to heavy rains and floods in different parts during the southwest monsoon season was more than 300 (mostly from northern and central parts)
2011	Nov	Heavy Rainfall	Heavy rainfall due to northeast monsoon activity took a toll of more than 90 lives from Tamil Nadu alone
2012	Mar-May	Thunder storming/ lightning accompanied with heavy rains	The heavy rains during pre-monsoon season claimed over 250 lives from different parts of the country.
2012	Jul-Aug	Heavy rains	Death toll due to heavy rains/floods in different parts of the country, during the south-west monsoon season was more than 250 (mostly from the northern and central parts)
2012	Jun-Sep	Floods	150 people died in Assam due to flood related incidents in June and September
2012	13 Sep	Cloud burst	50 lives were claimed by cloudburst in Uttarakhand
2013	16-18 Jun	Heavy rainfall, floods and landslides.	Extremely heavy rainfall (more than 24.5 cm) occurred over many stations in Uttarakhand and heavy rainfall over many stations in neighbouring states during 16-18th June 2013, leading to severe landslides and floods. Large scale loss of lives and properties, more than one lakh pilgrims were stranded in Uttarakhand. Countless others died due to flash floods and landslides in the Mandakini river, especially in the vicinity of Kedarnath temple
2014	Sep	Heavy rain falls resulted in floods	Heavy floods in the state of Jammu and Kashmir; Several thousand villages across the state were hit and over 250 deaths were reported.
Cyclones			
2009	May	Storm	Cyclone 'Alia';149 deaths, tens of thousands stranded
2010	May	Storm	Cyclone 'Laila'; winds of 120 km/h affected Andhra Pradesh region; more than 50 fatalities.
2010	Nov	Storm	Cyclone 'Jal', rice crops destroyed, mudslides, flooding, 54 fatalities in Andhra Pradesh

Year		Event	Details
2011	Dec	Severe Cyclonic storm	A severe cyclonic storm 'Thane' formed over south-east Bay of Bengal. About 50 lives lost
2012	Nov	Cyclonic storm	Heavy rainfall events over the south peninsula in October/November due to northeast monsoon activity and cyclonic storm 'Nilam'' took a toll of over 100 lives from Andhra Pradesh and Tamil Nadu.
2013	Oct	Very Severe Cyclonic storm	Cyclone caused very heavy rainfall over Odisha, leading to floods, and strong gale wind leading to large scale structural damage and storm surge. More than a million persons were evacuated and still human casualties were 39 due to flood and cyclone.
2014	Oct	Cyclone	Tropical cyclone "HudHud" affected eastern coast of India (Andhra Pradesh and Odisha), and Andaman Islands.

world's population as compared to only 4% of average global annual runoff in the rivers. The water resources of India are presented in the following sections.

Rivers: India annually receives around 4,000 BCM of water, of which only 1,123 BCM is utilizable. Of this, 690 BCM is available as surface water resource and the rest 433 BCM as ground water resource. India has twelve major rivers having a total catchment area of 252.8 million hectares (Mha) that covers more than 75% of the total area of the country. Indian rivers (Figure 1.5) are classified as the Himalayan rivers, peninsular rivers, coastal rivers, and inland drainage basin. Of the 12 major rivers, the Ganga-Brahmaputra-Meghana system is the largest with a catchment area of about 110 Mha which is more than 43% of the catchment area of all the total major rivers. The other major rivers with catchment area of more than 10 Mha are the Indus (32.1 Mha), the Godavari (31.3 Mha), Krishna, (25.9 Mha) and the Mahanadi (14.2 Mha). The catchment area of medium-sized rivers is about 25 Mha and the Subernarekha with 1.9 Mha catchment area is the largest among the medium-sized rivers in the country. Figure1.5 shows river basin map of India.

Figure 1.5: Basin map of India

The Himalayan rivers are snow-fed with a high-to-medium rate of flow throughout the year. The reason behind the high rates of flow in these rivers is the heavy annual rainfall in the Himalayan catchment areas. The volume of the rain fed-peninsular rivers and the exposure of catchment areas to floods increase during the months of June-September (summer monsoon).

Groundwater: Groundwater is one of the major components of the total available water resources. The total utilizable water resources in India are 1123 BCM approximately, out of which the contribution of surface water is 61.4%, and the rest is groundwater. Due to imbalance in volume of water extraction and replenishment rate of groundwater, water table is being rapidly lowered. This ultimately is leading to the consumption of more energy for pumping out the water from deeper water tables.

Wetlands: Owing to wide variation in rainfall, hydrology, physiography, geomorphology and climate, India is endowed with a rich diversity of wetlands, ranging from high altitude lakes of the Himalaya, floodplains and marshes of the Ganga-Brahmaputra alluvial plains, saline flats of the Great Indian Desert to the extensive mangroves and coral reef areas straddling the country's east and west coastline. As per the National Wetland Atlas prepared by Space Application Center of the Indian Space Research Organization at 1: 50,000 scale, India has 15.25 Mha area under wetlands, which is around 4.63% of its geographical area. As much as 69.23% of wetlands is classified as being inland, and the rest as coastal. The wetlands have been classified into 19 types. Natural wetlands, both inland and

coastal, account for 67.66% of the total area. Of the total 7.57 lakh wetlands identified, 5.55 lakh have area below 2.25 ha. Also identified in the national inventory are 4699 high altitude wetlands, located 3000 mamsl and covering an area of 0.12 million ha. India has so far designated 26 Ramsar Sites.

Glaciers

Indian Space Research Organization (ISRO) has carried out mapping of Himalayan glaciers covering Indus, Ganga and Brahmaputra basins, using Indian satellite data during 2004 and 2011. There are 34,919 glaciers spread over 75,779 sq. km glaciated area in the entire Himalaya. Further, ISRO has monitored the glacier advance and retreat of 2018 glaciers, across the Himalayan region using satellite data of 2000-2001 and 2010-11. The study indicated that 1752 glaciers showed no change, 248 glaciers were retreating and 18 glaciers were advancing.

Coastal ecosystems

About 35% of the population live within 100 km of the country's coastline measuring around 7500 km. Coastal zones in India assume importance because of high productivity of their ecosystems, population density, exploitation of renewable and non-renewable natural resources, industrialization and spurt in recreational activities. Coastal zones are continuously changing because of the dynamic interactions between the ocean and the land. Erosion and accretion, inundation due to sea level rise and storm surges, and shifting of shoreline caused by natural or anthropogenic forces, such as construction of artificial structures, ports and harbours lead to changes in the coastal zone and its environment. Coastal Regulation Zone (CRZ) Notification, 2011 and Island Protection Zone (IPZ) Notification, 2011 have been issued under the Environment (Protection) Act, 1986. The Coastal Regulation Zone (CRZ) Notification, 2011 was issued with three specific objectives:

i. To ensure livelihood security to fishing communities and other local communities living in coastal areas.

ii. To conserve and protect coastal stretches, their unique environment and the marine area.

iii. To promote sustainable development based on scientific principles taking into account the dangers of natural hazards in the coastal areas, and sea level rise due to global warming.

1.2.2 Land Use

The agriculture land use for the year 2011-12, as given in Agricultural Statistics of India, 2014, shows that of the reporting area of 305.81 Mha, the net sown area in India is approximately 46%, while 23% of area is under forest cover, and 14% area is not available for cultivation. The share of fallow lands is 8%, whereas the other un-cultivable lands excluding fallow lands constitute the remaining 9%. Figure 1.6 represents the land use changes in the country during the period 1950 to 2011. Area under agriculture has remained almost stable since 1990. Land use pattern seems to have stabilized in India in recent decades.

1.2.3 Forest

Forest constitutes the second-largest land use category in India after agriculture. From the tropical wet evergreen forests in the north-east and south-west India, through tropical deciduous forests over a large part of the country,

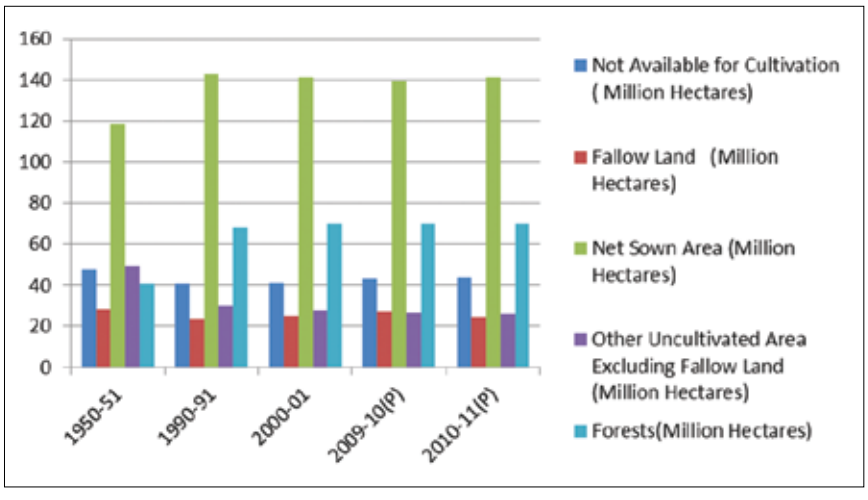


Figure 1.6: Land Use Changes, India (P=Provisional)
Source: Agricultural Statistics at a Glance-2013

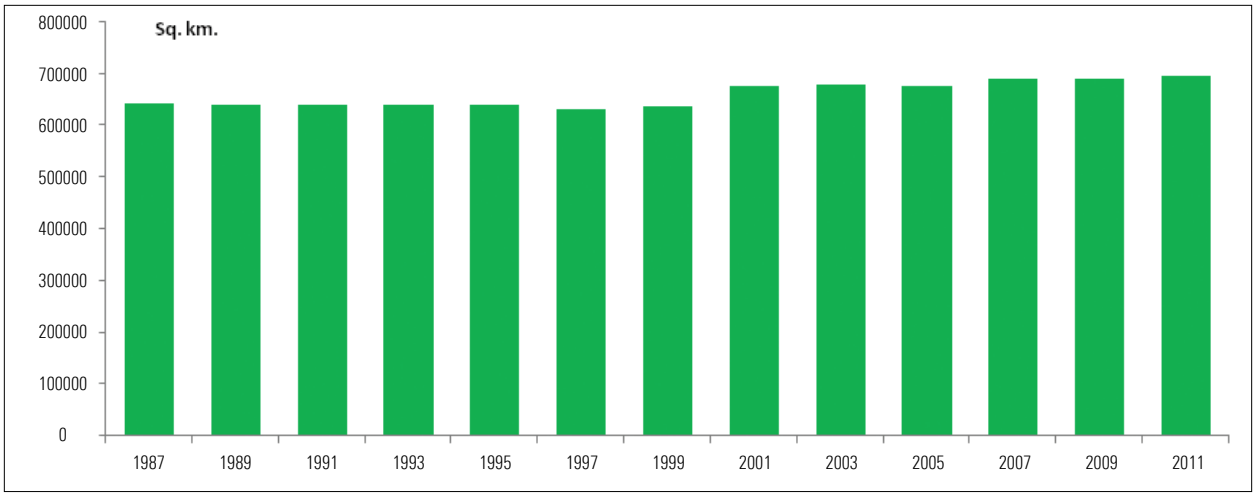


Figure 1.7: Trends in area under forest cover
Source: Various India State of Forest Reports (1989-2013) from Forest Survey of India

to the tropical dry thorn forests in the central and western parts, India is home to diverse types of forests. As per India State of Forest Report 2013, the forest cover is 697, 898 km^2 which is 21.23% of the geographical area of the country, while the total forest and tree cover is 789,164 km^2. An increase of 5,871 km^2 in the forest cover was reported in comparison to the 2011 assessment. Roughly, 275 million rural people in India (22.7% of the total population), depend on forests for at least a part of their subsistence and livelihoods, earned from trade in fuelwood, fodder, bamboo and a range of non-timber forest products. As much as 70% of India's rural population depends on fuelwood to meet its domestic energy needs.

The north-eastern states account for one-fourth of India's forest cover. There has been a net decline of 627 km^2 in the north eastern forest cover as compared to the 2011 assessment, because of shifting cultivation and biotic pressures. The area under mangrove is 4,628 km^2, a decline of 34 km^2 as compared to the 2011 assessment. In 2013 assessment, net improvement of 31 km^2 area in very dense forest, net decline of 1991 km^2 in moderately dense forests, and an increase of 7831 km^2 in the open forest area have been reported as compared to 2011 assessment. The assessment of forest cover is represented in the Figure 1.7.

Deforestation rates in India have declined since 1980, largely due to the implementation of the Forest Conservation Act (1980). Further, India has been implementing one of the largest afforestation and community forestry programmes, the JFM (Joint Forest Management). Such progressive policies have contributed to not only reducing deforestation, but also enhancing the area under forests, despite a large population depending on forests for fuelwood and livelihood. In fact, the deforestation rate per unit population is one of the lowest among all the major tropical countries.

The overall forest area largely remained stable and increased from 64.20 Mha in State of Forest Report 1987 to 69.7 Mha in 2013.

Although tropical dry deciduous forests and savannas are largely adapted to a long history of fire, the prevalence of uncontrolled or un-managed fires during the late dry season can pose a threat to the biodiversity of such ecosystem types. Uncontrolled fire is a threat to the forests, especially the tropical dry deciduous forests that are prone to severe dry season fires (ISFR 2013), even though natural fires are regarded a part of forest succession. The 2013 India State of Forest Report reported that fire prone areas in India under heavy, moderate and mild fires are 1.33%, 6.48% and 46.10%, respectively.

1.3 Demographic Profile

As per Census 2011, India's population was 1210 million, of which the urban population was 377 million. India is the second most populous country in the world and has a population density of 382 persons/km^2. The decadal population growth is steadily declining and stood at 17.6% during 2001-2011.

1.3.1 Demographic Transition

India's performance on critical demographic parameters is constantly improving. The average life expectancy

at birth improved to 66 years in 2012 from 63 years in 2002. As per the sample registration system, total fertility rate (average number of children that would be born to a woman over her lifetime, an important indicator for the population growth rate) has declined to 2.4 in 2011 from 3.1 in 2001. With improvement in the health facilities in the country infant mortality rate (IMR) has declined considerably to 44 in 2011 from 60 in 2003. Crude birth rate (number of births per 1000 of the population per year) has also declined to 21.8 in 2011 from 25.4 in 2001. The crude death rate (number of deaths during a year, per 1,000 population) has reduced to 7.1 in 2011 from 8.0 in 2003. Owing to high birth rate in the recent decades, India now has a sizeable share of young people in the total population mix. Yet, the rate of increase and the number of senior citizens are also growing.

1.3.2 Urbanization

Urbanization in India has been relatively slow as compared to other developing countries. In 2011, nearly 31% of India's population resided in urban areas. Continuous rapid economic growth is set to accelerate the pace of urbanization in the country. The number of urban agglomerations/cities is increasing. The number of cities with population of over a million has increased to 53 in 2011 from 35 in 2001. As the urban population and their income increase, the demand for key services such as water, transportation, sewage treatment and solid waste management, and hence energy consumption and emissions, will also increase. Multitude of policies and measures has been initiated to deliver sustained improvements in the quality of life of urban population, while simultaneously restraining the urban emission footprints.

1.4 Economic Profile

Based on the new growth estimates by Central Statistical Organisation (CSO), India, during the last 12 quarters ending March 2013, economic growth averaged 6.7%. Since 2013-14, growth has accelerated. GDP in the year 2014-15 showed a growth rate of 7.3% over the GDP for 2013-14. Because of the improvement in growth, India's macroeconomic position now compares favourably with other countries[1]. The relatively slow growth of the economy can be attributed mainly to weak industrial growth because of tight monetary policy followed by the Reserve Bank of India (RBI) to fight inflation, and continued uncertainty in the global economy. The slowdown is not just confined to India, as there has been a general slowdown in the global economy which is passing through a rather prolonged phase of uncertainty.

The growth rate of service sector in comparison to other sectors is fairly good. Contribution of service sector to incremental growth has been increasing over time. Nearly 60% of the increase in GDP is accounted for by the services sector in the last two decades. However, the growth rate in the service sector has also started moderating now. Reduction in the growth rate of the services sector is primarily due to a drop in the growth rate of major sub-sectors such as trade, hotels, transport and communication. Growth in these sectors is linked with the growth of agriculture and industry sectors, and a slowdown in these activities has an adverse impact on the growth of the trade and transport sectors too.

India's agricultural sector is primarily dependent on the monsoon. Rainfall during the south-west Monsoon (1st June – 30th September) in 2012 has been both erratic and uneven. It was deficient by 28% in June, 2012 and 13% in July, 2012 as compared to the respective monthly Long Period Averages (LPA). Because of erratic and poor rainfall agriculture and allied sectors registered a slower growth rate of 1.2% during 2012-13, and 3.7% in 2013-14 (Table 1.3a)

The per capita GDP is quite low and stood at approximately $1500 in 2014-15. This is perhaps the most visible challenge the economy is facing. The growth rate of per

Table 1.3a: Growth rate of real Gross Domestic Product (GDP) (in per cent per year)

	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13*	2013-14*
GDP growth rate	9.3	6.7	8.6	9.3	6.2	5.1	6.9
Agriculture	5.8	0.1	0.8	7.9	3.6	1.2	3.7
Industry	9.7	4.4	9.2	9.2	3.5	2.3	4.5
Services	10.3	10.0	10.5	9.8	8.2	8.0	9.1

Source: Central Statistical Organization, Government of India, 2013 and CSO's Press Notes dated 30th January 2015 and 9th February 2015
*GDP estimate as per new series of national accounts GDP (at market prices)

[1]On 30th January, 2015; the Central Statistics Office released a new GDP series deploying improved methodologies and also using more data. For the new methodologies, base year has been shifted from 2004-05 to 2011-12. New estimates for GDP have been provided for the years 2011-12 to 2014-15.

Table 1.3b. GDP per capita (in ₹) in 2011-12 base year				
Year	2011-12	2012-13	2013-14	2014-15
GDP Per capita (₹)	72,394	75,148	79,305	84,009

capita GDP was also not very encouraging – between 2011-12 and 2012-13 it was merely 3.8%; however, it improved to 5.9% between 2013-14 and 2014-15 (Table 1.3b).

1.4.1 Poverty

India has made substantial progress in reducing poverty over the years. During 2000-2012, the number of people below poverty line decreased from 455 million to 363 million, distributed almost uniformly across the country. Although India's poverty alleviation efforts are laudable, people below the poverty line still constitute around 30% of the country's population, making it one of the most vulnerable countries in the world to adverse impacts of climate change. Access to electricity and need for *pucca* (brick and cement) housing for all, along with health, sanitation, drinking water and education are priorities for the government. The central and state governments have enacted numerous legislations such as Employment Guarantee Act and Food Security Act, as well as varied policies and programmes to enhance the social cover in terms of pension to old people, farm insurance and other such measures. Due to the implementation of rural development and poverty alleviation programmes such as Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Rural Livelihood Mission, Integrated Watershed Development Programme and National Afforestation Programme, poverty has come down. Figure 1.8 shows the decline in poverty level from 2009-10 to 2011-12.

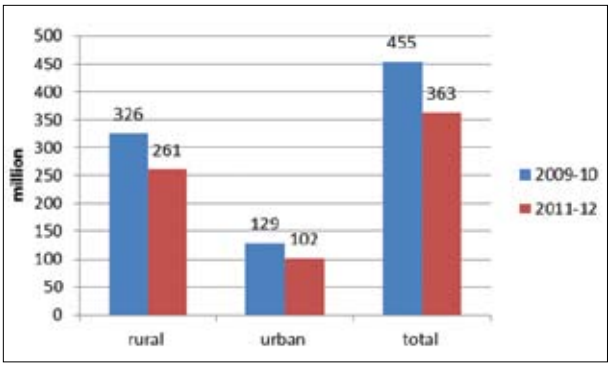


Figure 1.8: Population below poverty line
Source: Rangarajan Committee Report, 2014

Numerous studies carried out in the country show that future climate change will increase the vulnerability of the poor.

1.4.2 Employment

Sixty per cent of India's population figures in the age group of 15-59 years. This demographic dividend presents both a challenge and an opportunity. As per the 68th round of National Sample Survey (2011-12), the rural Labour Force Participation Rate (LFPR) fell by 1.93% while urban employment rose by 1.38% during 2009-10. LFPR was significantly lower for females than for males in both rural and urban areas. The reduction in labour force participation for females, mainly in rural areas, is due to increase in their enrollment in schools and withdrawal from working as casual labour, which is a positive sign.

1.4.3. Appliance Ownership

The appliance-possession levels per 1000 household in India are still low in comparison to the developed and even many developing countries. The report of the "Expert Group on Low Carbon Strategies for Inclusive Growth", released in May 2014, projects a large increase in possession of household appliances for all income classes in the year 2030. The rapidly rising disposable income is providing households with the means to possess appliances that upgrade lifestyles. Bureau of Energy Efficiency (BEE) has instituted a star rating system for household appliances to give consumers guidance on electricity consumption by rating the appliances from 1 to 5 stars. The rising energy cost and consumer awareness about climate change is driving the penetration of star-rated appliances with higher energy efficiency (Table 1.4 and Table 1.5). The introduction of energy demand-side measures and

Table 1.4: Shares of BEE labelled air conditioners sold					
Star rating	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
1 Star	17.1%	14.5%	16.2%	8.5%	1.7%
2 Star	74.5%	56.5%	39.0%	40.4%	34.8%
3 Star	3.5%	24.8%	31.0%	31.8%	39.6%
4 Star	3.7%	3.3%	3.2%	3.7%	2.5%
5 Star	1.2%	0.9%	10.6%	15.6%	21.3%

Table 1.5: Shares of BEE labelled frost free refrigerators sold					
Star rating	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**
1 Star	0.0%	0.0%	0.0%	0.0%	0.0%
2 Star	0.0%	0.0%	0.0%	0.0%	0.0%
3 Star	100.0%	0.0%	11.5%	14.7%	7.5%
4 Star	0.0%	0.0%	47.9%	27.8%	23.2%
5 Star	0.0%	0.0%	40.6%	57.5%	69.3%

demand-side push policies such as for efficient lighting devices, and enhanced dissemination of information to consumers are accelerating the penetration of energy efficient appliances.

1.5 Agriculture and Livestock

1.5.1 Agriculture

Net sown area in India which was 119 Mha in 1950-51 has increased to 141 Mha in 2010-11. The share of agriculture in the gross domestic product (GDP) has been continuously declining and has reached 17.6% in 2014-15 as compared to 18.9% in 2011-12. The population employed in agriculture in 2010-12 was 47.2%. Thus, a large proportion of the population is still dependent on agriculture.

Indian agriculture is moving from primarily rainfed and dependence on the monsoon to larger reliance on irrigation. There is variation in the average amount of rainfall received by the different regions. Apart from extreme events like droughts and floods, variations in rainfall pattern also pose high risks for agriculture. Assessing water availability

under varied climate conditions and increasing the area under irrigation are vital for mitigating climate related risks on agriculture. The area under irrigation in India has been increasing continuously (Figure 1.9), but has stagnated in recent years.

Fertilizer is another important input for agriculture. Growth in total fertilizer consumption has been significant (Figure 1.10) over the past decade. Irrigation, fertilizer, and the availability and use of seeds of high-yielding varieties have contributed substantially to increased food grain productivity. Despite these developments, agriculture in

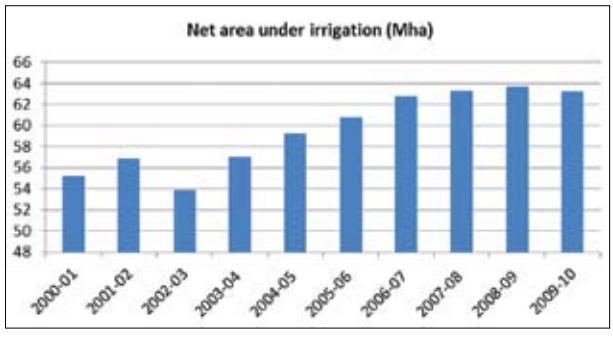


Figure 1.9: Net area under irrigation in Mha

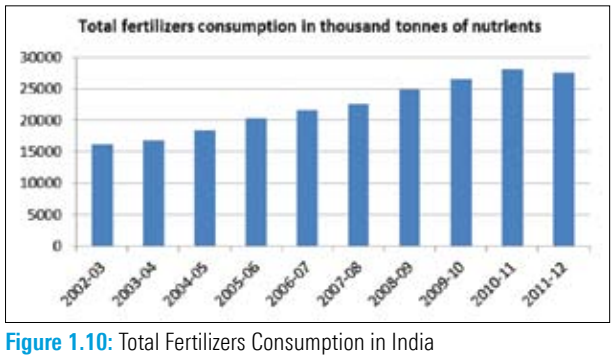


Figure 1.10: Total Fertilizers Consumption in India
Source: Department of Fertilizers

India has not grown at a corresponding rate and is still highly dependent upon the monsoon. Rainfall affects water available for irrigation because of which agriculture is vulnerable to climate change despite the support system.

1.5.2 Livestock

India ranks first in the world in total livestock population. The total livestock population was 512.05 million in 2012, showing a decrease of 3.33% from the previous census of 2007. The livestock sector alone contributes nearly 25.6% of value of output at current prices to the total

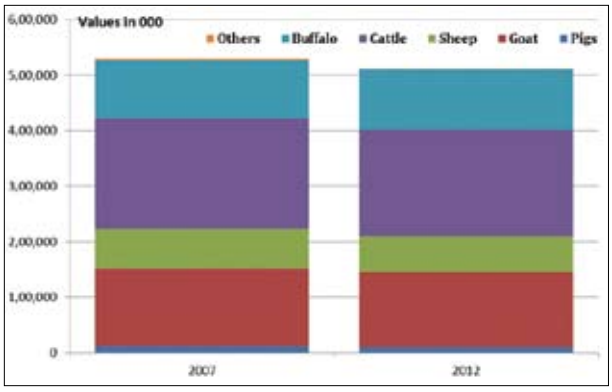


Figure 1.11: Livestock population
Source: 19th Livestock Census, Department of Animal Husbandry, Dairying and Fisheries

value of output in agriculture, fishery and forestry sectors. The overall contribution of livestock sector in total GDP is nearly 4.11% at current prices during 2012-13.

According to 19th Livestock Census carried out in 2012 (Figure 1.11), 37.28% were cattle, 21.23% buffaloes, 12.71% sheep, 26.40% goats and 2.01% pigs. The corresponding figures as per the 18th Livestock Census in 2007 were 37.58%, 19.89%, 13.50%, 26.53% and 2.10%. Mithun, yaks, horses, ponies, mules, donkeys and camels taken together are 0.37% of the total livestock.

1.6 Energy Profile

Energy is an important aspect of the modern economy. This makes the energy policy inseparable from the national development strategy. India's per capita energy consumption is nearly a fourth of the global average. In the year 2010-11, India's per capita primary energy consumption was 441kgoe (Figure 1.12), compared to the world's per capita primary energy consumption of 1885.2 kgoe (EIA Database)[2]. Per capita energy consumption grew at an average annual rate of 5.30% between 1970-71 and 2010-11 (Economic Survey of India, 2012-13).

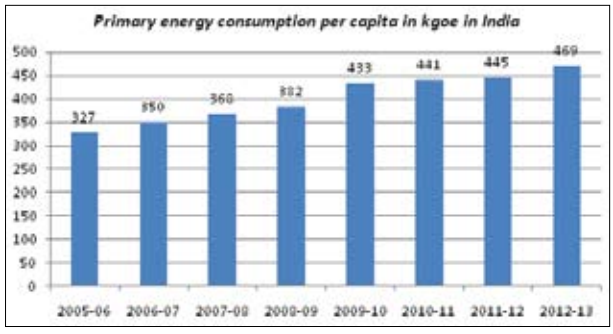


Figure 1.12: Primary energy consumption per capita in kgoe in India

The country depends heavily on imported crude oil for its energy needs.

The path traversed by the Indian energy policy can be viewed in the light of the overall developmental strategy. Energy and climate change related concerns of the Indian economy include the growing gap between the demand and supply of energy, and environmental externalities associated with energy use.

Despite high growth in energy intensive sectors, the growth in energy consumption and environmental emissions with respect to GDP are low. However, due to increased level of electrification, the electricity consumption has grown at a rate higher than the GDP and energy for the past two decades.

Apart from promotion of energy efficient lighting and appliances, India launched its Perform, Achieve and Trade (PAT) Mechanism in 2010, a first of its kind market-based mechanism to promote energy efficiency among large energy-intensive industries in India.

1.6.1 Energy Intensity

Falling energy intensity implies the decoupling of the growth in energy use vis-à-vis GDP growth. This has been achieved through implementation of national policies and measures as well as global market instruments in the areas of energy efficiency, industry competition and adoption of clean energy technologies like wind, solar and hydro. A range of programmes and schemes are initiated for energy conservation, including PAT for eight energy-intensive sectors covering aluminum, chlor-alkali, textile, pulp and paper, iron and steel, fertilizer, cement and thermal power plants. Railways has been included as ninth sector in the second cycle of PAT scheme after 31st March 2015.

1.6.2 Primary Energy Supply

Coal and crude oil are the important sources for the primary energy supply in the country. The primary energy

[2]Energy consumption data is taken from EIA data base, multiplied by relevant factors and then divided by population of the specific year to convert into kgoe per capita.

Table 1.6 Total primary energy supply in India from various sources	
Total primary energy supply of India for 2013-14 provisional (in Kilotonne of Oil Equivalent)	
Coal	382,355
Crude Oil	232,043
Natural Gas	9,896
Nuclear	8,913
Hydro	11,587
Source: Energy Statistics 2015, CSO, (MINISTRY OF STATISTICS AND PROGRAMME IMPLEMENTATION)	

supply from major sources in 2013-14 is given in Table 1.6.

India largely depends on import of crude for meeting its requirement of petroleum products. The significant gap in supply and demand poses considerable energy security concerns for India. The import of crude oil has increased from 74.10 Million Metric Tonne (MMT) in 2000-01 to189.44 MMT in 2014-15. Crude imports contributed 69.8% in 2000-01 and 78.8% in 2014-15 of the total crude refined in India. During this period the refinery capacity has increased from 112.04 Million Metric Tonne Per Annum (MMTPA) in 2000-01 to 215.07 MMTPA in 2014-15. The exports of petroleum products have increased substantially and represent about 19% of the total exports of the country. The crude oil input required to support India's consumption of petroleum products in 2013-14 was 16.72 MMT, out of which 70% was imported.

There is high potential for generation of power from renewable energy resources — wind, solar, biomass, and cogeneration bagasse (Table 1.7). The geographic distribution of the estimated potential of renewable power as on 31.03.2014 reveals that Gujarat has the highest share of about 25.04% (36,956 MW), followed by Karnataka with 13.08% (19,315 MW) and Tamil Nadu with 11.17% share (16,483 MW), mainly on account of wind power potential.

Table 1.7 Total all India estimated potential of renewable power	
Sources	In MW
Wind Power	102,772
Biomass Power	17,538
Cogeneration-bagasse	5,000
Waste to Energy	2,556
Source: Energy Statistics 2015, CSO (MINISTRY OF STATISTICS AND PROGRAMME IMPLEMENTATION)	

As per the 2011 census, almost 85% of rural households were dependent on traditional biomass fuels such as firewood, dung cake and wood chips for their cooking energy requirements. National Sample Survey 2009-10 revealed the continued dependence on firewood in rural areas for cooking, with percentage of households depending on firewood at 76.3% in 2009-10. There was a drop of only two percentage points since 1993-94 even though the percentage using LPG increased from about 2% to 11.5% over the same period. On the other hand, the incidence of dependence on firewood for cooking in urban areas has fallen from about 30% to 17.5% between 1993-94 and 2009-10, a drop of more than 12 percentage points. The dependence on kerosene has plunged from 23.2% to 6.5% during the same period – a 72% fall, while the percentage of urban households using LPG has more than doubled from under 30% to 64.5%.

1.6.3 Fossil Fuel (Coal) Reserves

India possesses sizable coal reserves (Table 1.8). Total coal reserves in India by current estimates are adequate to meet India's power needs for at least another 100 years at current level of consumption. With coal consumption growing at 5% per year, the currently known reserves may last around 40 years.

Table 1.8: Coal Reserves of India in million tonnes			
As On	Proved	Indicated	Inferred
1.4.2007	99060	120177	38144
1.4.2008	101829	124216	38490
1.4.2009	105820	123470	37920
1.4.2010	109798	130654	36358
1.4.2011	114002	137471	34390
1.4.2012	118145	142169	33183
1.4.2013	123182	142632	33101
1.4.2014	125909	142506	33149

The consumption of commercial fuel (coal, oil, natural gas) for production of power and other uses has been steadily rising over the years, with domestically abundant coal continuing to be the dominant source.

Crude oil and natural gas constitute 45% share in the total energy basket mix. With a growing economy, the demand for petroleum products has increased by 4.20% in 2014-15. As a large part of the energy is still derived from fossil fuel, energy security is a matter of concern for India, although in the future it is expected that alternate sources of energy like solar, wind and biofuels would also be available. However, as mentioned earlier, coal being

abundant, cheap, and locally available, it will continue to be the mainstay of energy in the country for many years to come.

1.6.4 Primary Energy Demand

In India, only around 67% of the households have access to electricity while the rest do not. Only 55% of households in rural areas have electricity as a source of lighting.

India's primary energy use is projected, through 2031-32, to expand from 397 Mtoe in 2006-07 to 1823 Mtoe to deliver a sustained GDP growth rate of 9% even after allowing for substantial reduction in energy intensity. In order to fuel this on a sustained basis, the growth of around 5.8% per year in primary energy supply including gathered non-commercial fuels such as fuelwood and dung, would be required. Commercial energy supply would need to grow at about 6.8% per annum so as to replace non-commercial energy, but this too involves a reduction of around 20% in energy use per unit of GDP over a period of ten years. Requirement of India's dominant fuel, coal and lignite, will expand from around 318 million tonnes in 2006-07 to over 1659 million tons per annum, based on the quality of available domestic coal over a period of 25 years.

India is striving to meet the basic need of access to energy at affordable price while addressing the growing concerns of climate change. Enhancing energy supply and access to energy for all are key components of the national development strategy. At the same time, the focus of policies and programmes is on reducing energy intensity and enhancing energy efficiency. However, despite achieving a relatively high growth rate in energy consumption, the per capita energy consumption in India is still low according to global standards, and the energy efficiency of GDP (Purchasing Power Parity basis) is among the best. This holds true even if it is compared with other countries at similar stage of development.

1.7 Power Sector

The Indian power sector is driven by state, central and private players. The total installed capacity in the country is 271,722 MW as on 31.03.2015 (CEA, 2015), with state sector accounting for 35%, central sector 26.7% and private producers 38.3%. The installed capacity according to sources is given in Table 1.9. There has been a significant increase in installed capacity of electricity from 2005 to 2015. The share of hydro power plants has come down in total installed capacity from 26% to 15.20%, and there has been a significant rise in wind and other renewable energy sources from 2% in 2005 to 13.2% in 2015.

Table 1.9: Installed generation capacity and generation of electricity in India

	As on 31.03.2015		As on 31.01.2005	
Fuel	**MW**	**%age**	**MW**	**%age**
Coal	164635.88	60.59	67166	58.13
Gas	23062.15	8.49	11840	10.25
Diesel	1199.75	0.44	1196	1.04
Hydro	41267.43	15.19	30135	26.08
RES*	35776.96	13.17	2489	2.15
Nuclear	5780.00	2.13	2720	2.35
Total	271722.17		1,15,546	

Source: Central Electricity Authority (2015) http://www.cea.nic.in/publication.html
* Source: Ministry of New and Renewable Energy

Renewable Energy Sources (RES) are adding capacity into grid, and are also increasingly being used for captive

Table 1.10: Installed capacity of RES in India as on 31.03.2015

S. No	Renewable Energy Programmes/ Systems		Cumulative Achievements
I.	**Grid-interactive Renewable Power (in MW)**		
	Wind Power		23444.00
	Small Hydro Power		4055.36
	Biomass Power and Gasification		1410.20
	Cogeneration		3008.35
	Waste to Power		115.08
	Solar Power		3743.97
	Total		35776.96
II.	**Off-grid/ Captive Power (MW)**		
	Biomass (Non-bagasse) Cogeneration		591.87
	Biomass Gasifiers	Rural	17.95
		Industrial	152.05
	Waste-to-Energy		154.47
	Aero-generators/Hybrid systems		2.53
	SPV Systems		234.35
	Water mills/Micro Hydel		17.21
	Bio-gas based energy system		4.07
	Total		1174.50
III	**Other Renewable Energy Generation systems**		
	Family Type Biogas Plants (nos. in lakh)		48.18
	Solar Water Heating – (collector area in million sq.m)		8.82

Source: Ministry of New and Renewable Energy

power generation. The status of renewable energy based power in country is presented in Table 1.10.

As per Central Electricity Authority, transmission and distribution (T&D) losses amounted to 23.97% in 2010-11 which was reduced to around 23.65% of generated electricity in the year 2011-12 and further to 23.04% in 2012-13. High losses cripple the financial viability of state-owned power transmission system, resulting in a persistent lack of funds for expanding and improving the network. However, the ongoing power sector reforms have targeted T&D as a prime area, and multiple improvements are being made.

1.8 Transport

Transport is a critical infrastructure for development. Adequate transport provision in terms of quality, connectivity and resource-efficiency is essential. If the required transport development is not accomplished in time, to satisfy both the burgeoning passenger and freight demand, the high inspirational growth envisaged will simply not be achieved. Transport sector is responsible for an appreciable share of pollution, both local and global. The sector accounts for a substantial share of consumption of petroleum products in India. Therefore, managing the transport sector to meet the requirements, while at the same time minimizing externalities such as local pollution, congestion and GHG emissions is a challenge.

The increasing pace of urbanization and lack of efficient and effective public transportation systems in urban areas are further fueling the demand for private vehicles. Table 1.11 provides figures of automobiles in various categories registered in India.

Efficient transport system is a critical infrastructure requirement in cities for economic productivity and quality of life. Transport plays a crucial role in urban development by providing access for people to employment, education, markets, recreation, healthcare and other key services. Development of efficient and effective public transport system will not only help in reducing the growth of private transport but, at the same time, provide better transportation options to weaker sections of society. The inability of low-income groups to access affordable transportation system imposes considerable hardships on them.

Total registered road vehicles' population in the country grew at a compound annual growth rate (CAGR) of 10.1%; growth rate of public vehicles (buses and goods vehicles) was 9.6% whereas for private vehicles (two wheelers, car, jeep and taxis) it was10.3% between 2005 and 2012. The growth of vehicles in metropolitan cities is much higher

Table 1.11: Total number of registered motor vehicles in India during 2001–2012 (in thousands)

Year (date as on 31st March)	All vehicles	Two wheelers	Cars, jeeps and taxis	Buses[b]	Goods vehicles	Others[a]
2001	54,991	38,556	7058	634	2948	5795
2005	81,501	58,799	10,320	892	4031	7451
2006	89,618	64,743	11,526	992	4436	7921
2007	96,707	69,129	12,649	1350	5119	8460
2008	1,05,353	75,336	13,950	1427	5601	9039
2009	1,14,951	82,402	15,313	1486	6041	9710
2010	1,27,746	91,598	17,109	1527	6432	11080
2011	1,41,866	1,01,865	19,231	1604	7064	12102
2012	1,59,491	1,15,419	21,568	1677	7658	13169

a-Others include tractors, trailers, three wheelers (passenger vehicles) and other miscellaneous vehicles that are not separately classified.

b-Includes omni buses.

Source: Road Transport Yearbook, 2011–12

than in smaller cities. Metropolitan cities account for about one-third of total vehicles in India. These trends indicate that the growth rate of vehicles is likely to be high as the cities continue to grow in tune with the country's high economic growth. The government has plans to develop 100 new smart cities in the country to contain the rapid growth rate of existing cities and to reduce the need for travel within cities, particularly by private vehicles.

1.9 Governance Profile

India is a "sovereign, secular, socialist, democratic republic" and has a federal form of government. India's government structure is divided into three distinct but interrelated branches — legislative, executive, and judicial. These three arms are able to function independently within the limits of their legitimate function, yet ensuring balance among each other, so as to operate national governance in an effective manner. The legislature directly elected by the people is entrusted to enact laws. The executive, politically accountable to the legislature through the principle of collective responsibility of the cabinet and the individual responsibility of the minister, implements the laws enacted by legislature. The power to interpret the constitution and laws, and the responsibility to ensure their enforcement lies with the judiciary. India is a union of states where respective jurisdiction and authority of both the union and the state governments are well defined. Articles 245 to 255 of the Constitution of India explain the distribution of powers between the Union and State. The Union list placed in the Seventh Schedule of the Indian Constitution comes exclusively under the jurisdiction of the central government. State governments are responsible to enact laws for the areas described in the State list, whereas the concurrent list falls under the joint jurisdiction of both central and state governments and both of these can enact law simultaneously for such sectors. Sectors such as forestry, industries and electricity belonging to energy and environment sectors are placed in the concurrent list of the Seventh Schedule of the Indian Constitution.

1.9.1 Environmental and Climate Change Governance

Protection of the environment is central to the country's sustainable and inclusive growth strategy. The Government of India attaches high priority to the environment. Ministry of Environment, Forest and Climate Change is the nodal agency and has the responsibility of planning, promoting, coordinating, and overseeing the implementation of environment and forest policies. Each state of India also has a ministry/department to deal with state specific environmental issues and concerns. Scientific and technical staff, as well as institutions and experts, support environment administration at the Union and state levels.

Right to wholesome environment is a fundamental right protected under Article 21 of the Constitution of India. In India, Environmental Law has seen considerable development in the last two decades. Indian environmental law recognizes the citizen's right to a clean environment as a component of The Right to Life and Liberty. Besides, matters of public interest get articulated through the vigilant media and active non-government organization (NGO) community. India's strong and independent judiciary protects these rights.

Environmental concerns are integral to the governance of India. Recognizing the need for environmental planning and of its integration with economic policies and programmes, Government of India established National Committee on Environmental Planning and Coordination (NCEPC) under the aegis of the Department of Science and Technology in 1972. This commitment was a major step taken by India, and the country was one of the pioneering countries in the world to amend its Constitution to incorporate provisions to protect its environment. The constitutional provisions are backed by a number of laws, acts, rules, and notifications. More than two dozen laws have been enacted to protect and safeguard India's environment. These cover all aspects of the environment — from pollution to conservation, deforestation to nuclear waste disposal. Some of these laws are precursors to today's environmental movements.

Prime Minister's Council on Climate Change was constituted by the Union Government in 2007. The Government re-constituted the Council to coordinate National Action for Assessment, Adaptation and Mitigation of Climate Change in November 2014. The Council is chaired by the Prime Minister and focuses on evolving a coordinated response to issues relating to climate change at the national level, on providing oversight for formulation of action plans in the area of assessment, adaptation and mitigation of climate change, and on periodically monitoring key policy decisions.

To deal with the challenge of climate change, and at the same time to maintain a high growth rate, is essential for rise in living standard of the vast majority of poor people. In order to achieve a sustainable development path that simultaneously advances economic and environmental

objectives, India announced a National Action Plan on Climate Change (NAPCC) in 2008. There are eight National Missions, which form the core of the NAPCC, representing "multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change". Broadly, the plan envisages promoting understanding of climate change with emphasis on issues related to adaptation and mitigation, energy efficiency, and natural resource conservation.

1.10 India's Commitment to Climate Change and Sustainable Development

India is one of the countries most vulnerable to climate change. Vast majority of the population depends on agriculture and other climate-sensitive livelihood activities. Low income levels also make the Indian population less climate resilient. It is in the interest of the country to contribute to global action for climate change. India has committed to voluntary energy intensity reduction of 20-25% by 2020 from 2005 levels in the Copenhagen Accord. India is taking various initiatives such as low carbon strategy for inclusive growth and formulation of eight missions under National Action Plan for Climate Change which promote renewable energy sources, sustainability and increasing forest cover. Simultaneously, India is striving to build resilience capacity through Employment Guarantee Act and Food Security Act, which provide a safety net to the poor. Research and development in environment, environmental protection and sustainable development are key national priorities for India.

India is recognized as a mega biodiversity country – with just 2.4% of the land area, accounting for over 7% of the recorded species, while supporting 17.5% of human population and the world's largest cattle population. As per State of Forest Report, the forest and tree cover in the country has increased from 14% in 1950-51 to 24.01% in 2011-12. This is a remarkable conservation achievement given that India is a large developing country with a high population density and low per capita forest area.

India's livestock population density is among the highest in the world. Nearly 70% of the population residing in rural areas depends on forest and other biomass resources for fuelwood, timber and non-timber forest products for its energy needs and livelihood. In such a socio-economic scenario, one would expect the forest area to decline. The progressive conservation-oriented forest policies and afforestation programmes are contributing to the stabilization of forest cover in India. Legislations and community awareness and participation endeavours such as Joint Forest Management (JFM) programme play a significant role. Forest Conservation Act, 1980 is one of the most effective legislations contributing to reduction in deforestation. This was enacted to reduce indiscriminate diversion of forest land for non-forestry purposes, and to help regulate and control the recorded forest land-use changes. Further, India has an ambitious plan to bring 33% of its geographical area under forest cover. These significant conservation achievements best illustrate India's commitment to climate change and sustainable development.

* * *

Chapter 2

National Greenhouse Gas Inventory

National Greenhouse Gas Inventory

2.1 Introduction

This chapter presents India's National Greenhouse Gas (GHG) inventory for the year 2010 as an update to the GHG inventory of India presented in the Second National Communication for the year 2000. A description of the emissions of GHGs, namely carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphurhexafluoride (SF_6) by sources and their removal by sinks, for the year 2010 has been presented.

The sectors covered are:

I. Energy

II. Industrial Processes and Product Use (IPPU)

III. Agriculture

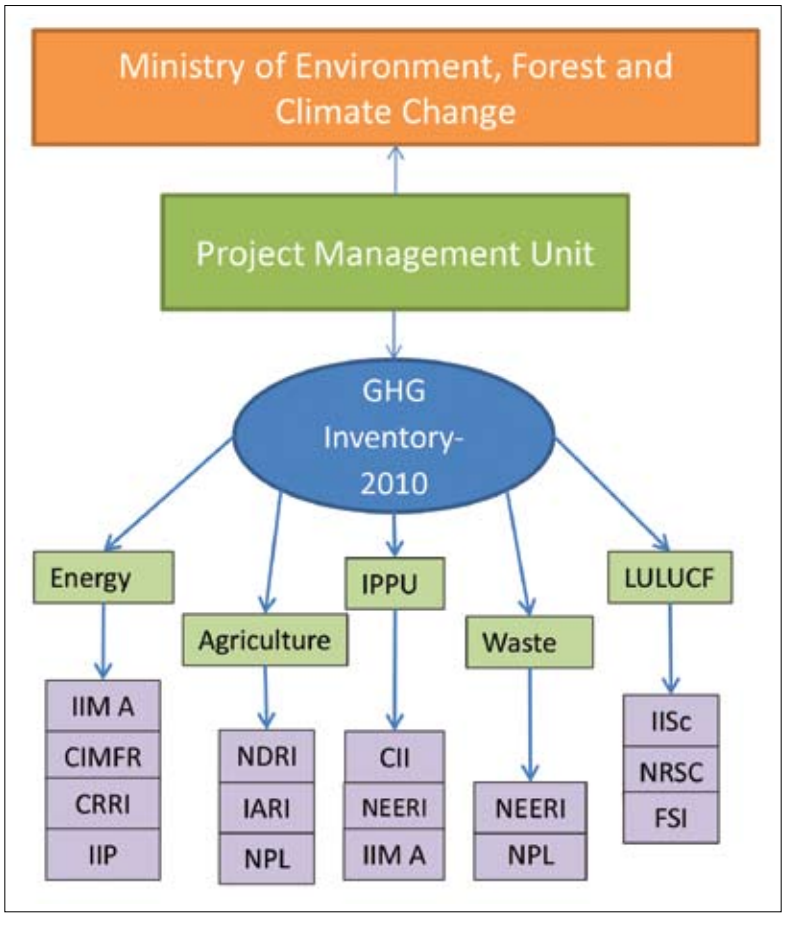
IV. Land use, Land-Use Change and Forestry (LULUCF)

V. Waste

Estimation and reporting of GHG inventory are in accordance with the UNFCCC decision 17/CP.8 meant for reporting National Communications from Non-Annex I Parties using relevant IPCC guidelines.

2.2 Institutional Arrangement for GHG Inventory

MoEFCC assigned twelve institutions to carry out the inventory preparation exercise as per their expertise in the respective sectors (Figure 2.1).



The twelve institutions are:

CIMFR - Central Institute of Mining and Fuel Research, Dhanbad

CRRI - Central Road Research Institute, New Delhi

CII - Confederation of Indian Industry, New Delhi

FSI - Forest Survey of India, Dehradun

IARI - Indian Agricultural Research Institute, New Delhi

IIM A - Indian Institute of Management, Ahmedabad

IIP - Indian Institute of Petroleum, Dehradun

IISc - Indian Institute of Science, Bengaluru

NDRI - National Dairy Research Institute, Karnal

NEERI - National Environmental Engineering Research Institute, Nagpur

NPL - National Physical Laboratory, New Delhi

NRSC - National Remote Sensing Centre, Hyderabad

Figure 2.1: Institutional arrangement for GHG inventory preparation

2.3 Methodology for GHG Inventory Preparation

Revised IPCC Guidelines 1996 have been used for reporting the GHG inventory. Elements have also been adopted from 2006 IPCC guidelines for estimation. In case of LULUCF sector, IPCC-Good Practice Guidance (GPG), 2003 is used along with the elements from the IPCC 2006 AFOLU guidelines. The methodology used has encompassed from Tier I to Tier III. Both default and country specific emission factors have been used in this report and are reflected in the table below for corresponding categories and gases. Table 2.1 presents the summary of methodological choices for estimating emissions and removal of greenhouse gases from different source/sink categories.

Table 2.1: Methodological choices

Type of Emission Factor and Level of Methodological Tier Employed for GHG Estimation

	CO_2		CH_4		N_2O	
	Method used	Emission Factor	Method used	Emission Factor	Method used	Emission Factor
1. ENERGY						
A. Fuel Combustion Activities						
1. Energy Industries	T1, T2	D, CS	T1	D	T1	D
2. Manufacturing Industries and Construction	T1, T2	D, CS	T1	D	T1	D
3. Transport	T1, T2	D, CS	T1	D	T1	D
4. Other sectors	T1	CS, D	T1	D	T1	D
B. Fugitive Emission from fuels						
1 Solid fuels			T2, T3	CS		
2 Oil and Natural gas			T1	D		
2. INDUSTRIAL PROCESSES AND PRODUCT USE						
A. Minerals	T1, T2	D, CS	T1, T2	D, CS	T1, T2	D, CS
B. Chemicals	T1, T2	D, CS	T1, T2	D, CS	T1, T2	D, CS
C Metal Production	T1, T2	D, CS	T1	D	T1	D
D. Other Production						
E. Non energy product use	T1	D	T1	D	T1	D
3. AGRICULTURE						
A. Enteric Fermentation			T2	CS	T1	D
B. Manure Management			T1	D	T1	D
C. Rice Cultivation			T2	CS		
D. Agricultural Soils					T2	CS
F. Field Burning of Agricultural Residues			T1, T2	D, CS	T1, T2	D, CS
4. LAND USE, LAND USE CHANGE AND FORESTRY						
A. Forestland	T2	CS	T2	D	T2	D
B. Cropland	T2	CS				
C.Grassland	T2	CS				
D. Settlement	T2	CS				
5. WASTE						
A. Solid waste disposal on land			T2	D, CS		
B. Waste-water handling			T1, T2	D, CS	T1	D
Memo Item (not accounted in total Emissions)						
International Bunkers	T1	D	T1	D	T1	D
CO_2 from Biomass	T1, T2	D, CS				

T1- Tier 1; T2- Tier 2; T3- Tier 3; CS- Country Specific; D- Default; Tier 1 is a basic method; Tier 2 is an intermediate method and Tier 3 is most demanding method in terms of complexity and data requirements

The present report builds on the methodology adopted for inventory preparation under India's Second National Communication. Sector specific Net Calorific Values have been used for coking, non-coking coal and lignite. Sub-categories 'Brick', 'Fertilizer' and 'Engineering' have also been reported under the category 'Manufacturing Industries' along with 'Ceramics' under IPPU.

2.3.1 Quality Assurance and Quality Control (QA/QC) Procedure

A QA/QC plan was developed, taking into consideration the requirements of maintaining quality of the data, the time constraints and capacity. All expert groups contributing to the preparation of national GHG inventory were provided a QC checklist in line with Table 8.1 of the IPCC GPG, 2000, taking guidance from Table 6.1 and Annex 6A.1 of 2006 IPCC Guidelines. General QA/QC checks for all inventory preparations include cross-checking the reliability of the activity data collected from the secondary sources for proper documentation and record; cross-checking for transcription errors in the activity data; consistency, completeness, and integrity of the database; documentation and reporting of the rationale of assumptions used for activity data; documentation and reporting of gaps in the database; consistency in labeling of units in ensuing calculations; and completeness checks on the reported data sets for designated years. The activity data sources such as the various ministries, industry associations, and the remote sensing agency were, however, not directly approached with the QA/QC list. Sector specific QC approaches were employed by the concerned twelve afore mentioned institutions.

2.4 National Greenhouse Gas Inventory in 2010

In 2010, India emitted 2,136,841.24 Gg of CO_2 eq. (2,136.8 million tonne of CO_2eq) from Energy, IPPU, Agriculture and Waste sectors. LULUCF sector was a net sink in 2010. Considering emissions and removals from LULUCF sector, net emissions for India were 1,884,309.46 Gg of CO_2eq (1,884.3 million tonne of CO_2eq) in 2010. A summary of emissions from these sectors is presented in the Table 2.2. Further details are provided in Table 2.3.

Table 2.2: Greenhouse gas emissions, by sectors, for India in 2010, Gg

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
TOTAL without LULUCF (Gg)	1,574,362.14	-	19,623.15	368.92	-	1.43	2.13	0.58	0.0042	2,136,841.24
TOTAL with LULUCF (Gg)	1,632,623.84	314,586.77	19,776.18	370.79	-	1.43	2.13	0.58	0.0042	1,884,309.46
ENERGY	1,441,882.67	-	2,534.30	48.44	-	-	-	-	-	1,510,120.76
IPPU	132,479.47	-	22.97	8.11	-	1.43	2.13	0.58	0.0042	171,502.87
AGRICULTURE	-	-	14,612.78	268.70	-	-	-	-	-	390,165.14
LULUCF	58,261.70	314,586.77	153.02	1.87	-	-	-	-	-	(252,531.78)
WASTE	-	-	2,453.10	43.67	-	-	-	-	-	65,052.47
Memo Item (not accounted in total Emissions)	589,760.13	-	0.05	0.10	-	-	-	-	-	589,793.42
International Bunkers	3,627.13	-	0.05	0.10	-	-	-	-	-	3,660.42
Aviation	3,281.64	-	0.02	0.09	-	-	-	-	-	3,310.64
Marine	345.49	-	0.03	0.01	-	-	-	-	-	349.77
CO_2 from Biomass	586,133.00									586,133.00

GWP indexed multipliers of CH_4, N_2O, HFC-134a, HFC-23, CF_4, C_2F_6 and SF_6 are 21, 310, 1300, 11700, 6500, 9200, and 23900 respectively.

Share of Sectors and Gases

GHG emissions according to gases and sectors for 2010 inventory are provided in Figure 2.2 and 2.3 respectively. It can be observed that CO_2 emissions dominate the total GHG emissions by accounting for 73.68% of it, followed by CH_4 with 19.3%, N_2O with 5.3% and halogenated gases with 1.7%. When sector-wise emissions are considered, Energy sector dominates by accounting for 71%, followed by Agriculture (18%) and IPPU (8%) and Waste (3%). LULUCF is a net sink and hence is not listed in Figure 2.3.

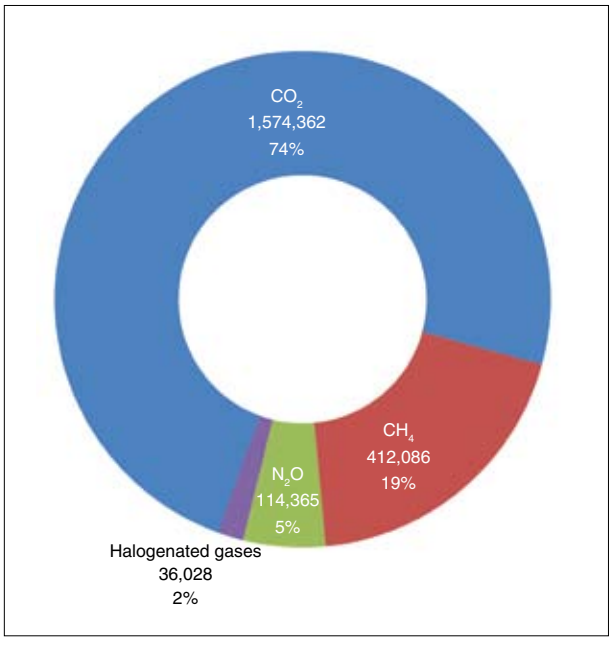


Figure 2.2: Distribution of emissions, by gas, 2010 (values in Gg CO_2eq)

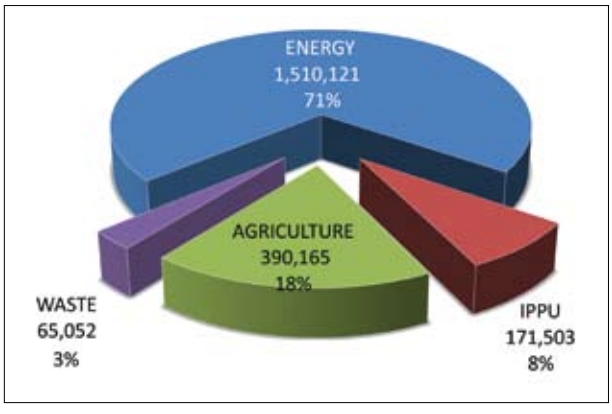


Figure 2.3: GHG emissions, by sector, 2010 (values in Gg CO_2eq)

2.5 Sectoral Description

2.5.1 Energy Sector

Greenhouse gas emissions from the energy sector is estimated to be 1510,120.76 Gg CO_2eq which accounts for 71% of the total national GHG emissions (excluding LULUCF), and 80% of the GHG emissions (including LULUCF) in 2010. Fugitive emissions constituted 3% of the total emissions of the energy sector. Distribution of CO_2eq emissions across energy sector is provided in Figure 2.4.

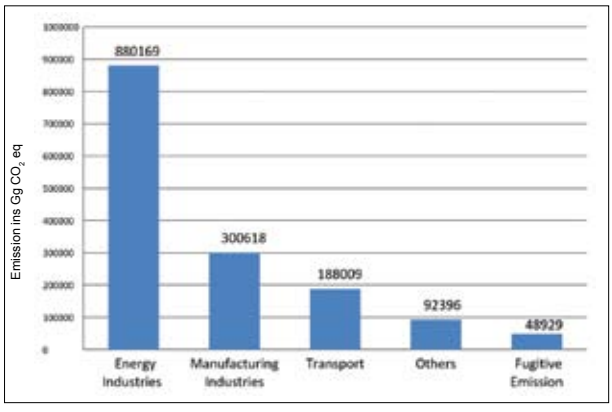


Figure 2.4: Distribution of CO_2eq emissions (Gg) across the energy sector categories in 2010

2.5.2 Industrial Processes and Product Use

Under Industrial Processes and Product Use (IPPU) sector, non-energy greenhouse gas emissions occurring from industrial processes are estimated and reported. The IPPU sector includes the emission estimates of CO_2, CH_4, N_2O, HFC-23, CF_4, C_2F_6, and SF_6 from the following sources:

- Mineral industries — Cement, lime, glass and ceramics.
- Chemicals — Ammonia, nitric acid production, carbide production, titanium dioxide production, methanol production, ethylene, ethylene dichloride (EDC) and vinyl chloride monomer (VCM), ethylene oxide, acrylonitrile, carbon black, soda ash production and caprolactam.
- Metal production — Iron and steel, ferro-alloys production, aluminium, lead, zinc, and magnesium.

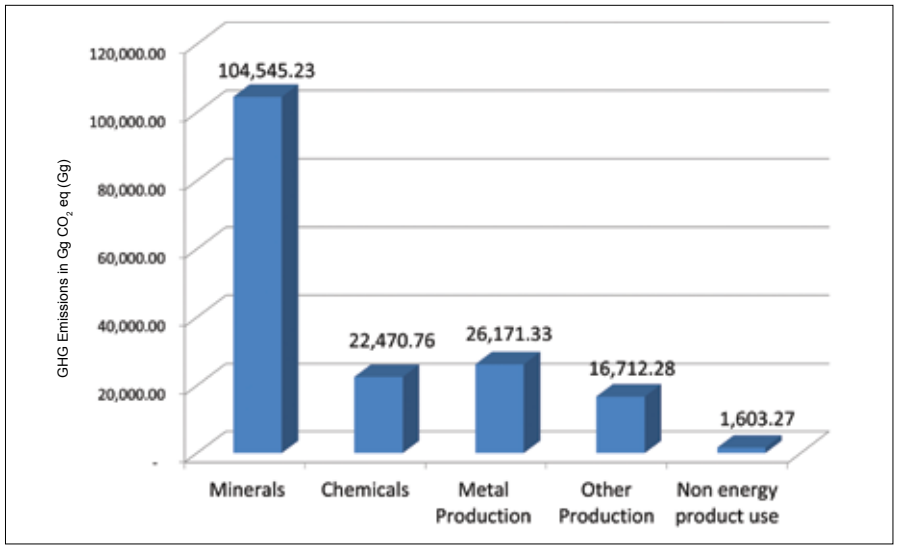


Figure 2.5: Distribution of CO_2eq emissions across categories of IPPU sector in 2010 (Gg)

- Other production — Production of halocarbons HFC-134a and HFC-23 and consumption of SF_6.
- Non-energy product use — Use of lubricants and paraffin wax.

Industrial Processes and Product Use sector emitted 171,502.87 Gg of CO_2eq in the year 2010. Details of emissions from each of the source categories are given in the Figure 2.5. Mineral industries consisting of Cement Production, Lime Production, Glass and Ceramics dominate the GHG emissions in IPPU sector, distantly followed by Metal production and Chemicals.

2.5.3 Agriculture Sector

Agriculture sector is a source of greenhouse gas emissions. For the year 2010, agriculture sector emitted 390,165.14 Gg of CO_2eq GHG emissions, which amounted to 18% of the emissions of India for that year. Mainly methane (CH_4) emission occurs from this sector due to livestock rearing (enteric fermentation and manure management) and rice cultivation. N_2O is also emitted, due to application of fertilizers to the agricultural soils. The sub-sectors of Agriculture that are considered for the GHG emission estimation are:

I. Enteric fermentation in livestock
II. Manure management
III. Rice cultivation
IV. Agricultural soils
V. Field burning of crop residue

Emissions from various sub-sectors of the agriculture sector are illustrated in Figure 2.6. Enteric fermentation dominates by accounting for 227,034 Gg CO_2eq of the emissions, followed by agricultural soils and rice cultivation.

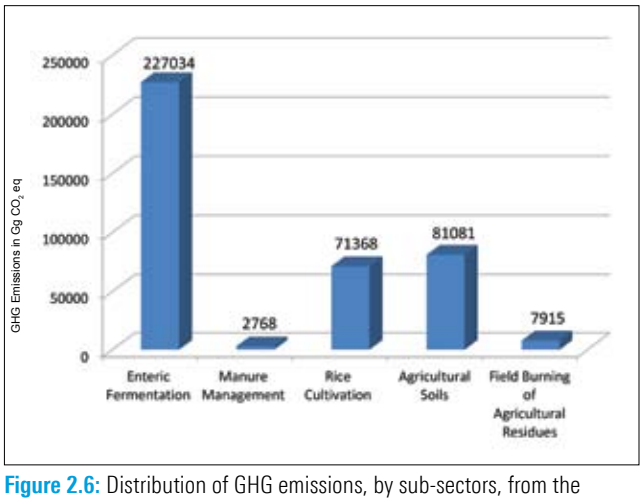


Figure 2.6: Distribution of GHG emissions, by sub-sectors, from the Agriculture Sector in 2010 (Gg)

2.5.4 Land use, Land-use Change and Forestry (LULUCF)

Under the LULUCF sector the following land categories have been considered:

I. Forest Land — all lands, more than 1 ha in area, with tree canopy density of more than 10%;

II. Cropland — includes all croplands and fallow land area;
III. Grasslands (and scrub) — areas covered with grassy and herbaceous growth as well as degraded forests with less than 10% tree canopy density;
IV. Others — includes all non-vegetated areas such as snow, rocky outcrops and surface water bodies; and
V. Settlements — include major built up areas and human habitations-both rural and urban.

Total CO_2 emission and removal estimates for all the land use categories in the LULUCF sector for India, for the year 2010 are presented in Figure 2.7. It can be observed that forestland dominates the CO_2 removal estimates. Forestland and Cropland categories are a net sink of 200,036 Gg CO_2eq and 110,757 Gg CO_2eq respectively. Grassland and Settlements are a net source of CO_2. Thus, LULUCF sector was a net sink of 252,531 Gg CO_2eq in the year 2010. The forest sector is a net sink due to progressive forest conservation policies in India, especially the Forest Conservation Act, 1980, and large afforestation programmes being implemented throughout the country over the years.

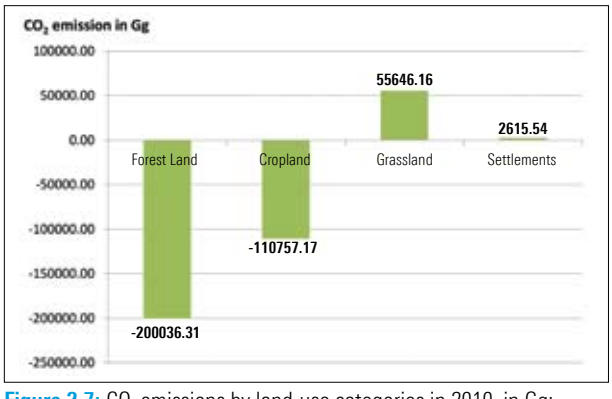


Figure 2.7: CO_2 emissions by land-use categories in 2010, in Gg; negative values indicate net removal and positive sign represents emissions.

2.5.5 Waste

The GHG emissions from the two key sub-sectors of the Waste sector for the year 2010 are shown in Figure 2.8. The Waste sector includes GHG emission estimations from the following categories:

I. Solid waste disposal
II. Waste water treatment and discharge

The total GHG emission in Waste sector for 2010 is estimated to be 65,052.47 Gg CO_2eq, with waste water treatment and discharge being the main source.

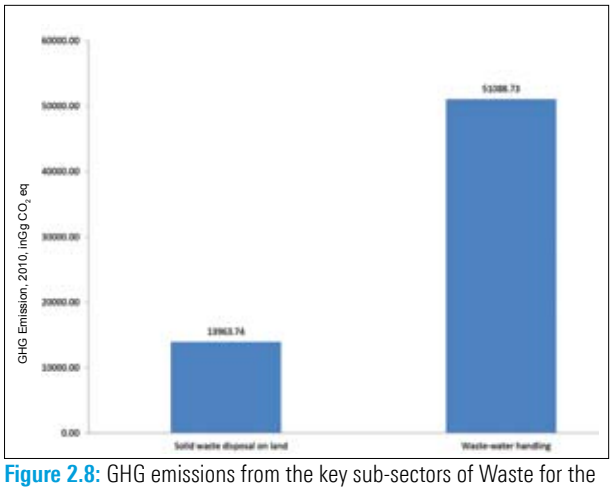


Figure 2.8: GHG emissions from the key sub-sectors of Waste for the year 2010

2.6 Summary of GHG Emission from All Sectors

A detailed break-up of the GHG emissions and removals of the sectors and sub-categories for India in 2010 is presented in Table 2.3. The table lists the sectors and sub-categories for which the GHG emissions and removals are estimated and reported.

Table 2.3: National greenhouse gas inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases (values in Gigagrams)

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
TOTAL without LULUCF (Gg)	**1574362.14**	**0.00**	**19623.15**	**368.92**	**0.00**	**1.43**	**2.13**	**0.58**	**0.0042**	**2136841.24**
TOTAL with LULUCF (Gg)	**1632623.84**	**314586.77**	**19776.18**	**370.79**	**0.00**	**1.43**	**2.13**	**0.58**	**0.0042**	**1884309.46**
1. ENERGY	1441882.67	0.00	2534.30	48.44	0.00	0.00	0.00	0.00	0.00	1510120.76
A. Fuel Combustion Activities	1441882.67	0.00	204.36	48.44	0.00	0.00	0.00	0.00	0.00	1461192.10
1. Energy Industries	876180.80	0.00	11.85	12.06	0.00	0.00	0.00	0.00	0.00	880168.90

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
a. Electricity production	815870.00		9.45	11.68						819690.49
b. Refinery	42191.86		2.20	0.07						42260.97
c.Manufacturing of solid fuel	18118.94		0.20	0.30						18217.44
2. Manufacturing Industries and Construction	299151.88	0.00	5.28	4.37	0.00	0.00	0.00	0.00	0.00	300618.29
a. Cement	40545.03		0.56	0.57						40733.55
b. Iron and steel	95507.80		1.17	1.50						95998.53
c. Nonferrous metals	1857.23		0.02	0.03						1866.59
d. Chemicals	7877.10		0.25	0.08						7905.62
e. Pulp and paper	6723.13		0.07	0.10						6755.85
f. Food and beverages	NE		NE	NE						NE
g. Nonmetallic minerals	NE		NE	NE						NE
h. Mining and quarrying	4298.93		0.17	0.04						4313.44
i. Textile/leather	2514.10		0.05	0.03						2524.78
j. Bricks	1138.93		0.01	0.02						1144.43
k. Fertilizer	5724.40		0.71	0.17						5790.46
l. Engineering Sector	3469.44		0.14	0.03						3480.73
m. Nonspecific Industries	129495.80		2.13	1.82						130104.32
3. Transport	184230.69	0.00	25.51	10.46	0.00	0.00	0.00	0.00	0.00	188008.96
a. Road transport	161503.70		24.77	7.40						164317.87
b. Civil Aviation	12376.90		0.09	0.35						12487.29
c. Railways	6696.10		0.38	2.58						7503.20
d. Navigation	3653.99		0.28	0.13						3700.59
4. Other sectors	82319.31	0.00	161.72	21.55	0.00	0.00	0.00	0.00	0.00	92395.96
a. Commercials/ Institutional	4251.00		8.04	1.08						4753.71
b. Residential	75144.00		152.58	20.42						84678.38
c. Agricultural/ fisheries	2924.31		0.12	0.02						2933.99
d. Biomass burnt for energy			0.98	0.03						29.88
B. Fugitive Emission from fuels	0.00	0.00	2329.94	0.00	0.00	0.00	0.00	0.00	0.00	48928.66
1. Solid fuels	0.00	0.00	772.00	0.00	0.00	0.00	0.00	0.00	0.00	16212.00
a. Above ground mining			474.00							9954.00
b.Underground mining			298.00							6258.00

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
2. Oil and Natural gas	0.00	0.00	1557.94	0.00	0.00	0.00	0.00	0.00	0.00	32716.66
a. Oil			66.29							1392.01
b. Natural gas			1491.03							31311.63
c. Venting and Flaring			0.62							13.02
2. Industrial Processes and Product Use	132479.47	0.00	22.97	8.11	0.00	1.43	2.13	0.58	0.0042	171502.87
A. Minerals	104545.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	104545.23
1. Cement production	83851.74									83851.74
2. Lime production	20132.00									20132.00
3. Limestone and Dolomite Use										0.00
4. Ceramics	7.50									7.50
5. Glass	553.99									553.99
B. Chemicals	19506.71	0.00	21.46	8.11	0.00	0.00	0.00	0.00	0.00	22470.76
1 Ammonia production	12602.12									12602.12
2 Nitric acid production				7.00						2170.29
3. Carbide production	42.93									42.93
4. Titanium dioxide production	87.73									87.73
5. Methanol production	243.62		0.84							261.26
6. Ethylene production	5054.66		7.88							5220.14
7. EDC and VCM production	286.26									286.26
8. Ethylene Oxide production	139.37		0.29							145.46
9. Acrylonitrile production	30.22		0.01							30.37
10.Carbon Black production	296.72		12.44							557.96
11. Caprolactam				1.11						343.17
12. Soda ash Production	723.08									723.08
C Metal Production	6824.27	0.00	1.52	0.00	0.00	0.00	2.13	0.58	0.0042	26171.33
1. Iron and Steel production	IE*									IE
2. Ferroalloys production	3684.93		1.52							3716.75
3. Aluminium production	3076.81						2.13	0.58		22291.68

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
4. Lead production	28.92									28.92
5. Zinc production	33.61									33.61
6. Magnesium Production									0.0042	100.38
D. Other Production	0.00	0.00	0.00	0.00	0.00	1.43	0.00	0.00	0.00	16712.28
1.Production of halocarbons						1.43				16712.28
2. Consumption of SF_6					NE	NE				NE
E. Non energy product use	1603.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1603.27
1. Lubricant	1448.35									1448.35
2. Paraffin wax	154.92									154.92
3. AGRICULTURE	0.00	0.00	14612.78	268.70	0.00	0.00	0.00	0.00	0.00	390165.14
A. Enteric Fermentation			10811.12							227033.52
B. Manure Management			130.60	0.08						2768.11
C. Rice Cultivation			3398.47							71367.95
D. Agricultural Soils				261.55						81080.50
Direct N_2O Emissions				216.68						67170.80
Indirect N_2O Emissions				44.87						13909.70
F. Field Burning of Agricultural Residues			272.59	7.07						7915.06
4. LULUCF	58261.70	314586.77	153.02	1.87	0.00	0.00	0.00	0.00	0.00	-252531.78
A. Forest Land		203829.60	153.02	1.87						-200036.31
B. Cropland		110757.17								-110757.17
C. Grassland	55646.16									55646.16
D. Settlements	2615.54									2615.54
5. WASTE	0.00000	0.0000	2453.10	43.67	0.00	0.00	0.00	0.00	0.00	65052.47
A. Solid waste disposal on land	0.00	0.00	664.94	0.00	0.00	0.00	0.00	0.00	0.00	13963.74
1. Managed Waste Disposal on Land			664.94							13963.74
B. Waste-water handling	0.00	0.00	1788.16	43.67	0.00	0.00	0.00	0.00	0.00	51088.73
1. Industrial Wastewater			1033.87							21711.30
2. Domestic and Commercial Waste Water			754.29	43.67						29377.43
Memo Item (not accounted in total Emissions)	589760.13	0.00	0.05	0.10	0.00	0.00	0.00	0.00	0.00	589793.42

	CO_2 emission	CO_2 removal	CH_4	N_2O	HFC-134a	HFC 23	CF_4	C_2F_6	SF_6	CO_2 equivalent
International Bunkers	3627.13	0.00	0.05	0.10	0.00	0.00	0.00	0.00	0.00	3660.42
Aviation	3281.64		0.02	0.09						3310.64
Marine	345.49		0.03	0.01						349.77
CO_2 from Biomass	586,133.00									586,133.00
GWP indexed multipliers of CH_4, N_2O, HFC-134a, HFC-23, CF_4, C_2F_6 and SF_6 are 21, 310, 1300, 11700, 6500, 9200, and 23900 **Included elsewhere- under Source Category-Energy*										

2.7 Trends in GHG Emissions during 2000 to 2010

Trends in GHG emissions are calculated and presented for the period 2000 to 2010 in Figure 2.9. It can be observed that GHG emissions (including LULUCF) increased from 1,301.2 Mt CO_2eq in 2000 to 1,884.3 Mt CO_2eq during 2010, an increase of 583.1 Mt CO_2eq during the 10 year period. LULUCF sector remained a sink of GHG emissions over this period. GDP of the country roughly doubled and the population increased by about 18% during this period.

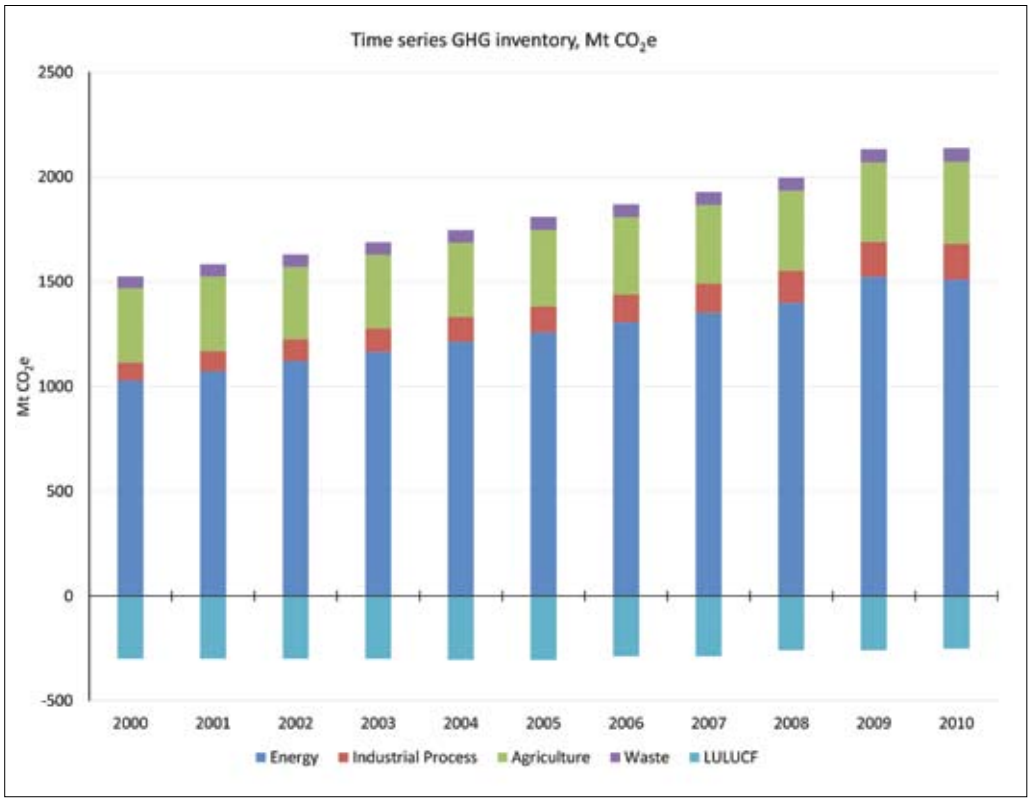


Figure 2.9: Time series of GHG Inventory (2000-2010)

* * *

Chapter 3

Mitigation Actions

Mitigation Actions

This chapter provides information on actions to mitigate anthropogenic emissions in India by sources and removals by sinks of all GHGs not controlled by the Montreal Protocol. The information on mitigation actions and their effects have been documented, to the extent possible, following the guidelines on BUR, including the associated methodologies and assumptions. Wherever possible, information on steps taken or envisaged to achieve mitigation is reported. However, there are capacity building needs in reporting mitigation actions. These are highlighted in this document at various places.

The chapter provides an update on major sustainable development activities and mitigation actions reported under the Second National Communication. It includes, in accordance with Article 12, paragraph 1(b) of the UNFCCC, the steps taken or envisaged by India to implement the Convention, taking into account the specific national development priorities, objectives, and circumstances. The chapter outlines India's commitment to address the challenges of climate change through its National Action Plan on Climate Change (NAPCC), following the underlying framework of sustainable development. It highlights, to the extent possible a range of climate-friendly measures initiated by India till March 2015 that promote sustainable development and mitigate climate change as co-benefit of their implementation. Some of these actions taken are supported by international mechanisms such as CDM. A description on CDM projects is provided in section 4.2.2 of this report.

3.1 Voluntary Pledge

As deliberated in chapter 2, the quantum of India's total GHG emissions (including LULUCF) in 2010 was 1,884,309 Gg CO_2eq which is far lower than GHG emissions of China, USA, and the EU. India's per capita GHG emission in 2010 was 1.56 metric tonnes CO_2eq which is less than one-third of the world's per capita emissions.

In accordance with the provisions of Article 12, paragraphs 1(b) and 4, and Article 10, paragraph 2(a), of the Convention, India communicated its voluntary pledge to reduce the emissions intensity of its GDP by 20–25 per cent by 2020 compared with the 2005 level. Emissions from the agriculture sector would not form part of the

assessment of its emissions intensity. India stated that the proposed domestic actions are voluntary in nature and will not have a legally binding character. It added that these actions will be implemented in accordance with the provisions of relevant national legislation and policies, as well as the principles and provisions of the Convention, in particular Article 4, paragraph 7[3] .

Emission intensity of India

India's voluntary pledge to UNFCCC is a 20-25% reduction in GHG emissions intensity (excluding emissions from agriculture) of Indian GDP by 2020 from 2005 levels. The emission intensity of GDP was 35.14 kg CO_2eq/₹1,000 (at constant 2004-05 prices) in 2005, which declined to 31.01 kg CO_2eq/₹1,000 (at 2004-2005 prices) in 2010. Both these emission intensities have been calculated excluding emissions from agriculture. This registers a reduction of about 12% over a five-year period of 2005-2010. India's emissions would have risen to significantly higher levels in the absence of actions that fulfill the voluntary pledge of reducing emission intensity of GDP.

3.2 National Action Plan on Climate Change

The National Action Plan on Climate Change (NAPCC) was launched in 2008 in order to address climate change concerns and to promote sustainable development. There are eight National Missions, which form the core of the NAPCC, representing "multi-pronged, long-term and integrated strategies for achieving key goals in the context of climate change". This underscores the fact that several of the programmes enumerated under the NAPCC are already being undertaken under various schemes/

[3]FCCC/AWGLCA/2011/INF.1

programmes of Government of India (GoI), but in the present context would require a change in "direction, enhancement of scope and accelerated implementation". Implementation of NAPCC would require appropriate institutional mechanisms. Details of NAPCC missions are given in Table 3.2 and in the text below. Some of the missions have focus on mitigation and others have adaptation as the main objective.

Jawaharlal Nehru National Solar Mission: National Solar Mission was launched by the Government of India on 11th January 2010. The objective of National Solar Mission is to establish India as a global leader in solar energy, by creating the policy conditions for its rapid diffusion across the country and achieve a scale to drive down costs to levels required to achieve grid parity as soon as possible.

Solar power in India is poised to grow significantly with Solar Mission as a major initiative of the Government of India. The ambitious solar expansion programme seeks to enhance the capacity to 100 GW by 2022 subject to financial support including international financial and technological support. A scheme for development of 25 solar parks, ultra mega solar power projects, canal top solar projects, providing one hundred thousand solar pumps for farmers, and deployment of 20 million solar lights by 2022 is under implementation. Government of India is also promoting solar installations in some 55,000 petrol pumps across the country of which installations have been completed in around 3,135 petrol pumps. Government of India is creating favourable conditions for developing solar manufacturing capability in the country.

As of 31st March 2015, a total grid connected solar power capacity of 3743.97 MW was commissioned (Table 3.1)

National Mission for Enhanced Energy Efficiency (NMEEE): The Mission seeks to enhance efforts to unlock the energy efficiency market on a Public Private Partnership (PPP) basis so as to result in a total avoided capacity addition of 19,598 MW by 2017. Under it, specific energy consumption targets have been set for 478 designated consumers across eight sectors. Under the Market Transformation for Energy Efficiency, BEE has framed standards and verification-based incentive structure to create super-efficient fans.

Table 3.1: National Solar Mission — targets and achievements

Application Segment	Target for Phase I (2010-13)	Achievement of Phase-I	Achievement till 31-03-2015
Grid solar power (large plants, roof top and distribution grid plants)	1,100 MW	1686.44 MW	3743.97 MW
Off-grid solar applications	200 MW	252.5 MW	362.18 MW
Solar thermal collectors (*e.g.* SWHs, solar cooking/cooling, industrial process heat applications)	7 million sq. meters	7.01 million sq. meters	8.872 million sq. meters (approx)

National Mission on Sustainable Habitat (NMSH): This mission promotes sustainable cities, including energy-efficient buildings and local government adoption of ECBC, and other efficiency measures. The programme aims to transform the design of new construction and major retrofits of commercial and high-rise residential buildings to optimize their energy efficiency. It is estimated that, in overall terms, the implementation of energy efficiency measures would help in achieving about 30% energy savings in new residential buildings, and 40% in new commercial buildings. In the case of existing buildings, these estimates are about 20% and 30%, respectively. NMSH identifies the Bachat Lamp Yojana model as an effective mechanism to promote energy efficiency in buildings. A comprehensive implementation of this plan could translate into a demand reduction of 10,000 MW.

National Water Mission (NWM): The main identified goals of the mission are: development of a water database in the public domain, particularly regarding the assessment of the impact of climate change on water resources; promoting water conservation, augmentation and preservation, focusing attention on over-exploited areas from water use perspective; increasing water use efficiency by 20% through regulatory mechanisms; promoting basin level integrated water resource management. National Water Mission has proposed studies which would help in downscaling the global circulation models/regional models to basin-wise scale. The models will be downscaled to a finer spatial scale to assess the likely impacts of climate change on water resource scenarios in 20 major river basins of the country. These studies shall be specially designed to assist in mitigation and adaptation of water resources in relation to climate change.

National Mission on Green India: The Mission aims at responding to climate change by a combination of adaptation and mitigation measures, which would help — enhancing carbon sinks in sustainably managed forests and other ecosystems; adaptation of vulnerable species/ ecosystems to the changing climate; and adaptation of forest-dependant communities.

National Mission on Sustaining Himalayan Ecosystem (NMSHE): It identifies the importance of continuity and enhancing the monitoring of the Himalayan eco-system, in particular the state of glaciers and the impact of changes in the glacial mass on river flows. The broad objectives of NMSHE include: understanding of the complex processes affecting the Himalayan ecosystem and evolving suitable management and policy measures for sustaining and safeguarding the Himalayan ecosystem; creating and building capacities in different domains, networking of knowledge institutions engaged in research and development of a coherent database on Himalayan ecosystem; detecting and decoupling natural and anthropogenic signals of global environmental changes in mountain ecosystems; studying traditional knowledge systems for community participation in adaptation, mitigation, and coping mechanisms inclusive of farming and traditional healthcare systems; developing regional cooperation with neighboring countries; to generate a strong database through monitoring and analysis to eventually create a knowledge base for policy interventions. These measures are over and above the specific measures/strategies identified in The National Environment Policy 2006.

National Mission on Sustainable Agriculture (NMSA): The Mission was launched with four focus areas. Firstly, the Mission recognizes the need for enhancing agricultural productivity by identifying the enormous growth potential of dryland agriculture in the country (farm-based livelihoods included). Secondly, the focus is on mitigating risks due to extreme climatic events on agriculture. Thirdly, the mission focuses on developing adequate systems and processes so as to provide customized information to farmers to boost farm productivity and farm incomes. Finally, the mission envisions using biotechnology in agriculture (relating to various themes such as drought proofing, advantageous use of elevated CO_2 concentrations, increasing yields and increased resistance to pests and diseases) so as to improve agricultural productivity and also provide livelihood security to millions.

National Mission on Strategic Knowledge for Climate Change (NMSKCC): The NMSKCC has been launched with the broad objectives of mapping of the knowledge and data sources relevant to climate change, and positioning of a data sharing policy framework for building a strategic knowledge network among the various arms of the government. The focus of the mission is on identification of knowledge gaps and formation of global technology watch groups to accomplish the task of technology selection and prioritization; networking of knowledge institutions, after investing critical mass of physical, intellectual and policy infrastructure resources; creation of new dedicated centers within the existing institutional framework; building international cooperation for science and technology for climate change agenda through strategic alliances and assistance in the formulation of

policies for a sustained developmental agenda within a responsive climate change framework with inputs to the Ministry of Environment, Forest and Climate Change and the Ministry of External Affairs.

In addition to aforementioned national missions, the national action plan also mentions 'other initiatives' such as GHG mitigation in power generation by use of supercritical technology, Integrated Gasification Combined Cycle Technology, Closed Cycle Three Stage Nuclear Power Programme, efficient T&D, hydro power and other renewable energy technologies.

Table 3.2: National Missions under the NAPCC — objectives and targets

S.N.	Mission	Some key objectives	Goals and Targets	Outlay
1	Jawaharlal Nehru National Solar Mission	To establish India as a global leader in solar energy by creating the policy conditions for its diffusion across the country as quickly as possible	• The cumulative targets stand upscaled to 100 GW by 2022. • Favourable conditions for solar manufacturing capabilities • 20 million solar lighting systems for rural areas by 2022	To be implemented in three stages. Budgetary allocation for the twelfth five year plan (2012-2017) is ₹8795 crore (approx. US$ 1.4 billion). Enhanced funding imperative for upscaled targets.
2	National Mission on Sustainable Habitat	• Promoting energy efficiency in residential and commercial sectors • Urban planning/Shift to public transport: Long-term transport plans for small/medium cities • Recycling of material and urban waste management: power from waste	• Increasing energy efficiency in buildings: building bye laws and standards, energy performance monitoring, national standards for construction and recycling of construction waste • Urban transport: norms integrating congestion charges, parking, norms for pedestrian and cycling, integrating transport planning with spatial planning • Water supply: mandatory rainwater harvesting, water and energy audits	The total funding requirement assessed for the 12th five year plan period (2012-2017) is ₹ 950 crore (approx. US$ 153 million).
3	National Mission on Green India	• To increase forest/tree cover to the extent of 5 million hectares (Mha) and improve quality of forest/tree cover on another 5 Mha of forest/non-forest lands; • To improve eco-system services like carbon sequestration • To increase forest based livelihood income of about 3 million households. • Enhanced annual CO_2 sequestration by 50-60 million tonnes in the year 2020	• Qualitative improvement of forest cover/ ecosystem in moderately dense forests (1.5 Mha), open degraded forests (3 Mha) , degraded grassland (0.4 Mha) and wetlands (0.1 Mha); • Eco-restoration/afforestation of scrub, shifting cultivation areas, cold deserts, mangroves, ravines and abandoned mining areas (1.8 Mha); • Bringing urban/ peri-urban lands under forest and tree cover (0.20 Mha); and • Agro-forestry /social forestry (3 Mha). • Improvement of forest- based livelihoods for about 3 million households living in and around forests.	The total mission cost is estimated to be ₹ 46,000 crore (approx. US$ 7.4 billion). Funding of ₹ 13,000 crore (approx. US$ 2.1 billion) has been approved for implementation of various activities under the mission.
4	National Mission on Sustaining Himalayan Ecosystem	• To develop in a time bound manner asustainable National capacity to continuously assess the health status of the Himalayan Ecosystem and enable policy bodies in their policy-formulationfunctions and assist States in the Indian Himalayan Region with their implementation of actions selected for sustainable development.	• Continuous Monitoring of the Eco-system and Data Generation. • Glaciology Research • Generation of Bio-Geo Database & Ecological Modeling For Himalayas • Prediction of Socio-Economic and Climate Change Scenarios • Vulnerability Assessment • Identification of desirable Adaptation Policies to Improve Regional Sustainability • Sustainable forestry • Strengthening of Regional Cooperation • Enhanced implementation of guidelines for Priority Action in the National Mission on Sustaining the Himalayan Ecosystem	The total funding requirement for 2010 to 2017 is ₹ 1,695 crore (approx. US$ 273 million). Proposals for ₹ 500 crore (approx. US$ 81 million) have been approved.
5	National Mission on Enhanced Energy Efficiency	• To upscale the effort to unlock the market for energy efficiency • Cumulative avoided electricity capacity addition of 19,598 MW	• Specific Energy Consumption (SEC) reduction targets for energy-intensive units • Incentivizing action through Energy Savings Certificates (ESCerts) - Traded and Used for compliance • National Energy Efficiency CDM Roadmap • National Energy Efficiency Financing Platform • Creating markets for energy efficient products and services	The total outlay for the 12th five year plan period (2012-2017) is ₹ 775 crore (approx. US$ 118 million).

S.N.	Mission	Some key objectives	Goals and Targets	Outlay
6	National Water Mission	Conservation of water, minimising wastage and ensuring its more equitable distribution both across and within states through integrated water resources development and management	• Goal I: Comprehensive water database in public domain and assessment of impact of climate change on water resource. • Goal II: Promotion of citizen and state action for water conservation, augmentation and preservation. • Goal III: Focused attention to vulnerable areas including overexploited areas. • Goal IV: increasing water use efficiency by 20% • Goal V: Promotion of basin level integrated water resources management.	The mission requires budgetary support of ₹ 89,101 crore (approx. US$ 14.4 billion) during the 11th (2007-2012) and 12th (2012-2017) five year plan periods. Proposals for ₹ 196 crore (approx. US$ 31.6 million) have been approved.
7	National Mission on Sustainable Agriculture	• To make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific integrated/composite farming systems; • To conserve natural resources through appropriate soil and moisture conservation measures; • To adopt comprehensive soil health management • To optimize utilization of water resources • To develop capacity of farmers and stakeholders	• Conservation Agriculture • On Farm Water Management • Varietal Improvement • Integrated Nutrient/Pest Management • Integrated farming system • Improved Crop, Seeds, Livestock and Fish • Water Use Efficiency • Improved Farm practices • Agricultural Insurance Credit Support • Access to information and livelihood diversification	The mission requires budgetary support of ₹ 1,08,000 crore (approx. US$ 17.4 billion) upto the end of 12th five year plan period (2012-2017). ₹ 13,034 crore (approx. US$ 2.1 billion) have been allocated.
8	National Mission on Strategic Knowledge on Climate Change	• Network of Institutions • Promotion of climate science research • Data sharing among various arms of government • Building human and institutional capacity: filling knowledge gaps in modeling and technology	• Climate change research and fellowship programme • Climate change Professor Chairs • Network of Climate Change research institutes and scientists	The total funding requirement for the 12th five year plan period (2012-2017) is ₹2,500 crore (approx. US$ 403 million). The allocations to undertake these mission activities will be met out of the budget allocation of the existing scheme of the Department of Science and Technology, Government of India.

3.2.1 State Action Plans on Climate Change

As a second step, after the National Action Plan on Climate Change (NAPCC) was announced, all States were asked to prepare their State level action plan to deal with the challenges of climate change. Broadly, the State level action plans are envisioned to be an extension of the NAPCC at various levels of governance, aligned with the eight National Missions. So far, 27 States and 5 Union territories (UTs) namely, Andaman and Nicobar Islands, Andhra Pradesh including Telangana, Arunachal Pradesh, Assam, Bihar, Chandigarh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Kerala, Karnataka, Lakshadweep, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Odisha, Puducherry, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttarakhand, Uttar Pradesh and West Bengal have submitted their SAPCCs. Other states and UTs are in the process of finalizing the State Action Plans.

Subsequent sections discuss some important sectoral policies.

3.3 Mitigation Actions in Energy Sector

3.3.1 Energy Sector Policies and Measures

Energy Conservation (Amendment) Act, 2010

The ***Energy Conservation Act, 2001*** provides the regulatory, legal and institutional framework for promoting and implementing energy efficiency measures. Some of the major provisions of the Act include Standard and Labeling of Appliances, Energy Conservation Building Codes, setting up of BEE and Establishment of Energy Conservation Fund.

The Energy Conservation (Amendment) Act, 2010

was introduced by making amendment in The Energy Conservation Act, 2001 to look after all the matters related to the efficient use of energy and its conservation.

The main amendments are as follows:

- The Central Government may issue the energy savings certificate to the designated consumer whose energy consumption is less than the prescribed norms and standards in accordance with the procedure as may be prescribed.
- The designated consumer whose energy consumption is more than the prescribed norms and standards shall be entitled to purchase the energy savings certificate to comply with the prescribed norms and standards.
- The Central Government may, in consultation with the BEE, prescribe the value of per metric tonne of oil equivalent of energy consumed.
- Commercial buildings which are having a connected load of 100 kW or contract demand of 120 kVA and above come under the purview of ECBC under EC Act.

The ***Electricity Act, 2003*** as amended in 2007 provides legal framework across various components of the electricity sector and enables India to undertake rural electrification through decentralized generation using mainly the renewable energy resources.

3.3.2 Integrated Energy Policy

Union government approved Integrated Energy Policy in December, 2008. It is a comprehensive and significant policy, aimed at matching energy supply and demand across all sectors. It includes provisions for promoting renewable energy, exploring alternative technologies, increasing energy efficiency, along with necessary fiscal and pricing mechanisms. The policy envisages a competitive energy market with market determined energy pricing, instead of the price determination by the government.

3.3.3 The 12th Five Year Plan

India is presently engaged with the 12th Five Year Plan (2012-2017), which has laid down a detailed agenda for sustainable development. Relevant highlights are given below:

- Government of India has taken the initiative of facilitating the development of Ultra Mega Power Projects of about 4,000 MW capacity each under tariff based competitive bidding route. The successful bidder is identified on the basis of the lowest levellised tariff. Objective is to achieve faster capacity addition and reduce the cost of power based on economy of scale. The projects represent large point emission sources which are more amenable to mitigation through technology interventions. The Ultra Mega Power Projects would use Super Critical Technology with a view to achieve higher levels of fuel efficiency, resulting in fuel saving and lower greenhouse gas emissions.
- Adoption of supercritical technology is an important shift towards energy efficiency. The super-criticality of the power plants has been incrementally increased to improve mitigation. Early vintage plants used conventional steam temperature of 540°C, while new projects are considering above 600°C temperatures. Total of 53,310 MW coal-based capacity was added in the first three years of the 12th Plan period. Out of this, 21,405 MW capacity is supercritical technology based. In the last two years of 12th Plan, 29,285 MW coal based capacity addition is envisaged. Out of 29,285 MW envisaged coal-based capacity, 11,045 MW will be based on supercritical technology.
- Super-Efficient Equipment Programme (SEEP) for superefficient fans, LED bulbs and tube lights, to incentivize the sale of these products to increase their volumes and bring down their prices for large-scale adoption. It is proposed to provide the performance standards for each of the super-efficient devices before the start of the programme. The SEEP for lights and fans could result in savings of 6.06 billion units per year by 2016-17, and help offset an installed capacity of 1500 MW during the 12th Five Year Plan period.

The 12th Five Year Plan proposes setting up a National Wind Energy Mission, similar to the mission for solar energy. This mission would include incentives for design, manufacture and installation of turbines, land tenure policies encouraging mixed land use for wind generation and agriculture, approaches for feed-in tariff through independent regulator and mechanisms for using the National Clean Energy Fund (NCEF) to finance development of local grids by state utilities and distribution companies.

3.3.4 Clean Coal Technology Initiative

Coal based power as of now accounts for about 60.6% (164.6 GW as on 31st March 2015) of India's installed capacity. In order to secure reliable, adequate and

affordable supply of electricity, coal will continue to dominate power generation in future. Government of India has already taken several initiatives to improve the efficiency of coal based power plants and to reduce their carbon footprint. All new, large coal-based generating stations have been mandated to use the highly efficient supercritical technology. Renovation and Modernisation (R&M) and Life Extension (LE) of existing old power stations are being undertaken in a phased manner. Around 144 old thermal stations have been assigned mandatory targets for improving energy efficiency. Coal beneficiation has been made mandatory. Introduction of ultra-supercritical technology, as and when commercially available, is part of future policy. Besides, stringent emission standards being contemplated for thermal plants would significantly reduce emissions.

Realizing the importance of coal as a key primary source for Indian economy as well as the commitment of the Government of India to environment, development of advanced coal technologies which could be used for next generation power plants is being promoted. Early initiatives date back to the 1980s much before climate concerns emerged. The development efforts were also focussed on the fact that Indian coals characterise uniquely in terms of high ash content and burning profile. Alternate energy conversion approaches of fluidized bed combustion and gasification have been investigated in pilot plants while large number of equipment efficiency enhancement programmes has been a regular feature.

IGCC Initiative

The alternate coal energy conversion approach of using integrated gasification combined cycle (IGCC) has been investigated. An Indian domestic manufacturer has also set-up a 6.2 MW demonstration plant at its Trichy boiler works. NTPC Limited, the Indian power major, also carried out a feasibility study for a 100 MW plant. Testing of Indian coals in different types of gasifiers has been a highlight. Further work is required to develop gasifiers suited to Indian coals.

Supercritical Fleet

Thermal power stations based on present-day subcritical technology have efficiency of about 35% (depending on coal used). Supercritical technology reduces the use of coal per unit of electricity produced. Supercritical power plants operate at steam conditions of around 565/593°C, 247kg/cm^2 with improved heat rate compared to sub-critical power plants. The increased thermal efficiency results in

emission reduction to the tune of 3-10% depending upon the steam parameters selected. Supercritical technology is now mature and is only marginally more expensive than sub-critical power plants. To improve energy efficiency of the coal based power plants and reduce the GHG emissions, it is envisaged that 2017 onwards new thermal power plants will be based mainly on supercritical technology. Already, 40 supercritical units with a total capacity of 27,485 MW have been installed and 50,725 MW of supercritical capacity is under construction.

Advanced USC Technology

A consortium of Indian industries BHEL, NTPC and IGCAR (Indira Gandhi Centre for Atomic Research) has been formed under the aegis of Principal Scientific Adviser to the Government of India for development of power plant technology having steam parameters of about 310 kg/cm^2- 710^{0}C/ 720^{0}C. The programme targets an 800 MW unit demonstration plant which will be the world's first in this league. The efficiency of the plant will be 46% and will result in emission reduction of almost 20% compared to conventional sub-critical plant.

3.3.5 Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY)

This is a flagship programme of the Ministry of Power and was launched in 2014 with the aim of electrifying the un-electrified villages and providing free electricity connections to rural Below Poverty Line (BPL) households. Rural electrification and universal access to electricity is one of the most important goals of the government. The earlier scheme for rural electrification viz. Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) has been subsumed in the new scheme as its rural electrification component. According to a survey conducted by National Sample Survey Office (NSSO) in 2010, the percentage of rural households with access to electricity has gone up

from 55% in 2005 to 67% in 2010. DDUGJY is a critical programme in improving the access to electricity in rural households. The scheme aims for separate agriculture and non-agriculture feeders and augmentation of rural electricity distribution system.

3.3.6 Integrated Power Development Scheme (IPDS)

The scheme was launched in December 2014 and covers urban areas under distribution utilities in India. The scheme has following components:

i. Strengthening of sub-transmission and distribution networks in the urban areas, including provisioning of solar panels.

ii. Metering of feeders/distribution transformers/ consumers, including prepaid/smart meters in government establishments and Advance Metering Infrastructure (AMI), smart meters in SCADA towns (under R-APDRP).

iii. IT enablement and distribution strengthening work under R-APDRP (approved outlay of ₹44,011 crores, budgetary support of ₹22,727 crores for 12th and 13th plan carried forward to IPDS).

Accelerated Power Development and Reform Programme (APDRP) was launched in 2003 to address the problems of distribution system by financing the modernization of sub-transmission and distribution networks with the objective to reduce aggregate technical and commercial (AT&C) losses to 15%. A re-structured APDRP (R-APDRP) was launched in 2008 with a focus on actual, demonstrable performance in terms of AT&C loss reduction. The programme is subsumed in the IPDS. The IPDS is under implementation in several states. Power Finance Corporation (PFC) is the Nodal Agency for the scheme.

3.3.7 National Clean Energy Fund (NCEF) 2010

Government of India has set up a NCEF by imposing a cess on coal. A statutory cess rate of ₹100 per tonne for coal, lignite and peat was prescribed by the Tenth Schedule of the Finance Act, 2010. Effective rate of cess was ₹50 per tonne. With effect from July 2014, the rate of cess was increased to ₹100 per tonne. In the Union Budget of 2015-16 the cess has been raised to ₹200/ metric tonne.

The amount of clean energy cess collected/accrued in the last few years is given in Table 3.3.

The NCEF will support projects, programmes and policies that promote clean energy technologies. This fund will be used to establish a focused investment vehicle for companies investing in green technology, and environmentally supportive enterprises.

3.3.8 Renewable Energy

Government of India has increased the overall renewable energy capacity target by about five times from 35,776.96 MW (as of 31st March 2015) to 175,000 MW by 2022.

Target of renewable energy capacity was revised upwards in Union Budget of 2015-16 to 175,000 MW till 2022, comprising 100,000 MW Solar, 60,000 MW Wind, 10,000 MW Biomass and 5,000 MW Small Hydro.

Ministry of New and Renewable Energy (MNRE) has established numerous programmes to promote clean energy supply and use in rural areas. Some notable programmes include: (i) grid connected and stand-alone power generation from small hydro, wind, solar, biomass, and industrial/urban wastes; (ii) rural energy programmes such as electrification of remote villages, biogas, and

Table 3.3: Amount of clean energy cess collected

Financial Year	Amount of Clean Energy Cess collected (crore₹)	Amount transferred to NCEF (crore₹)	Amount financed from NCEF for projects (crore₹)	
			For all projects	For National Renewable Energy Projects (out of finance for all projects)
2010-11	1066.46	0.00	0.00	0.00
2011-12	2579.55	1066.46	220.75	160.80
2012-13	3053.19	1500.00	236.43	125.80
2013-14	3527.75	1650.00	1313.16	1313.16
2014-15 (Provisional)	6857.50	2350.00	1578.00	1578.00

improved cook-stoves; (iii) decentralized solar energy applications such as thermal water heaters, solar photovoltaic applications for lighting and water pumping; (iv) integrated rural energy programme (IREP). MNRE also promotes research, development, and demonstration programmes in new technologies, such as geothermal, hydrogen energy, fuel cells and alternative fuels for surface transport.

Renewable Purchase Obligations (RPO)

Pursuant to the section 86 (1) (e) of the Electricity Act, the State Electricity Regulatory Commissions (SERCs) have issued RPO regulations specifying share of renewable energy in the electricity mix. Further, in order to assist in meeting RPO, the Central Electricity Regulatory Commission (CERC) has notified the Renewable Energy Certificates (RECs) mechanism and almost all SERCs have notified follow up regulations enabling the obligated entities to purchase RECs to meet their RPO. All states, except Sikkim, have specified overall RPO targets with separate solar RPO. The RPO specified by SERCs are not uniform across the states, it varies from 1 per cent in case of Meghalaya to 10.25 per cent in case of Himachal Pradesh and Karnataka for the year 2013-14. Similarly the solar RPO varies from 0.05 per cent in case of Uttarakhand to 1 per cent in case of Gujarat, Rajasthan and Uttar Pradesh. Further, most of the states have not specified long-term RPO trajectory. While the Technical Document of National Action Plan on Climate Change (NAPCC) recommended Renewable Portfolio Standard (RPS) of 15% by 2020, the State Electricity Regulatory Commissions (SERCs) have set year-wise targets in their respective states.

Renewable Energy Certificate (REC)

The Central Electricity Regulatory Commission (CERC) has notified Terms and Conditions for the recognition and issuance of Renewable Energy Certificate (REC) for Renewable Energy Generation Regulations 2010. The framework is expected to give a push to renewable energy capacity addition in the country. The REC is a market-based instrument to promote renewable energy and facilitate renewable purchase obligations (RPOs). It can make the renewable electricity market stable and predictable by maximizing the benefits of renewable energy generation while reducing costs. It could also be used by those States that do not have substantial renewable energy resources to meet their RPOs. The CERC and SERCs have created the necessary regulatory and institutional framework and rolled out the scheme from November 2010. The REC mechanism sets the way forward for encouraging competition and eventually mainstreaming renewable energy.

3.3.9 Civil Nuclear Power Programme

India pursues a unique sequential three-stage nuclear power programme aimed at optimal utilisation of Indian nuclear resources of modest uranium and abundant thorium to provide the country energy security in the long term in a sustainable manner. Large capacity reactors based on foreign cooperation have also been introduced as additional ties to the indigenous three-stage programme for faster capacity addition to meet the huge and growing electricity demand.

Currently, Nuclear Power Corporation of India Ltd. (NPCIL) is operating 21 nuclear power reactors with an installed capacity of 5780 MW at seven different sites. These include 18 Pressurised Heavy Water Reactors (PHWRs), two Boiling Water Reactors (BWRs) at Tarapur and one Pressurised Water Reactor (PWR) at Kudankulam. From these reactors, during the year 2014-15 nuclear power plants generated 37,835 million units of electricity. This was 3.61% of the total electricity generation of 1048.67 billion units.

Six reactors, with an installed capacity of 4300 MW, are at different stages of commissioning and construction. Kudankulam Nuclear Power Plant's Unit-2 having 1000 MW capacity and Prototype Fast Breeder Reactor of 500 MW capacity are under commissioning. Four more PHWRs (Rajasthan Atomic Power Project — Units-7&8 and Kakrapar Atomic Power Project — Units 3&4), each of 700 MW capacity, are under construction. Thus, the cumulative installed capacity after the completion of ongoing projects in 2018-19 would be 10,080 MW. In the coming year, construction of two PHWRs of 700 MW capacity each and two PWRs (Russian VVERs) of 1000

Table 3.4: Measures for reduction of emission intensity in major industries	
Industry	**Measures for reduction of emission intensity**
Iron and Steel Industry	1. A shift in the technology-mix of the iron and steel sector towards more efficient processes 2. Diffusion of energy efficient technologies into the sub-processes of various process routes 3. Coke dry quenching/ Waste heat recovery systems for coke moisture reduction and power generation 4. Utilization of renewable energy in specific process/ plant/colony applications 5. Increased use of waste heat/process gas as alternate fuels 6. Increased scrap utilization 7. Improving quality of coal/coke before its use in the industry 8. Low carbon captive power generation using process gas
Cement Industry	1. Diffusion of energy-efficient technologies in various sub processes of cement manufacture. 2. Waste heat recovery systems for moisture reduction in coal and raw materials and for power generation. 3. Utilization of renewable energy in specific process/plant/colony applications. 4. Increased use of waste as alternate fuels, rationalizing the various policies that regulate this activity. 5. Increased blending using fly ash from thermal power plants and granulated blast furnace slag from steel plants, and the increased use of composite cements. 6. Improving quality of coal before its use in the industry. 7. Low carbon captive power generation. 8. Increase of blended cements in the public procurement process.
Source: 12th Five Year Plan	

MW capacity each will commence. Plans are also under finalisation to launch Advanced Heavy Water Reactor of 300 MW capacity. All efforts are being made to achieve the target of 63000 MW capacity by the year 2032.

The Government has made significant efforts in augmenting fuel supplies from both domestic and foreign sources, thus easing out the constrained position to a large extent. In this context, an agreement was entered in April 2015 with Canada for supply of 3000 tonnes of uranium ore concentrate. Similar agreement has been entered with Kazakhstan for supply of 5000 tonnes of uranium in July 2015. This allows our nuclear reactors to operate at higher capacity factor and availability factors, thereby enabling higher generation of electricity. Every unit of electricity generated by nuclear power saves about one kg of CO_2 emissions in India, and its lifecycle greenhouse gas emissions are comparable to those of renewable sources like wind.

Capacity factors as well as availability factors for the Nuclear Power Plants have been improving from 71.37% and 83.44% in 2010-11 to 82.43% and 88.36% respectively in 2014-15. India has plans for large expansion in nuclear power, based on both indigenous technologies and with foreign cooperation.

3.4 Industrial Processes Sector

The industry sector has made significant advances in the conservation of energy. Government policies, campaigns by industry associations and strategic decisions by firms have all contributed to sizeable improvements in the intensity of energy use in industries. The major energy-consuming sectors implemented varied measures such as promotion of fuel-efficient practices and equipment, replacement of old and inefficient boilers and other oil-operated equipment, and fuel switching and technology upgradation. Table 3.4 shows proposed measures to reduce emissions intensities in two major industry sectors — Iron & Steel and Cement.

Zero Effect, Zero Defect (ZED): The Make in India campaign with ZED is a policy initiative to rate Medium & Small Industries on quality control and certification for energy efficiency, enhanced resources efficiency, pollution control, and use of renewable energy waste management using ZED Maturity Assessment Model. The scheme, launched in 2015, envisages coverage of about one million medium and small enterprises.

3.4.1 Perform Achieve Trade (PAT) scheme

PAT has been developed as per the legal requirement under the Energy Conservation Act, 2001 and as one of the mechanisms under NMEEE of NAPCC. Details of the PAT scheme are outlined in the Box on the next page. The framework of PAT scheme is illustrated in Figure 3.1.

3.5 Buildings Sector

One of the key drivers of India's escalating future energy needs is the rapid growth in building stock expected over the coming decades. Currently, buildings in both

Box: PAT Framework

Main Elements of the PAT Framework

1. Methodology for setting Specific Energy Consumption (SEC) for each Designated Consumer (DC) in the baseline year.
2. Methodology for setting the target to reduce the Specific Energy Consumption (SEC) by the target year from the baseline year.
3. The process to verify the SEC of each DC in the baseline year and in the target year by an accredited verification agency.
4. The process to issue energy savings certificates (ESCerts) to those DCs who achieve SEC lower than the specified value.
5. Trading of ESCerts.
6. Compliance and reconciliation of ESCerts.
7. Cross-sectoral use of ESCerts and their possible synergy with renewable energy certificates.

PAT Cycles

First Cycle (2012-15): In the first phase, the energy-intensive DCs will be assigned individual SEC targets and allotted a 3-year time period to accomplish it. The Monitoring and Verification (M&V) is carried out from the second year onwards. After the completion of M&V, energy saving certificates will be issued and trading will be permitted.

Second Cycle (post 2015): The number of DCs may get revised as more plants and sectors could be added. Petroleum refineries, petrochemicals, gas crackers/naphtha crackers, sugar, chemicals, port trusts, transport (industries and services), electricity transmission and distribution companies, and commercial buildings and establishments are some of the probable DCs that could be added in the second PAT cycle.

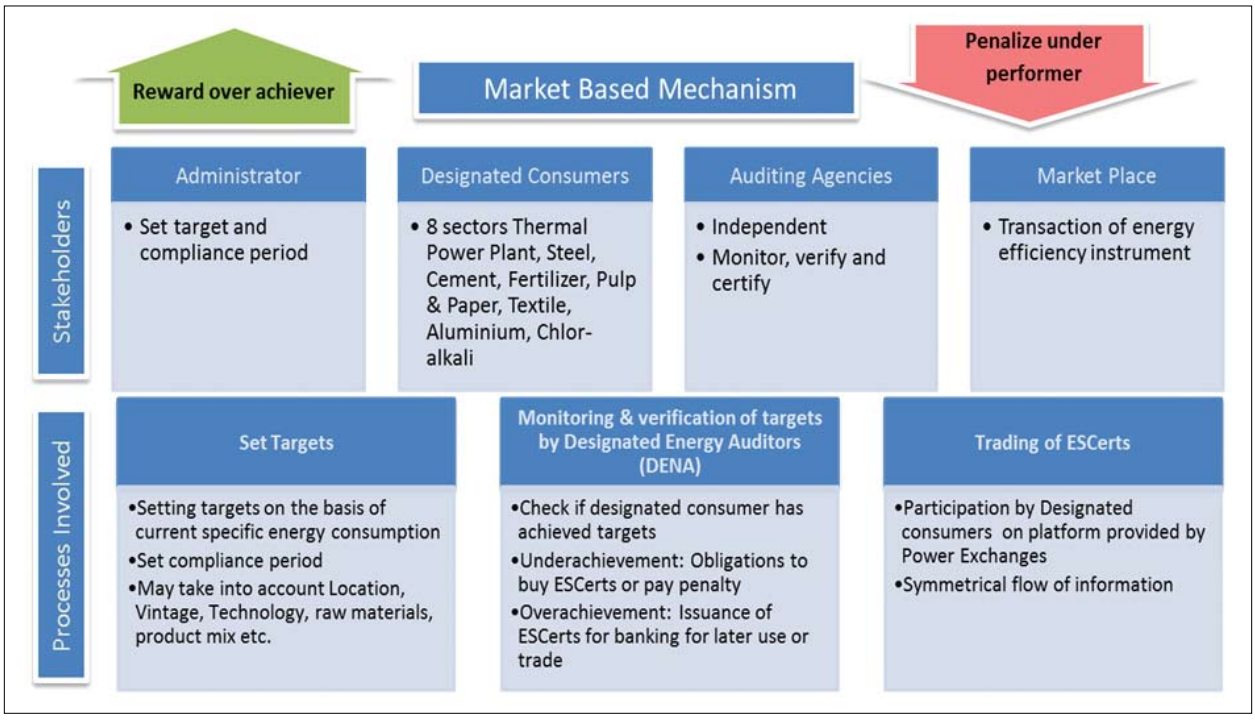


Figure 3.1: PAT Framework

residential and commercial sectors account for 29-30% of the total electricity consumption, which is on increase. A significant part of this percentage goes into heating, cooling and lighting.

Given this scenario, the government is taking a number of measures such as building codes, policy interventions, labelling/rating systems, and appliance standards to streamline efforts to promote energy efficiency in the buildings sector.

The **Energy Conservation Building Code (ECBC)**, developed by the Bureau of Energy Efficiency (BEE), prescribes a minimum standard for energy use in new commercial buildings and major retrofits. The ECBC establishes minimum requirements for energy-efficient building design and construction. The code is voluntary at the national level, and the Ministry of Urban Development and state governments are responsible for its implementation and enforcement. Several states have announced plans to make the ECBC operational for new construction with major retrofits in Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal.

The **National Building Code (NBC)** of India provides guidelines for regulating construction activities. It serves as a model code for adoption by all agencies involved in building construction.

LEED India is the localized version of the international rating system and is administered by the Indian Green Building Council (IGBC). In 2014, there were 2760 LEED India registered buildings and 524 LEED certified buildings, representing 2.19 billion square feet of registered green building footprint. According to IGBC, projects that comply with the ECBC also qualify for LEED India ratings, provided they are equivalent to specific standards, such as ASHRAE 90.1-2007.

Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system for green building design, developed and implemented by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE). If buildings contain fully air-conditioned interiors, ECBC compliance is mandatory for GRIHA ratings. If buildings are naturally ventilated, only partial ECBC adoption is required. All new central government and public sector buildings are to comply with the requirements of at least three-star GRIHA ratings.

Indira Paryavaran Bhawan, the headquarters of Central Government's Ministry of Environment, Forest & Climate Change is a model building of Government of India and has received LEED India Platinum and a five Star GRIHA rating. It is a 'Net Zero Energy' building with 100% onsite power generation.

BEE has a star rating programme called the **BEE Buildings Star Rating System** based on the actual performance of a building in terms of its specific energy usage in kWh/sq. m/year. The programme rates buildings (office buildings, shopping malls, hotels, hospitals, and IT parks) on a one-to five-star scale, with five stars being the most efficient. The rating considers operational characteristics that define building use, hours of operation, climatic zone, and conditioned space. It allows comparison to a peer group representing buildings with similar primary function and operating characteristics.

Besides the energy efficiency measures in the buildings, the BEE is also promoting use of energy efficient/star labelled appliances in the buildings such as for lighting and cooling. One such remarkable initiative for lighting is the **Bachat Lamp Yojana (BLY)** which promotes the use of Compact Fluorescent Lamps (CFL). A CFL can provide the same level of light as an Incandescent Lamp (IL) at a much lower consumption of electricity, but the price of CFL is 7-10 times of IL. To address this challenge, the BEE launched its "Bachat Lamp Yojana" (BLY) in February 2009. Under this scheme, a working incandescent bulb is exchanged with a CFL at a small cost of ₹15 (a CFL usually costs ₹100 approximately) by the distribution company. The scheme is registered as Clean Development Mechanism Programme of Activities (CDM POA). In the year 2011, nearly five million ILs were replaced by CFLs saving 231 MU of electricity and 85 MW of installed capacity. The programme's aim is to replace 400 million ILs to save 6000 MW of installed capacity and 18400 MU of electricity per year. The sale of CFL in the year 2012 was 408 million in number. BLY is a mitigation measure under Market Transformation for Energy Efficiency (MTEE) of NMEEE.

BEE is also undertaking an **Appliances Labelling/Rating Scheme.** The appliances are rated with one to five stars, five stars referring to most energy efficient model. The label carries the amount of electricity consumed by the appliance and also its energy efficiency. Every year, an independent evaluation is carried out which assesses the penetration of starred products. Using the data from such evaluations, penetration of different starred products has been worked out. In the light of significant success of this programme, there are proposals to continue and extend the appliance-labelling programme together with presently uncovered appliances. Also, BEE would periodically revise its rating system to reflect best global technologies.

National Programme for LED-based Home and Street Lighting: This programme was launched by the Prime Minister in January 2015 along with a web-based system to enable consumers in Delhi to register requests for procuring LED bulbs under Domestic Efficient Lighting Programme (DELP). Under the national programme, LED bulbs are being distributed in a phased manner from March 2015 onwards. The entire project of installing LED bulbs for domestic and street lighting in 100 cities is targeted for completion by March 2016. LED bulbs have a long life, almost 50 times that of ordinary bulbs, and 8-10 times that of CFLs, and therefore provide both energy and cost savings.

Use of LEDs in domestic and public lighting could result in 50-90% reduction in energy consumption. However, the high cost of LEDs and inadequate information of their comparative advantages has limited their demand. The Bureau of Energy Efficiency and Energy Efficiency Services Limited (EESL), a public sector entity under Ministry of Power, have developed interventions in

domestic and street lights to enhance efficiency in the lighting sector, and to make energy efficiency affordable to household consumers and municipalities alike.

The estimated three crore street lights in the country can potentially save five billion kWh (2000 MW) every year, which would result in cost savings of ₹3,000 crore to Municipalities and Urban Local Bodies. Additionally, if all the 77 crore incandescent bulbs sold in India for domestic (household) lighting are converted to LEDs, 25 billion KWh (20,000 MW) of energy can be saved every year. LEDs provide better light output than conventional lights and use 88% less energy as compared to incandescent bulbs, 50% less as compared to CFLs and other lighting fixtures used for public lighting.

The features of the scheme are: EESL will procure high quality LED bulbs (having illumination better than 60 W incandescent bulb) and provide two LED bulbs each to all Domestic Consumers in the license area of the DISCOMs. The replacement would be provided from designated counters in the DISCOMs. The LEDs will be given at an upfront cost of ₹10 each and the balance ₹120 will be recovered from the consumers' electricity bill over a period of 12 months at the rate of ₹10 every month. Further, the LED bulbs will carry a 3-year warranty. Equivalent high quality LED bulbs are sold at ₹350-500 in the open market. An awareness campaign will be run by BEE and EESL to enhance the awareness about the programme and the benefits of the use of LEDs in households.

3.6 Telecommunication Sector

The Telecom Regulatory Authority of India (TRAI) has released a consultation paper on 'Green Telecom' in 2010 which offers guidance for the use of eco-friendly equipment in the ICT sector. Based on the TRAI's recommendations, Department of Telecommunication issued the following directions to the licensees for implementation with immediate effect:

- At least 50% of all rural towers and 20% of the urban towers are to be powered by hybrid power (Renewable Energy Technologies+ Grid power) by 2015, while 75% of rural towers and 33% of urban towers are to be powered by hybrid power by 2020.
- All telecom products, equipment and services in the telecom network should be energy and performance assessed and certified "**Green Passport** (GP)", utilizing the ECR's Rating and the Energy 'passport' determined, by the year 2015.
- All service providers have to **declare to TRAI, the carbon footprint of their network** operations in the format prescribed by TRAI.
- Service providers **should adopt a Voluntary Code of Practice** encompassing energy efficient network planning, infra sharing, deployment of energy efficient technologies, and adoption of renewable energy.
- Service providers should evolve a **'Carbon Credit Policy'** in line with carbon credit norms with the ultimate objective of achieving a maximum of 50% over the carbon footprint levels of the Base Year in rural areas, and achieving a maximum of 66% over the carbon footprint levels of the Base Year in urban areas by the year 2020.

3.7 Transport Sector

3.7.1 Auto Fuel Policy

The number of motor vehicles in India has been growing at a rapid pace. Accordingly the fuel consumption has also increased, resulting in increasing GHG emissions from the transport sector. To introduce fuel efficiency norms for the automobile industry in order to address both energy and environment challenges, The Auto Fuel Policy 2003 was introduced.

BS-III auto fuel (MS/HSD) has been extended to all cities of India from 1st April, 2010. BS-IV auto fuel was introduced in 13 identified cities on 1st April, 2010 and is now extended to 50 more cities, with preference to most polluted cities, subject to availability of fuel and logistic constraints. It has also been decided that the provision will be extended in entire country by 1st April, 2017 in phases.

As per Auto Fuel Vision and Policy 2025, with effect from 1st April, 2015, the states of northern India, namely J&K, (except Leh/Kargil), Punjab, Haryana, Himachal Pradesh, Uttarakhand, Delhi and the bordering districts and parts of Rajasthan and Western UP, have been covered. From 1st April, 2016, all of Goa, Kerala, Karnataka, Telengana, Odisha and the Union Territories of Daman & Diu, Dadra Nagar Haveli and Andaman & Nicobar will be covered. Part of Maharashtra (Mumbai, Thane and Pune districts), part of Gujarat (Surat, Valsad, Dangs and Tapi districts) will be covered. From 1st April, 2017 rest of the states/districts are proposed to be covered.

It has also been decided that BS-V fuel quality and emission norms will be implemented in the entire country from 2019, and BS-VI emission norms for four wheelers shall be implemented from 2023.

To further reduce the GHG emissions from the transport sector, demand side measures such as vehicle labelling that enable consumers to take an informed decision while purchasing a vehicle are proposed.

A major initiative in the transportation sector has been the upgradation of vehicular emission norms. The Auto Fuel Policy 2003 laid down a road map for the emission standards for the various vehicles throughout the country (Table 3.5).

In line with the recommendations of the Auto Fuel Policy of Government of India, oil industry has already introduced BS-IV grade petrol and diesel in the 13 notified cities and BS-III grade petrol and diesel in rest of the country in 2010. A Committee set-up in 2013 to draft an updated Auto Fuel Policy has recommended implementation of Bharat Stage IV fuel nationwide from April 2017, followed by the Bharat Stage V in April 2020.

Increase in share of alternative fuels in overall fuel mix is yet another strategy to reduce emissions from the sector. The number of CNG cars and taxies in India grew from 23,166 in the year 2001 to 439,250 in 2011. In the year 2011, Delhi (64%) had the highest share of CNG cars followed by Gujarat (18%) and Maharashtra (15%). According to the National Electric Mobility Mission Plan 2020, the share of CNG cars will be 30-35% in the new vehicle sales by 2020. Apart from the increase in CNG vehicles, an increase in electric vehicles is planned as a significant strategy. Given that electric vehicles have higher operational efficiencies than internal combustion engines, increasing the shares of electric vehicles is expected to enhance the overall energy efficiency of the transport sector with corresponding reduction of energy demand. Electric vehicles in the form of electric-rickshaws have already made their appearance in several urban centres across the country.

In line with the policy of finding alternative to oil for the transport sector, the Ministry of Petroleum and Natural Gas has set up a **Hydrogen Corpus Fund** with a corpus of ₹100 crore, with contributions from five major oil companies and Oil Industry Development Board (OIDB), for supporting research and development in various aspects of hydrogen fuel, which could substitute part of natural gas as transport fuel in future. R&D Centre of Indian Oil Corporation Ltd. has taken steps for promoting hydrogen as auto fuel with the help of Hydrogen Corpus Fund.

To encourage production of bio-diesel, the Ministry of Petroleum and Natural Gas announced a **Bio-diesel Purchase Policy** in October, 2005, which became effective from 1st January 2006. Under this scheme, Oil Marketing Companies (OMC) will purchase bio-diesel for blending with High Speed Diesel to the extent of 5% at identified purchase centres across the country. Ministry of Petroleum and Natural Gas vide its notification dated 20th September, 2006 has directed the OMCs to sell 5% Ethanol-Blended Petrol (EBP) subject to commercial viability as per Bureau of Indian Standards specifications. Efforts are being made to ensure availability of ethanol on consistent basis for the EBP Programme and OMCs are in discussion with the sugar industry to firm up the status of availability at various locations.

In July 2013, it was decided that Oil Marketing Companies will procure ethanol from domestic sources only to achieve the mandatory requirement of 5% ethanol blending in areas/parts of the country where sufficient quantity of ethanol is available. In other parts of the country, blending of ethanol may be increased progressively depending upon the availability of ethanol to reach the 5% mandatory level.

Table 3.5: Emission Standards

Standard	Reference	Date	Region
India 2000	Euro 1	2000	Nationwide
Bharat Stage II	Euro 2	2001	NCR*, Mumbai, Kolkata, Chennai
		2003.04	NCR*, 11 Cities†
		2005.04	Nationwide
Bharat Stage III	Euro 3	2005.04	Nationwide
Bharat Stage IV	Euro 4	2010.04	NCR*, 13 Cities‡

* National Capital Region (Delhi)

† Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Secunderabad, Ahmedabad, Pune, Surat, Kanpur and Agra

‡ Above cities plus Solapur and Lucknow. The programme was later expanded with the aim of including 50 additional cities by March 2015.

In order to improve the availability of ethanol, the Government has decided to fix the delivery price of ethanol in the range of ₹48.50/litre to 49.50/litre, depending upon the distance of distillery from the depot/installation of OMCs.

As regards policy for purchase of bio-diesel, it has been decided that OMCs would purchase bio-diesel, meeting the prescribed BIS standard, at a uniform price, as may be decided by the OMCs from time to time, for blending with High Speed Diesel to the extent of 5%, at identified 20 purchase centres across the country. OMCs have reviewed the procurement price of bio-diesel at various purchase centres, and with effect from 7th November 2014 the declared price of bio-diesel is ₹41/litre. Moreover, it has been decided to allow the direct sale of bio-diesel (B100) to all consumers by private manufacturers, their authorized dealers and Joint Ventures of OMCs authorized by MoPNG.

Urban transport is one of the key elements of urban infrastructure. A major objective of urban transport initiatives is to provide efficient and affordable public transport. A **National Urban Transport Policy (NUTP)** was laid down in 2006, with the objectives of ensuring easily accessible, safe, affordable, quick, comfortable, reliable, and sustainable mobility for all. In order to provide better transport, proposals for **bus rapid transit system (BRTS)** were approved for Ahmedabad, Bhopal, Indore, Jaipur, Pune, Rajkot, Surat, Vijayawada and Vishakhapatnam cities under the JNNURM. During 2009-10, one more proposal for a BRTS in Kolkata has been approved under the JNNURM taking the number of cities supported for BRTS to 10, covering a total length of 453.20 km. Till December 2010, more than 10,000 modern intelligent transport system (ITS)-enabled, low floor and semi-low floor buses have been delivered to States/Cities.

3.7.2 Corporate Average Fuel Consumption (CAFÉ) standards for cars

A major initiative in the transport sector has been the introduction of Corporate Average Fuel Consumption norms for cars. Two sets of standards have been notified, one of which will come into effect from 2017, and the other from 2022. The standards define a line linking the Corporate Average Fuel Consumption with the Corporate Average Kerb Weight of cars sold in a year, with the requirement that the actual Corporate Average Fuel Consumption should be less than that prescribed by the standards at the actual Corporate Average Kerb Weight of cars sold by a particular manufacturer. Both these standards would ensure that the Corporate Average Fuel Consumption in India remains at the lower end of the range of fuel consumption requirements notified by the various countries.

3.7.3 National Mission on Electric Mobility

Government of India approved the National Mission on Electric Mobility in 2011. Subsequently National Electric Mobility Mission Plan 2020 was unveiled in 2013. As part of the mission, Department of Heavy Industry has notified a scheme namely FAME — India (Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles in India) for implementation with effect from 1st April 2015.

This scheme is proposed to be implemented over a period of six years, till 2020, wherein it is intended to support the hybrid/electric vehicles market development and its manufacturing ecosystem to achieve self-sustenance at the end of the stipulated period. This scheme is aimed at incentivizing all vehicle segments *i.e.* 2-wheelers, 3-wheeler auto, passenger 4-wheeler vehicles, light commercial vehicles and buses.

This scheme aims at a cumulative fuel saving of about 9500 million litres equivalent, resulting in reduction of pollution and greenhouse gas emissions by two million tonnes, with targeted market penetration of 6-7 million vehicles per year by 2020. This mission will be one of the biggest contributors in reducing pollution from road transport sector in the near future.

3.7.4 Rail Transport

Electrification of Indian Railways is an important step towards not only enhancing the efficiency of the system but also mitigating GHGs from its operation. By March 2012, electrification of Indian Railways had been extended to 22,224 RKMs, which included 25 RKMs of Kolkata Metro. This constitutes 34.48% of the total Railway network and 40.27% of the broad-gauge system. As per Indian Railways Year Book 2010-11, 64.30% of goods transport and 51% coaching are based on electric power. Indian Railways is also installing solar panels on its land and roof tops of coaches.

With a mission to enable Indian Railways to introduce alternate energy sources, fuel efficient and emission control technologies, the government has established an institution called **Indian Railways Organization for Alternate Fuels (IROAF)**. It will function as a

single window entity for knowledge and database on technologies, carbon market, suppliers, business partners and consultants. Consequently, trains are operated with bio-diesel blend of up to 20% on selected routes. Efforts are also underway to replace diesel with CNG/LNG or dual fuel mode engines.

3.7.5 Mass Rapid Transit System

The mass-transit and urban transport projects initiated under the National Urban Renewal Mission have positive climate change impacts in the long-run.

The Government of India has approved the implementation of additional MRTS projects in several cities:

- Bangalore Metro Rail Project by Bangalore Metro Rail Corporation Ltd. (BMRCL).
- East-west metro corridor in Kolkata by Kolkata Metro Rail Corporation Ltd (KMRCL).
- Chennai Metro Rail Project by Chennai Metro Rail Ltd. (CMRL).
- Extension of metro network in Delhi.
- Metro Rail Projects on PPP basis in Mumbai.
- Viability gap funding (VGF) for Hyderabad Metro.

In order to give proper legal cover to metro projects, the **Metro Railways Amendment Act, 2009** was brought into effect in September 2009, providing an umbrella 'statutory' safety cover for metro rail work in all the metro cities of India.

3.7.6 Aviation

To deal with climate change, the Directorate General of Civil Aviation (DGCA) issued five circulars prior to mid-2013 addressing the use of aircraft power supply, fuel efficiency, single engine taxi and data reporting. One of the most important initiatives is the Aviation Environment Circular 2 of 2013 on Climate Change Initiatives in Civil Aviation. According to this Circular, the DGCA shall operate a Climate Change Task Force, while airlines and airports will submit fuel and electricity consumption data on a regular basis and manage their own carbon footprint. The DGCA had also undertaken the first-ever detailed carbon footprint study of Indian aviation for 2011.

The Indian airlines operate modern, fuel-efficient aircraft (*e.g.* Boeing 787 Dreamliner, Airbus 320/B737 NG with sharklets/winglets) resulting in significant fuel savings. The modes of operations are altered to reduce emissions. As of 2013, several Indian airports obtained LEED certifications and have introduced energy efficient systems and environment friendly vehicles. Four Indian airports are participating in Airport Carbon Accreditation. The Future India Air Navigation System (FIANS) initiative, which is based on projects in the fields of communication, navigation and surveillance, has been launched. The Performance Based Navigation (PBN) project, for instance, has led to reduced flight distances. The Indian Ocean Strategic Partnership to Reduce Emissions (INSPIRE) was launched in 2011. This project represents a partnership between the Airports Authority of India (AAI), Air Services Australia, Dubai Airports, and many other organisations which are "dedicated to improve the efficiency and sustainability of aviation."

3.7.7 Shipping

Recognizing their fuel efficiency, environmental friendliness and cost effectiveness, the Government is promoting growth of Coastal Shipping and Inland Water Transport. To enhance the inland waterways transport, Government has announced the implementation of Jal Marg Vikas for capacity augmentation of National Water Way -1. It is also proposed to establish integrated waterways transportation grid with a view to connecting all existing and proposed national waterways with road, rail and ports connectivity. Another initiative in this direction is the Sagarmala Project, with the objective to augment port-led development and promote efficient transportation of goods. Bharatmala Project all along the coastal areas will further provide connectivity to the ports.

IMO's Marine Environment Protection Committee (MEPC) has given extensive consideration to control of GHG emissions from ships. In July 2009, it finalized a package of specific technical and operational reduction measures. The work was completed in July 2011 with the adoption of first ever mandatory global reduction regime for an entire industry sector. The adopted measures add to MARPOL

Annex VI a new chapter entitled "Regulations on energy efficiency for ships", With this, in 2011, IMO adopted mandatory technical and operational energy efficiency measures which are expected to significantly reduce the amount of CO_2 emissions from international shipping. These mandatory measures, namely Energy Efficiency Design Index (EEDI) for new ships, and the Ship Energy Efficiency Plan (SEEMP) for all ships entered into force on 1st January 2013 and apply to all ships of 400 gross tonnage and above. The same has been incorporated in all the Indian vessels as per the applicability. Existing Indian vessels registered under Merchant Shipping Act, 1958 are strictly following the same.

3.8 Agriculture Sector

Various measures have been undertaken to enhance food security, while at the same time there have been focused interventions aimed at diversifying Indian agriculture into non-food grain crops and promoting animal husbandry and fishing. The National Food Security Mission aims at increasing cereal and pulses production by 20 million tonnes by concentrating on those areas which have the greatest potential for increase in yields with the given technology. The National Horticulture Mission has also been expanded. Rashtriya Krishi Vikas Yojana (RKVY) is a focused programme that provides additional financial resource to the state governments to finance agriculture development programmes. The strategy is also aided by the MNREG Act, by building projects that help in the larger objectives of enhancing agricultural productivity because priority is also being given to projects aimed at water conservation.

The Ministry of Agriculture, Government of India has adopted a mega project called the **National Initiative on Climate Resilient Agriculture (NICRA)** in 2011 with four main modules – natural resource management, improving soil health, improving crop production and livestock to make the farmers self-reliant for adaptation under changing climate. Several technologies to reduce the GHG emissions with sustainable crop and livestock management have been developed under the project head of NICRA. Government of India has proposed several programmatic interventions that can help farmers and other agriculture stakeholders to adapt to the changing climate.

As a part of NICRA, the focus of mitigation interventions in the project is on quantifying the greenhouse gas (GHG) emissions from various important production systems of the country using state of the art equipment, development of management practices for reducing GHG emissions, and exploiting the potential of conservation agriculture systems and agroforestry systems towards GHG mitigation.

The government has also proposed complementary actions in terms of identification of cost-effective opportunities for reducing methane generation, emissions in ruminants by modification of diet, and in rice paddies by water and nutrient management. **National Mission for Sustainable Agriculture (NMSA)** was derived from the Sustainable Agriculture mission component of the NAPCC. Improved crop seed, nutrient management, soil health management and the on farm water management components of the NMSA have the potential to reduce the GHG emissions from cropland through the management of water use and fertilizer application to the soil.

Overview of the mitigation actions initiated in the agricultue sector

Expansion of area under horticulture systems: The horticulture sector encompasses a wide range of crops such as fruits, vegetables, flowers, spices and nuts. The fruit crops produce relatively higher biomass and are retained in the field for a relatively longer period, and thus sequester carbon both above and below ground. Government of India has launched National Horticulture Mission (NHM) in 2005-06 with an objective to raise horticulture production, improve nutritional security and enhance income to farmers. The area under horticulture grew about 3.8% and production rose by 7.4% per annum during the last decade.

System of Rice Intensification (SRI) cultivation: System of Rice Intensification is a method of rice cultivation consisting of transplanting 8-12 day old seedlings at wider spacing of 25 cm x 25 cm. Unlike the traditional transplanted paddy system, standing water is not maintained in SRI system and the field is maintained at saturation. Due to alternate wetting and drying cycles the methane emissions get reduced significantly. As a part of the National Food Security Mission (NFSM), SRI method of cultivation is being promoted in 199 districts which have been selected for paddy interventions in NFSM. The extent of coverage of area with SRI system is given in Table 3.6.

Table 3.6: Area covered (in ha) with SRI system of cultivation		
Year	**Target envisaged for coverage of SRI system of cultivation (ha)**	**Target achieved for coverage of SRI system of cultivation (ha)**
2009-10	9735	9600
2010-11	6043	6171
2011-12	11224	12496
2012-13	116977	114023
2013-14	-	175298
Source: NFSM, Ministry of Agriculture		

Crop diversification from transplanted paddy to other food crops: Under this initiative ₹500 crores were sanctioned for diverting the paddy area to other crops due to the depleting ground water resources and decline in soil quality due to continuous paddy cultivation in three states, Punjab, Haryana and Uttar Pradesh. This will indirectly reduce methane emission too.

Improvement in energy efficiency through micro irrigation: Micro irrigation systems (MIS) deliver water directly to the root zone of crops resulting in better water use efficiency. Loss of water during application and conveyance gets reduced in micro irrigation systems resulting in savings of water and reduced time for irrigation. MIS curtails working hours in delivering water and thus reduces the consumption of electricity. Replacing flood method of irrigation with micro irrigation systems reduces electricity consumption required for pumping of water. This eventually reduces green house gas emissions through reduced consumption of grid power or fossil fuel based captive power. Micro irrigation systems also enhance productivity and quality of agriculture product. Area covered under efficient irrigation systems is given in Table 3.7.

Tree plantations to meet the raw material needs of the wood industry: Of the total wood requirement for the paper industry, nearly 80% is from agroforestry or farm forestry which is basically on private land holdings. If we consider the last five years, the plantations developed by these industries are to the tune of 3,00,000 ha at a rate of over 50,000 ha year. Commercial plantation for producing woody raw materials for industry reduces pressure on forests, leading to conservation of carbon stocks in forests.

Mitigation actions/ projects aimed at regulated carbon markets (CDM)

Large numbers of initiatives have been taken by the industry and private individuals for reducing the GHG emissions and also to sequester carbon in agricultural sector. Significant numbers of projects are being taken up in the category of biomass energy wherein fossil fuels are being replaced with agricultural residues, mainly the crop residues for heating. Residues used include rice husk, sugarcane bagasse and stubbles of cotton, jute and mustard. In the category of biomass energy, 260 projects were registered as in March 2015 and the total emission reductions envisaged from these projects were to the tune of 36.814 million tonne.

Mitigation actions/ projects aimed at voluntary carbon markets

In addition to the regulated markets, a number of projects were registered and implemented aiming at voluntary markets. The predominant categories in this sector are the voluntary carbon markets and the Climate, Community and Biodiversity Alliance. One of the important categories is substituting the fossil fuel consumption with agricultural residues. About 31 projects are in operation in this category and the emission reduction achieved by this category of projects is to the tune of 4,304,574 t CO_2eq.

Table 3.7: Area covered (in ha) with micro irrigation systems during the study period			
Year	**Drip**	**Sprinkler**	**Total**
2009-10	277823	319031	596854
2010-11	331603	359214	690817
2011-12	322138	286795	608934
2012-13	315381	257884	573265
2013-14	256162	152446	408608

Total mitigation due to various initiatives

Mitigation is envisaged due to various initiatives of the Government of India as well as the private sector initiatives. **The total quantum envisaged is 96,468,814 tCO_2 eq** during 2009-2014.

National Agroforestry Policy (NAP)

The Government of India has recently approved the National Agroforestry Policy to encourage and expand tree plantations in an integrated manner with crops and livestock to improve productivity, employment, income and livelihoods of rural households, to protect and stabilize ecosystems, promote resilient cropping and farming systems to minimize the risk during extreme climatic events, to meet the raw material requirements of wood-based industries, reduce import of wood and wood products, augment the availability of agroforestry products (AFPs) such as the fuelwood, fodder, non-timber forest produce and small timber to the rural and tribal populations, and to reduce the pressure on existing forests.

3.9 Forestry Sector

India is implementing one of the largest afforestation programmes in the world, and has also formulated and implemented numerous forest conservation related legislations, and policies such as the Forest Conservation Act, 1980, the National Forest Policy, 1988, and the Wildlife (Protection) Act, 1972. Important measures adopted under the Joint Forest Management/Social Forestry include banning of timber extraction in reserve forests, improved cook-stove programme, and biogas to conserve fuelwood. Similarly, there are conservation programmes for mangroves, coral reefs and lake ecosystems. The National Wasteland Development Board is responsible for regenerating degraded non-forest and private lands. The National Afforestation and Eco-Development Board is responsible for regenerating degraded forest lands, the land adjoining forest areas as well as ecologically-fragile areas. The Forest Survey of India monitors changes in the forest areas across the country biennially. All these measures have led to stabilization of the forest area and afforestation, and reduction in deforestation, significantly contributing to conservation of the forest carbon sink. These preparations will act as a buffer for the forest-dependent communities against the challenges posed by climate change. MoEFCC constituted Compensatory Afforestation Fund Management and Planning Authority (CAMPA) in 2004 for management and use of funds generated by levying cost of compensatory afforestation in equivalent forest land offered by the user agencies or in degraded land whenever there is a diversion of forest lands for non-forestry purposes under the Forest (Conservation) Act, 1980. Total forest and tree cover of India is 78.92 Mha which constitutes 24.01% of the total geographical area. Forest and tree cover in India is showing increasing trend since 2000. Within the forestry sector, the cost effective mitigation actions include large scale afforestation, reducing deforestation, and sustainable management of forests. India has designed the Green India Mission, aiming to enhance carbon stocks for an area of 10 Mha over a period of 10 years in the forest sector, along with conservation of ecosystem services and building resilience to climate change risks. Further, most states have prepared State Action Plans on Climate Change which include mitigation activities in forest sector. India is also hosting 10 CDM afforestation/reforestation projects.

National Afforestation Programme is the dominant afforestation programme being implemented in India, largely supported by central and state governments. India is also implementing a variety of developmental programmes such as MGNREGA and Integrated Watershed Management Programme, which includes afforestation and agroforestry programmes. Several afforestation programmes are also part of the projects funded by Multilateral Agencies such as World Bank and Bilateral Agencies such as JICA (Table 3.8).

Figure 3.2 gives the details of plantations undertaken in India during successive years under the National Afforestation Programme.

It is noteworthy that after implementation of Forest (Conservation) Act 1990, the rate of diversion of forests has come down drastically (Figure 3.3).

Table 3.8: Initiatives in the forestry sector			
Type	**Programme**	**Mitigation Component**	**Coverage**
National/Domestic Mitigation Programmes			
Central	National Afforestation Programme	Nationwide afforestation drive	Nation-wide
	12th Five Year Plan	Afforestation, forest conservation and restoration	Nation-wide
	MGNREGA	Afforestation and drought related programmes	Nation-wide
	IWMP	Afforestation in catchment areas; Agroforestry	Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh
Dedicated Climate Change Mitigation	Green India Mission	Forest restoration, Afforestation, Agroforestry, Urban forestry	Nation-wide
State	CAMPA	Compensatory afforestation	Andhra Pradesh, Jammu and Kashmir, Karnataka, Uttarakhand
	SAPCC	Forest restoration and afforestation mitigation programmes	Andhra Pradesh, Arunachal Pradesh, Assam, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Odisha, Rajasthan, Sikkim, West Bengal
Private	ITC Bhadrachalam	Plantation forestry on farmlands	Andhra Pradesh, Karnataka, Tamil Nadu, Maharashtra, West Bengal
	JK Paper Mills	Plantation forestry on farmlands	Odisha, Andhra Pradesh, Chhattisgarh, Gujarat, Maharashtra andWest Bengal
International Mitigation Programmes			
Internationally Funded	Bilateral	Afforestation, social forestry, community forestry projects	JICA funds projects in Tamil Nadu, West Bengal, Rajasthan, Sikkim, Uttar Pradesh, Gujarat, Tripura, Himachal Pradesh, Odisha, Haryana, Karnataka, Assam.
	Multilateral	Afforestation as a part of watershed management, and other projects	World Bank funds projects in Andhra Pradesh, Odisha, Uttarakhand, Himachal Pradesh as well as a few nation-wide mitigation initiatives
Dedicated Climate Change Mitigation	CDM	Afforestation, reforestation	Odisha, West Bengal, Delhi, Andhra Pradesh, Uttar Pradesh, Himachal Pradesh, Haryana, Karnataka
	REDD-plus	Pilot projects	Karnataka, Madhya Pradesh, Himachal Pradesh, Uttarakhand, Meghalaya, Sikkim

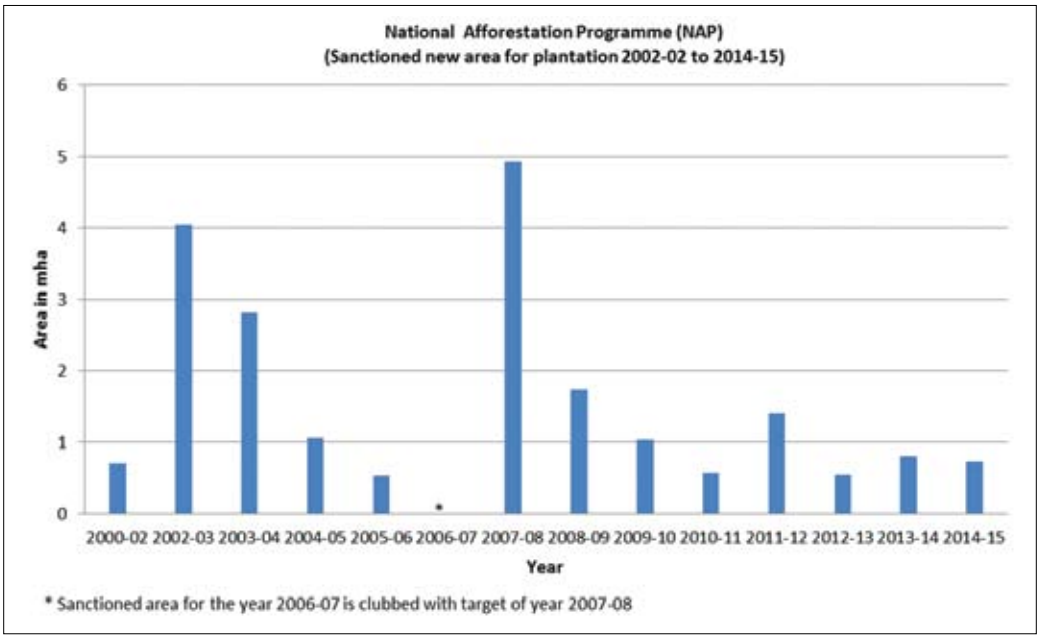


Figure 3.2: Afforestation undertaken in India during successive years under National Afforestation Programme (NAP)

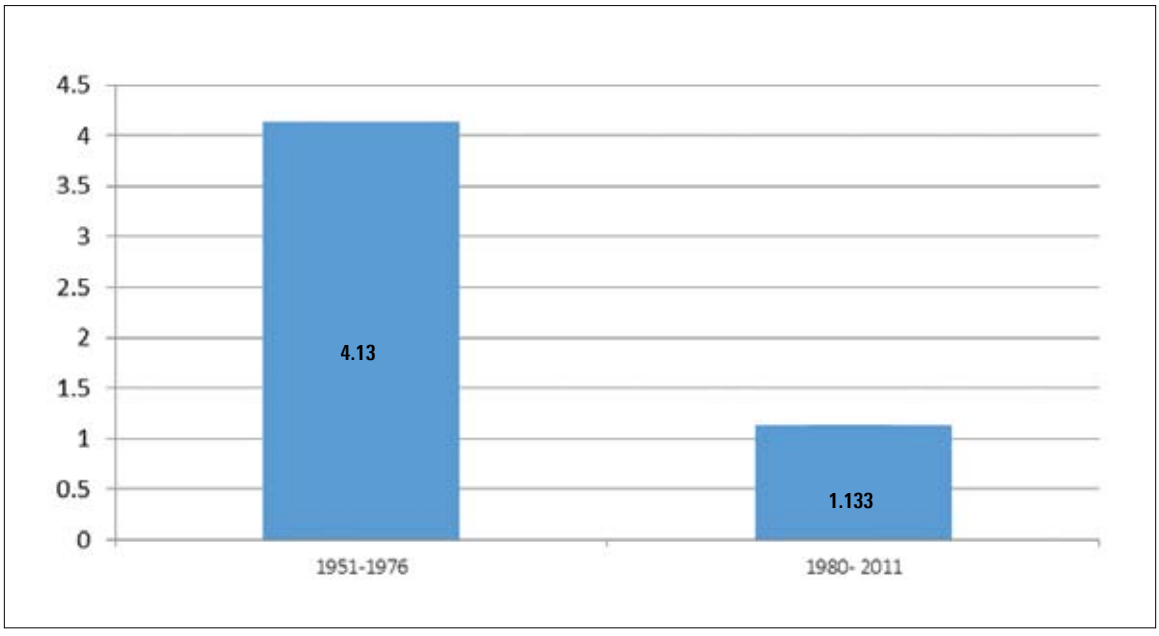


Figure 3.3: Diversion of forest land (in million ha) before and after Forest Conservation Act (1980)

In 1990, India initiated forest protection and management programme involving local communities as **Joint Forest Management** (JFM). The local communities and the forest department jointly plan and implement forest regeneration and development programmes, and the communities are rewarded with substantial share in forest produce in return for their efforts in protection and management of forests. So far, more than 112,816 JFM committees (JFMCs) have been formed covering about 25 million ha of forest area. JFM has enabled protection and regeneration of existing forests as well as raising of forest plantations, thus contributing to conservation of existing forests and also augmenting carbon stocks. JFM covers approximately 29.8% of the total forest area of the country. Over the years, the involvement of the local communities in the management of forest has increased manifold due to setting up of JFMCs in many parts of India. In India, 59.31% forestland is administered by the government and 28.5% is designated for use by communities and indigenous groups.

Under the Joint Forest Management Programme local communities participating in regeneration, protection and management of the forests will have full access to non-timber forest products which contribute to their livelihood.

Initiatives of the private sector and NGOs

There are 759 paper mills in India of which 26 are wood based and depend on wood-based raw materials for manufacturing various kinds of paper and packaging material. Of the total wood requirement for the paper industry, nearly 20% is procured from the government sources, mainly from the forest departments/ forest development corporations and World Bank aided projects.

REDD-plus and India

Government of India is in the process of developing its National REDD+ strategy. MoEFCC has prepared a draft national REDD+ policy and strategy. Similarly, to facilitate REDD at National level among all stakeholders, government has also prepared a 'REDD+ Reference Document'. India's national REDD+ strategy aims at enhancing and improving the forest and tree cover thereby enhancing the quantum of forest ecosystem services that flow to the local communities.

The Government of India has established a **REDD+ Cell** in the Ministry of Environment, Forest and Climate Change having the task of coordinating and guiding REDD-plus related actions at the national level, and to discharge the role of guiding and collaborating with the State Forest Departments (SFDs) to collect, process and manage all relevant information and data relating to forest carbon accounting. National REDD+ Cell would also guide formulation, development, funding, implementation, monitoring and evaluation of REDD-plus activities in the States. The Cell will assist the MoEFCC and its agencies in developing and implementing policies relating to REDD-plus implementation in the country.

Local communities and co-benefits including carbon service

While moving forward towards implementation of REDD-plus, participation of local communities with compulsory representation of women would be the central theme. Government of India is committed to ensure that full and adequate incentives from REDD-plus go to the local communities as and when these become available. The forest will be managed for 'carbon services' as well as all the ecosystem services that flow to the local community. The latest Forest Survey of India (FSI) assessments in India State of Forest Report (ISFR) 2011 and ISFR 2013 show increase in forest and tree cover. Several REDD-plus pilot projects have been initiated in India.

A REDD-plus pilot project in the *Van Panchayat* (Village Community Forests) of Uttarakhand is focused on community managed forest. REDD-plus actions are being initiated as demonstration activities in these forests. With sizable potential for sequestration of carbon and biodiversity conservation, *Van Panchayats* in Uttarakhand will be selected in consultation with Uttarakhand Forest Department. The Project will be conceived in about 15,000-20,000 ha of the lands of *Van Panchayats*.

USAID initiative Forest-PLUS is collaborating with Indian forestry institutions and local communities on a pilot programme aimed at strengthening India's capacity to develop systems for forest carbon measurement and monitoring, as well as conduct greenhouse gas inventories and support the application of science and technology for improved and more cost-efficient management and monitoring systems. Pilot sites lie in landscapes of Karnataka, Madhya Pradesh, Himachal Pradesh, and Sikkim as these landscapes represent tropical moist deciduous, tropical dry deciduous, moist temperate and subtropical broad leaf forest types.

The Energy and Resources Institute (TERI), financed by the Norwegian Government, is implementing small REDD-plus pilot projects at six sites in different states of India. A pilot project in the East Khasi Hills in Meghalaya is operated jointly by a California-based non-profit organization, Community Forestry International (CFI) and the Mawphlang community (Meghalaya). The total project area is 17,052 ha. The net CO_2 emission reduction/removal additionally per year on account of avoided deforestation and degradation and afforestation in the project area works out to 11,444 tonne. The project is registered with Plan Vivo Standard.

3.10 Waste Sector

India recognizes the dual benefits that can arise from efficient waste disposal leading to enhanced environmental benefits along with conversion to energy. Incentives are being granted to cities to take up waste to energy conversion projects.

Figure 3.4: Waste to energy generation projects in India

The **Waste to Energy** capacity is sought to be enhanced. Government is also encouraging conversion of waste to compost by linking it with sale of fertilizers and providing market development assistance.

Government has invested significantly in **Solid Waste Management (SWM)** projects over the years and has provided grant-in-aid to states and Urban Local Bodies specifically for SWM through public-private partnerships.

Government of India has recently launched a one-of-its kind '**Swachh Bharat Mission**' with the objective of making the country clean and litter free with scientific solid waste management in about 4041 towns. It aims to construct 10.4 million individual household toilets and 0.5 million Community and Public Toilets.

India has implemented several mitigation actions in waste sector. These include actions taken under National Mission for Sustainable Habitat which promotes recycling of material, urban waste management and power from waste. The lead programmes in this sector include- National Biogas and Manure Management Programme (NBMMP), Accelerated Programme on Energy Recovery from Urban Wastes, Scheme on Biogas Based Distributed/Grid Power Generation Programme and Programme on Recovery of Energy from Industrial Wastes. The distribution of waste to energy projects in India is presented in Figure 3.4.

The Ministry of Urban Development in India has formulated benchmarks for different indicators of solid waste management which include 100% household level coverage of Solid Waste Management services, efficiency of collection of municipal solid waste, 100% segregation of municipal solid waste and its scientific disposal, 100% cost recovery in solid waste management services, processing and treatment of MSW, and a recovery/recycling of 80% of municipal solid waste.

The Plastic Waste (Management and Handling) Rules, 2011 were issued in supersession of the "Recycled Plastic Manufacture and Usage Rules, 1999" notified under the Environment (Protection) Act, 1986. Rule 6 of the said Rules mandates that a plastic waste management system be put in place, and identifies municipal authority as the agency responsible for implementation of the said Rules within its jurisdiction.

3.11 Mitigation Actions: nature, coverage, objectives, methodologies, steps taken, results achieved and emission reductions achieved

In accordance with AWGCLA/2011/INF.1, following information on mitigation actions is provided below:

- Description of the mitigation action
- Methodologies and assumptions
- Objectives of the action and steps taken or envisaged
- Progress of implementation.

The details are provided in a set of Tables in the following section for Energy Efficiency (Table 3.9), Renewable Energy (3.10), Forestry (3.11), Agriculture (Table 3.12), Transportation (Table 3.13) and Sustainable Habitat (Table 3.14) Sectors. These tables are indicative and non-exhaustive.

Table 3.9: Mitigation actions in energy efficiency

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Steps taken and envisaged, and Results achieved	Relevant national legislation / policy
National Mission for Enhanced Energy Efficiency (NMEEE)	Cumulative avoided electricity capacity addition of 19598 MW by 2017 through reduction of energy consumption	Policy	CO_2, CH_4, N_2O	Improving energy efficiency	Energy Saving Targets under PAT Cycle-1 is 6.686 Mtoe.	Perform Achieve and Trade	478 designated consumers in 8 large energy consuming industrial sectors to reduce their specific energy consumption in PAT Cycle 1 (2012-15).	National Action Plan on Climate Change
						Market Transformation for Energy efficiency	1. Bachat Lamp Yojana (Promotes use of compact fluorescent lamps). 2. BEE has framed standards and verification based incentive structure to create super-efficient appliances	

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Steps taken and envisaged, and Results achieved	Relevant national legislation / policy
					A mechanism to finance DSM programmes in government buildings, municipalities, SMEs and industries.	Energy Efficiency Financing Platform	Partial risk guarantee fund created for supporting energy efficiency DSM programmes. The GoI has approved around ₹ 3.12 billion for partial coverage of risk involved in extending loans for energy efficiency projects.	
						Framework for Energy Efficient Economic Development	Seeks to develop innovative fiscal instruments to promote energy efficiency and policy measures such as partial risk guarantee fund (PRGF) and Venture Capital fund for energy efficiency, Public procurement of energy efficient goods and services, utility based DSM	
Standards and Labeling programme	This is a regulatory measure taken by BEE.	Rating scheme	ACs, ceiling fans, refrigerators, colour TVs	Create the appropriate legal and regulatory environment for energy efficient end use products.	Estimated saving of electricity consumption by households in 2030 is 136.8 billion units (24%).		The appliances are rated with one to five stars; five stars referring to most energy efficient model. The label carries the amount of electricity consumed by the appliance and also its energy efficiency.	Energy Conservation Act, 2001
Supercritical power plants	Supercritical technology reduces the use of coal per unit of electricity produced. Supercritical power plants.	Technology	Coal/ Power; CO_2	To improve thermal efficiency and reduce CO_2 emissions	The increased thermal efficiency results in emission reduction to the tune of 3%-10% depending upon the steam parameters selected.		2017 onwards new thermal power plants be based mainly on supercritical technology. Already 40 supercritical units with a total capacity of 27,485 MW have been installed.	
National Mission for clean coal (Carbon) technologies	Supercritical technology reduces the use of coal per unit of electricity produced. Supercritical power plants.	Technology	Coal/ Power; CO_2	To promote Clean Coal Technology.	The increased thermal efficiency results in emission reduction to the tune of 20%	Development of advanced ultra-super critical technology for coal based thermal power plants	MoU among Indira Gandhi Centre for Atomic Research (IGCAR), NTPC and BHEL for indigenous development of Advanced Ultra Supercritical Technology which will have substantially higher power plant efficiency resulting in 20% reduction in CO_2 emission with respect to conventional sub-critical plants.	

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Steps taken and envisaged, and Results achieved	Relevant national legislation / policy
Removal of Barriers to Energy Efficiency Improvement in the Steel Rerolling Mill Sector	Reduce GHG emissions by providing technical assistance to small and medium-sized steel rerolling mills in India that will enable them to adopt more energy efficient technologies.		Steel Rerolling Mill Sector	Improving energy efficiency		Ministry of Steel will establish a center for training, information and capacity strengthening on a sustained basis.	It will also develop institutional linkages with energy-service companies for providing off-the-shelf technologies from international equipment vendors.	UNDP-GEF Steel Projects
Integrated Power Development Scheme (IPDS)	To address the problems of distribution losses by financing the modernization of sub-transmission and distribution networks		T&D	To reduce AT&C losses		i. Strengthening of sub-transmission and distribution networks in the urban areas, ii Metering of feeders / distribution transformers / consumers iii IT enablement anddistribution strengthening work .	Under i) and ii) DPR's are under examination/ approval by PFC/ MoP. Under iii) IT projects have been sanctioned in 1412 towns, SCADA projects in 72 towns and distribution system strengthening projects in1259 towns. Projects sanctioned have been completed in some areas whereas others are at various stages of completion.	

Table 3.10: Mitigation actions in renewable energy

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/Progress indicator	Methodology/ Assumption	Steps taken and envisaged, and Results achieved	Relevant national legislation/ policy
National Solar Mission (renamed as Jawaharlal Nehru National Solar Mission)	Reducing the cost of solar power generation in the country through (i) long term policy; (ii) large scale deployment goals; (iii) aggressive R&D; and (iv) domestic production of critical raw materials, components and products, as a result to achieve grid tariff parity by 2022	Economic and fiscal	National; Solar Energy; CO_2, CH_4, N_2O	To develop a solar capacity in India that is capable of delivering solar energy competitively against fossil-options	To deploy 100 GW solar power by 2022.	Grid connected solar power capacity of 1 GW by 2013. Atleast additional 3 GW through mandatory purchases backed with preferential tariff by 2017.	To be implemented in three stages. The total financial outlay during Phase 1 is estimated as ₹4,337 crore. Requirement for second phase will be assessed after review of phase 1. As of March 2015, a total of 3743 MW Grid connected Solar Power Projects have been commissioned.	National Action Plan on Climate Change
Renewable Purchase Obligations	Minimum percentages of the total power that electricity distribution companies and some large power consumers need to purchase from renewable energy sources	Affirmative action. Economic, and fiscal	National; Renewable Energy; CO_2, CH_4, N_2O	To create a market for renewables		State electricity regulatory commissions (SERC) sets year-wise targets in their respective states.	Except Sikkim all states/ UTs have such targets.	Renewable Energy Regulatory Framework /Electricity Act 2003 / The National Tariff Policy (NTP) 2006

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/Progress indicator	Methodology/ Assumption	Steps taken and envisaged, and Results achieved	Relevant national legislation/ policy
National Clean Energy Fund (NCEF)	Imposing a cess on coal at an effective rate of ₹ 200 per tonne of coal produced and imported into India	Fund	National; Renewable Energy; Environment, Forest, CO_2, CH_4,	For funding research and innovative projects in clean energy technology	The Government expects to collect US$ 3.2 billion under the Fund by 2015.		To support projects, programmes and policies that promotes clean energy technologies. To establish a focused investment vehicle for companies investing in green technology.	Clean Energy Cess Rules, 2010

Table 3.11: Mitigation actions in forestry

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology / Assumption	Step taken/ envisaged and Results achieved	Relevant national legislation and/policy
Green India Mission	Afforestation and reforestation in degraded forests and non- forests area	Mitigation and Adaptation	Forestry; CO_2	Increased forest/tree cover on 5 Mha of forest/ non-forest lands and improved quality of forest cover on another 5 Mha (a total of 10 Mha)	10 million Ha in 10 years (2010-2020)/ Area afforested, change in tree crown density, C-sequestration rate	Participatory approach	Decentralized forest governance Revamping Forest development agency Engaging new stakeholders Peoples participation Convergence with existing programmers and other Missions Eco-restoration of degraded forest; REDD plus benefits	National Action Plan on Climate Change
Clean Development Mechanism- Afforestation and reforestation	C-sequestration, horticulture plantations; mangrove restoration; agroforestry; reforestation of wastelands; A/R under JFM and livelihood improvement through plantation forestry	Mitigation	Forestry; CO_2	To achieve net additional Carbon sequestration.	Number of CDM A/R Projects registered Area afforested, C-stock in baseline, MAI of biomass and soil carbon	As per CDM Approved methodology	Horticulture plantations, mangrove restoration, agroforestry, reforestation of waste lands, livelihood improvement through plantation forestry, A/R under JFM, etc. 10 CDM A/R projects registered from India	CDM
Mitigation in Voluntary Carbon Markets	Agriculture Forestry and Other land use projects (AFOLU)	Mitigation	Forestry; CO_2	GHG emission reduction Sustainable development of the host country	Number of AFOLU Projects registered	As per VCS Approved methodology	Voluntary participation of AFOLU Project developers. 4 AFOLU projects registered from India so far.	Voluntary Carbon Market
REDD-plus	Khasi Hills community Carbon Project in Meghalaya	Mitigation and Adaptation	Forestry; CO_2	GHG emission reduction; Addressing livelihood issues	Projects registered with Plan Vivo standard	As per approved standard methodology	Avoided Deforestation and degradation and afforestation	Voluntary action

Name of mitigation action	Description	Nature	Coverage (gases/ sectors)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology / Assumption	Step taken/ envisaged and Results achieved	Relevant national legislation and/policy
Low carbon strategy	Protected Areas (PAs)	Mitigation and Adaptation	Forestry; CO_2	GHG emission reduction/ removal	Protection of 16 million ha forest	Continued protection of PAs	Protection	Vision document of Planning Commission of India
	Sustainable Management of Forests other than PAs	Mitigation and Adaptation	Forestry; CO_2	GHG emission reduction/ removal	Sustainable management of of 16 million ha forest		Forests subject to sustainable harvests. (53 m ha)	
	Improvement in Forest and Tree Cover	Mitigation and Adaptation	Forestry; CO_2	GHG emission reduction/ removal	Improving 1 mha area each of open forests and medium dense forests		Improving 1 mha area each of open forests and medium dense forests with a view to upgrading these forests to the next higher category.	
	Increase in Forest and Tree Cover in Forest Fringe Villages	Mitigation and Adaptation	Forestry; CO_2		1.7 million ha afforestation/ reforestation per annum		17 mha can be added by creating forest and tree cover in and around 170,000 forest fringe villages.	
National Afforestation Programme	Includes afforestation and reforestation of degraded forests and non forest areas.		Forestry; CO_2	Afforestation/ reforestation: 3 Mha (2002-07) and rehabilitation of ~ 20 Mha of land	Area afforested, biomass growth rate, timber and fuelwood production	Area brought under different activities, survival rates and biomass growth.	Increase and/or improve forest and tree cover, rehabilitation of degraded forests and other areas 7.4mha area The NAP was reconstituted into Greening India Mission under 12th FYP. India is adding or improving about 1 mha of forest and tree cover annually	National Afforestation and Eco-Development Board

Table 3.12: Mitigation actions in agriculture sector

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Expansion in the area under fruit tree based systems	Fruit trees such as mango, citrus, cashew nut, guava, amla, cocoa, apple, sapota, litchi, coconut and areca-nut	Carbon Sequestration	CO_2	To increase the production of horticulture crops	Area planted	Estimation of carbon sequestration in tree systems	Support establishment of nurseries and green houses, subsidy for obtaining quality planting material for farmers, inputs such as fertilizers, pesticides, drip irrigation facility in some states. The area planted under the fruit trees is 7.0 million ha in 2013-14	National Horticulture Mission/ Mission for Integrated Development of Horticulture
Expanding area under System of Rice Intensification	Irrigation is given to maintain soil moisture near saturation. Rice fields are kept moist rather than continuously saturated, minimizing anaerobic conditions		CH_4, N_2O	To increase the coverage under best practices in rice	Coverage of the area every year and enhanced productivity of rice		To produce an additional 10 m t of rice during the 12th plan period by expanding the area under rice and also by enhancing the productivity in a sustainable manner in the identified districts. SRI expanded to 175298 ha till 2013-14	National Food Security Mission

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Crop diversification from paddy to alternate crops	To divert about 5% of the area under paddy to alternate crops such as coarse cereals, Pulses, poplar based agroforestry systems from 2013-14 year.		Haryana, Punjab and Western Uttar Pradesh CH4	The overall goal is to divert 5% of the area under paddy to other crops	Area covered under the action	Reduction in electricity usage for pumping water is a co-benefit	Support in the form of crop demonstrations with alternate crops, farm mechanization, land development, for establishment of agro based food processing units for value addition etc. 1.63 Lakh ha were achieved during the year2013-14.	Crop diversification programme
National Mission on Micro Irrigation	Improvement in energy efficiency through micro irrigation systems		CO_2	To increase area under micro irrigation through improved technologies		The life of the MIS is about 10 years	To enhance water use efficiency and to enhance agricultural productivity	
Improvement in energy efficiency through replacement of energy efficient pump sets			CO_2		Coverage of the area and the number of efficient pump sets installed		As part of the agriculture demand side management Initiatives, upgradation of existing pump sets is being taken up with the energy efficient pumps by BEE. 2209 pump sets have been replaced in pilot project at Solapur district.	A component under the NMEEE in convergence with NMSA.

Table 3.13: Mitigation actions in transport sector

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Auto Fuel Policy	Alternate Fuels	Regulatory	National, CO_2 mainly	Reduction in emissions	Bharat stage III norms for vehicles	Applicable on all road vehicles	BS-III auto fuel (MS/ HSD) has been extended to all the cities of India from 1st April, 2010. BS-IV auto fuel was introduced in 13 identified cities on 1st April, 2010 and is now extended to 50 more cities, with preference to most polluted cities, subject to availability of fuel and logistics constraints. It has also been decided that it will be extended in entire country by 1st April, 2017 in phases.	Government of India is already implementing this in stages
Coastal shipping promotion	Modal shift	Regulatory	National, CO_2 mainly	Enhancing modal shift from road to navigation	Installation of Ro-Ro ferry services	Modal shift	Coastal shipping, it is proposed to setup jetties for the Ro-Ro Ferry service network in Gulf of Kutch, Gulf of Cambay and western / southern coastal states up to Kerala.	This policy is being implemented in phases
Ethanol Blending Programme	Alternate fuels	Regulatory	National, CO_2 mainly		5% blending of ethanol		Blending is already in progress across the Indian states	Government notification exists

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Promoting inland waterways	Modal shift	Regulatory	National, CO_2 mainly	Enhancing modal shift from road to navigation		Modal shift	National waterways created, mainly in eastern India	This policy is being implemented in phases
National Road Transport Policy	promote modern, energy efficient and environment friendly road transport	Regulatory	National		Central Road Fund through collection of cess from petrol and diesel. Promotion of public transport and creation of better roads, upgrading State road transport co-operations		Cess of ₹2/- per litre is collected as cess on petrol and High Speed Diesel (HSD) Oil. The fund is distributed for development and maintenance of National Highways, State Roads, Rural Roads and for provision of road over brides/under bridges and other safety features at unmanned Railway Crossings.	Central Road Fund Act, 2000.
National Urban Transport Policy	Putting Public Transport and Non-motorized vehicle at forefront	Regulatory	National, all gases	To ensure safe, affordable, quick, comfortable, reliable and sustainable access for the growing number of city residents				This policy is being implemented in phases
	Reducing pollution levels through changes in transport infrastructure	Regulatory						
	Promoting the use of cleaner vehicular technologies	System Efficiency						
Metro railways	Modal shift	Regulatory	National, mainly CO_2		15 cities are already implementing metro railway systems in India	There are two registered CDM projects on Delhi metro – regenerative breaking and modal shift	Delhi metro alone would save around 0.5 million tonnes CO_2e each year.	Extending the Delhi Metro Railway Act to other cities in order to facilitate the provision of Metro Rail based public Transport
Electrification of Railways	Fuel switching	Regulatory	National, mainly CO_2	System Efficiency	By March 2012, electrification on Indian Railways has been extended to 22224 RKMs which includes 25 RKMs of Kolkatta Metro. This constitutes 34.48% of the total Railway Network and 40.27% of the BG system respectively.		Complete documentation is available for traffic shifting from diesel traction to electric traction on an annual basis. GHG emission savings need to be estimated.	Ministry of railways has detailed plans for electrification of main routes
Bus Rapid Transit Projects	Modal shift	Regulatory	National, mainly CO_2	Supportive measure-Market Development	Operational in 8 cities, plans to expand this to 24 cities	Methodology similar to Metro rail could be deployed.	Already operational in 8 cities including Ahmedabad, Surat, Bhopal, Delhi, Jaipur	This policy is being implemented in phases

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Monorail Projects	Modal shift	Regulatory	National, mainly CO_2	Supportive measure-Market Development	Operational in 6 cities, plans to expand this to 28 cities	Methodology similar to Metro rail could be deployed.	Mumbai monorail operational	This policy is being implemented in phases
Lighrail Projects	Modal shift	Regulatory	National, mainly CO_2	Supportive measure-Market Development	Being planned for Delhi and Kolkata as of now	Methodology similar to Metro rail could be deployed.		This policy is being implemented in phases

Table 3.14: Mitigation actions for sustainable habitat including buildings and waste sectors

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
National Mission on sustainable Habitat	Increasing energy efficiency in buildings; Urban transport and Water supply	Regulatory	National	Increasing energy efficiency in buildings; Urban transport and Water supply		Building bye laws and standards, Mandatory rainwater harvesting, water and energy audits	Energy performance monitoring, national standards for construction and recycling of construction waste; norms integrating congestion charges, parking, etc., norms for pedestrian and cycling, integrating transport planning with spatial planning	NAPCC
Promotion of Solar Thermal Systems for air-heating/ Steam generating applications, Solar buildings	To accelerate widespread use of solar thermal systems for air heating and steam generating applications	Regulatory	National				Use of solar thermal systems of air air heating and steam generating applications as well as use of solar passive techniques in building design, through a combination of financial and promotional incentives and and Akshay Urja Shops	

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
JNNURM	Integrated development of infrastructure services in cities	Directed Financial Incentives	National/ Urban	To encourage reforms and fast track planned development of identified cities.		Focus is to be on efficiency in urban infrastructure and service delivery mechanisms, community participation, and accountability towards citizens.	Water supply and sanitation, sewerage, solid waste management, road network, urban transport, and redevelopment of old city areas with a view to upgrading infrastructure) and basic services to the urban poor	
	Solid waste management projects						Waste to compost, waste to energy, recycling of waste, sanitary landfills	
	Waste water management						Recycling of waste water	
	Urban transport						Promoting public transport (incl. mass transit), NMT, comprehensive and integrated land use and mobility plans, and Intelligent Transport System (ITS), and launching of awareness campaign in line with the NUTP, 2006	
	Developing Comprehensive Mobility Plans (CMP)							
Solar Cities	A total of 60 cities/towns are proposed to be supported for development as "Solar/ Green Cities"	Regulatory-System Efficiency	National/ Urban	To enable and empower Urban Local Governments to address energy challenges at City - level.	Targets at minimum 10% reduction in projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources	At least one city in each State to a maximum of five cities in a State may be supported. The cities may have population between 0.5 to 50 lakh. Relaxation could be considered for special category states including North-Eastern States.	Sanctions have been issued for 50 Cities. Eight Cities are to be developed as 'Model Solar Cities'. So far, Nagpur, Chandigarh, Gandhinagar and Mysore have been identified/ sanctioned. Fifteen Cities to be developed as 'Pilot Solar Cities'.	MNRE
Waste to Energy Projects	Power generation from MSW	Regulatory	National / Waste			Use of high rate biomethanation technology		
Home Bright	Residential High-Efficiency Lighting Programme,	Regulatory	State (Karnataka)			CFL/LED/Electronic chokes		

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Public Buildings Partnership Programme	Energy Efficiency	Regulatory-System Efficiency	State (Karnataka)				Implementation in public buildings using ESCOMs route.	
Green Buildings Programme	Construct one or two new Green Buildings in each district of the state	Market Development	State (Karnataka)				ECBC Code. The Green Building concept will be mandatory for all corporate buildings and the buildings constructed by the developers in all the city corporation limits of the state under the suitable amendment to building bye-laws.	
Bharat Nirman	To create and augment basic rural infrastructure	Directed Financial Incentives	Cross Sectoral	Time bound business plan for action in rural infrastructure			Irrigation, Rural Roads, Rural Housing, Rural Drinking Water Supply, Rural Electrification and Telephone Connectivity	
Energy Conservation Building Code (ECBC)	Developed by the Bureau of Energy Efficiency (BEE), prescribes a minimum standard for energy use in new buildings	Voluntary	Buildings (commercial)	Establishes minimum requirements for energy-efficient building design and construction	The load requirement for buildings to comply is 100 kW or 120 kVA	Enables commercial and high-rise residential buildings (~ five stories or higher) to come under the code's purview.	Both Leadership in Energy and Environmental Design (LEED) and Green Rating for Integrated Habitat Assessment (GRIHA) rating systems have adopted ECBC as a minimum compliance requirement.	Energy Conservation Act, 2001
National Building Code (NBC)	A comprehensive building code which provides guidelines for regulating construction activities. It serves as a model code for adoption by all agencies involved in building construction.	Voluntary	Buildings (Commercial and residential)	To promote energy efficiency and resource optimization in buildings.	Stipulations regarding materials, structural design and construction, and building and plumbing services.	Administrative regulations and general building requirements.	The Bureau of Indian Standards is in the advanced stage of revising the code to incorporate sustainability and ECBC references (BIS).	
Green Rating for Integrated Habitat Assessment (GRIHA)	GRIHA is the national rating system for green building design, developed and implemented by The Energy and Resources Institute (TERI) and the Ministry of New and Renewable Energy (MNRE) (MNRE, 2010).	Voluntary	Buildings (Commercial and residential)	To promote energy efficiency and resource optimization in buildings.		If buildings contain fully air-conditioned interiors, ECBC compliance is mandatory for GRIHA ratings. If buildings are naturally ventilated, only partial ECBC adoption is required.	All new central government and public sector buildings are to comply with the requirements of at least three-star GRIHA ratings.	

Name of mitigation action	Description	Nature	Coverage (gas/ sector)	Objectives of the action	Quantitative Goal/ Progress indicator	Methodology/ Assumption	Step taken/ envisaged, and results achieved	Relevant national legislation and/policy
Programme on Energy from Urban Industrial and Agricultural wastes/residues	Power generation from MSW involving RDF Power generation on high-rate biomethanation Power from MSW on gasification-pyrolysis and plasma arc Biomethanation technology for power generation from vegetable market waste, slaughter house waste above 250KW capacity	Regulatory	National/ Waste	To promote setting up projects for recovery of energy from urban, industrial and agricultural wastes		Provides total financial assistance in the form of capital subsidy ad grant in aids.		Implemented by MNRE through state nodal agencies, local bodies, NGOs, ESCOs etc.
Power generation at sewage treatment plants	Generation of power from biogas being produced at Sewage Treatment Plants.	Regulatory	National/ Waste				Project cost will include the cost of engine-genset, H_2S removal plant and other related equipment	

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Chapter 4

Finance, Technology and Capacity Building Needs and Support Received

Finance, Technology and Capacity Building Needs and Support Received

According to decision 2/CP.17, non-Annex I Parties are to provide updated information on constraints and gaps, and related financial, technical and capacity-building needs, as well as updated information on financial resources, technology transfer, capacity-building and technical support received from the Global Environment Facility, Parties included in Annex II to the Convention and other developed country Parties, the Green Climate Fund and multilateral institutions for activities relating to climate change, including for the preparation of the current BUR.

Accordingly, this chapter presents information on the need for continued reporting of the GHG inventory under the Convention, and financial, technological and capacity-building needs, constraints and financing received. The contents of this chapter should be read in conjunction with the information provided on technology and finance needs in SNC as the needs remain largely relevant for present reporting as well.

4.1 GHG Inventory Reporting: Constraints, Gaps and Improvements

Government of India is continuously striving to improve national GHG estimation and reporting to the UNFCCC from INC to SNC and from SNC to the first BUR. To achieve continuous improvement in national reporting, Government of India made institutional arrangements, specific for the nature and scale of the BUR preparation. Seventeen institutions were engaged to conduct a number of studies for BUR, including those which especially carried out studies to identify constraints and gaps and related financial, technical and capacity needs, including information on financial support needed and received.

Financial support from the Global Environment Facility towards preparation of BUR was received in December 2013, while as per UNFCCC decision 2/CP.17 as reported in document number UNFCCC/CP/2011/9/Add.1 clause 44, it should have been received as early as possible in 2012 so as to provide more than two years for preparing the BUR and its submission by 31st December, 2014. Government of India, under these time constraints, has prepared this Biennial Update Report well within two years of receiving financial support.

As a part of the BUR preparation, refinement of NCVs for coking, non-coking coal and lignite used for various industries for 2010, was attempted. Emission factor for road transport sector has been modified as per the IPCC 2006 guidelines. Non-CO_2 GHG emissions arising from biomass consumption have also been estimated under Energy sector. Sub-categories 'Brick', 'Fertilizer' and 'Engineering' were newly attempted sectors under the category 'Manufacturing Industries'. Under IPPU, sub-category 'Ceramics' was included. A consistent time series inventory of GHG emissions from Energy, IPPU, Agriculture, Waste and LULUCF sectors for 2000-2010 was prepared.

Emissions from sub-categories such as energy consumption in unorganized sectors, Food and Beverages, Non-Metallic Minerals, Glass and Ceramics could not be estimated very precisely because of lack of availability of relevant and reliable data sets. Due to poor availability of reliable data for the inventory year (2010), extrapolated values have been used for the sub-categories such as glass production, ceramics and nitric acid production (IPPU). The non-accessibility of data, particularly those available with private entities, and integration related issues, add to the constraints in preparation of national GHG inventory.

For the LULUCF sector, the IPCC-2006 guidelines were adopted for estimating the GHG inventory for the year 2010. Further, trends in GHG inventory were estimated for the period 2000-2010 for this sector. Remote sensing data was used to generate a land use change matrix for the inventory period. Carbon stock changes for cropland and grassland categories were estimated from the field studies. Further, information on carbon stock changes from ICAR research institutions was compiled and used.

The requirement of BUR submission entails data needs on a regular basis. Table 4.1 depicts gaps and constraints in GHG inventory estimation. These include designing consistent data reporting formats for continuous GHG inventory reporting, collecting data from formal and informal sectors of the economy, enhancing data depths to move to higher tiers of inventory reporting, and

conducting detailed and fresh measurements for Indian emission coefficients. Capacity development has to be at two levels — institutional and individual researchers. Institutional capacity development requires financial support, technological support, instrumentation, and networking. Individual researcher capacity development is required to sensitise and train data generating teams in various sectors and at different institutions about GHG inventory estimation process so that the researchers would be better equipped to collect and report the desired data on a continuous basis. Institutional networking and coordination is a critical success factor for establishing new data frameworks and reporting formats in various sectors. Central and State government ministries and departments, industry, research institutions, and academia have to coordinate closely for this. The Government of India has initiated a process, including creating a National Inventory Management System (NIMS), to establish long term institutional structure for periodic and continuous GHG inventory for BUR and National Communications reporting, along with QA and QC arrangements. The uncertainty involved in the activity data and emission factors will be reduced with improved data gathering and archiving arrangements. However, sustained and timely international support for finance and technology needs is critical to sustain and strengthen these processes.

Quantification of emission reductions from mitigation measures for reporting in the BUR was also constrained by the gaps indicated in Table 4.1.

4.2 Financial Resources

India has received GEF funding for the preparation of third National Communication and BUR. Government of India has been providing considerable domestic funding for climate change related research and mitigation and adaptation actions. Government of India is consistently committing resources through the annual Union Budgets towards public spending on climate change adaptation. As per a working document titled Climate Change and India: Adaptation GAP (2015), over the last ten years, the overall budget outlay has increased by a factor of four (from 2003-04 to 2014-15). On the other hand, development

Table 4.1: Gaps and constraints in GHG inventory estimation

Gaps and constraints	Description	Possible solutions Under NIMS
Data organization	Published data not available in IPCC friendly formats for inventory reporting	Design consistent reporting formats
	Inconsistency in top-down and bottom-up data sets for same activities	Data collection consistency required
	Mismatch in sectoral details across different published documents	Design consistent reporting formats
Non-availability of relevant data	Time series data for some specific inventory sub-categories, e.g. municipal solid waste sites	Generate relevant data sets from now onwards
	Data for various Medium, Small and Micro Enterprises (MSME) sectors and various informal sectors of the Indian economy	Involve concerned stake holders, Conduct data surveys
	Data for refining inventory to higher tier levels for the key sources of GHG inventory	Data depths to be improved
Data non-accessibility	Proprietary and trade secret data for inventory reporting at tier III level	Involve industry and monitoring institutions
	Data not in electronic formats	Identify critical data and convert
	Security concerns	
	Devise protocols to access data	
Technical and institutional capacity needs	Training the activity data generating institutions in GHG inventory methodologies and data formats	Arrange extensive training programmes for all sectors
	Institutionalise linkages of inventory estimation with broader perspective of climate change research	Wider dissemination activities
Non-representative emission co-efficients	Inadequate sample size for representative emission coefficient measurements in many sub-sectors	Conduct more measurements for emission factors, especially for key sources of GHG inventory

and adaptation related outlays have increased by a factor of five. This implies that rate of growth of government allocation to development and building adaptive capacity has been increasing steadily over the years, much faster than that of overall annual budgets. The public spending on adaptation last year was ₹2130 billion *i.e.* 12% of the budget for the year (~2% of GDP). Various state governments contributed another ₹3100 billion through their state budget for similar activities. In addition to the overall development expenditure for enhancing adaptation to climate change, twenty-one (from a total of sixty-six) Central Government Schemes have been identified that are directly related to climate change adaptation. The total commitment for these 21 schemes (actual expenditure as per revised estimates for 2013-14) was ₹740 billion during 2013-14 or 0.7% of GDP. The total spending, therefore, on developing adapting capacity and adaptation was ₹5970 billion (around US$ 91.8 billion) in 2013-14. The Loss and Damage from extreme events were estimated in addition at US$ 5-6 billion in the same year.

This indicates that despite resource constraints and many competing demands, India has been making specific and ambitious budgetary outlays to address the challenges of climate change. According to UNFCCC, international financial support is to be provided to developing countries to enable them to take voluntary actions for mitigation and adaptation. It is important to ensure that flow of funds through these sources is indeed 'new and additional resource' and the terms of finance are in accordance with the provisions enshrined in the Convention.

4.2.1 Global Environment Facility

Global Environment Facility (GEF) is one of the mechanisms of the UNFCCC to promote projects aimed at global environmental benefits. Since 1991, India has accessed US$ 327 million as GEF grant. Of this, US$ 154 million was accessed during the GEF 4 cycle (July 2006 – June 2010). An allocation of US$ 76 million was utilized for climate change and US$ 30 million for biodiversity during GEF 4 cycle. However, during the GEF 5 cycle, India has received an allocation of US$ 93.75 million for climate change, US$ 30.58 million for biodiversity and US$ 5.1 million for land degradation. The list of projects receiving GEF funding currently consists of 37 national approved projects, and five regional and global projects. "Preparation of Third National Communication (TNC) and Other New Information to the UNFCCC" is also one of the approved projects with project tenure of five years and with total outlay of US$9 million as grant from GEF. This project includes preparation of three Biennial Update Reports.

Financial support from the Global Environment Facility towards preparation of Biennial Update Reports and third National Communication was received in December 2013. The team involved in the preparation of this report would like to acknowledge the support received from UNDP India to organize consultative meetings for preparation of the project document, and GEF for providing funding for the preparation of BUR.

4.2.2 Clean Development Mechanism

India is a major contributor towards CDM projects globally and has received CDM Executive Board's registration for over 1500 projects. Renewable energy technologies such as wind, biomass, hydro and solar energy accounted for almost 70% of the total number of projects registered, with wind energy alone accounting for 669 projects. Energy efficiency projects accounted for almost 14% (224) of the projects. Afforestation and reforestation projects accounted for 0.6% of all projects. Table 4.2 gives number of projects in different sectoral scopes that were granted host country approval by Government of India.

4.2.3 Latest Initiatives

Government of India has announced various policies and measures enhancing the ambition levels of climate change mitigation efforts that would require international financial support. Some of the main programmes include: enhancing total renewable energy targets to 175 GW capacity by 2022 which includes solar energy generation capacity enhancement to 100 GW from the present target of 20 GW by 2022; enhancing the wind based power generation capacity to 60 GW; a thrust to biomass based generation capacity with 10 GW and 5 GW of small hydro projects by 2022; civil nuclear programme for power generation; dedicated rail freight corridors; metro rail and BRTS in many cities; national highway development projects; enhancing the clean energy cess on all coal used in India four-times (from ₹50 per tonne to ₹200 per tonne); cutting subsidies and increased taxes on fossil fuels (petrol and diesel) turning a carbon subsidy regime into one of carbon taxation; tax free infrastructure bonds for renewable energy; promoting coastal shipping and inland water ways as more energy efficient transport; LED lighting in residential sector and municipalities all over India. These would also require technology transfer appropriately in all sectors. The existing and operational programmes that contribute to GHG emission mitigation

Table 4.2: Host Country Approval of the CDM projects by the National CDM Authority as on 14.08.2015			
Sectoral Scope		**Number of Projects**	**Potential of CERs Generation upto 2020 (tonnes of CO_2eq)**
1	Energy industries (renewable-/non-renewable sources)	2317	486,616,787
2	Energy distribution	9	657,149
3	Energy demand	223	27,063,340
4	Manufacturing industries	241	64,126,630
5	Chemical industries	18	10,604,072
7	Transport	13	1,238,906
8	Mining/mineral production	4	19,053,935
9	Metal production	4	5,382,938
10	Fugitive emissions from fuels (solid, oil and gas)	4	165,438
11	Fugitive emissions from (production and consumption of halocarbons and sulphur hexafluoride)	6	63,855,771
12	Waste handling and disposal	71	12,498,337
13	Afforestation and reforestation	28	10,902,464
14	Agriculture	3	74,393
	Total	**2941**	**702,240,160**

CDM Programme of Activities (PoA) accorded Host Country Approval as on 14.08.2015			
Sectoral Scope		**PoAs accorded HCA**	**Emission Reduction Potential (tonnes of CO_2eq)**
1	Energy industries (renewable/non-renewable sources)	21	720,331
2	Energy distribution	1	28,496
3	Energy demand	10	690,223
4	Manufacturing industries	3	363,566
5	Transport	1	637,440
6	Waste handling and disposal	2	36,007
7	Agriculture	1	-
	Total	**39**	**2,476,063**

and sink enhancement are being continued with zeal and deft. India is also investing in upcoming zero and low-carbon technologies such as renewable energy storage, fuel cells, electric cars, solar wafers and smart grids.

These programmes require committing substantial financial resources. International support in the form of new and additional financial and technological resources is, therefore, required.

Enhancing road transport infrastructure in North-Eastern states of India requires funds to the tune of ₹40,000 crore along with another ₹20,000 crore for railway infrastructure by 2016. The national highways development projects all over India would require around ₹54,000 crore over the next five years. Ongoing metro rail network construction across eight large cities alone would cost around ₹130,000 crore, while BRTS project in Ahmedabad alone is worth ₹ 600 crore of investments. Bio-diesel and ethanol blending in fossil oils is a strong programme. A 5% blending could mitigate around 12 million tonne GHG from the Indian transport sector each year by 2020. This programme needs financial support to take off. Methane capture projects have also been initiated at municipal sewage treatment plants on commercial basis, with an all-India estimate of ₹500 crore financing requirements, if around 100 cities are to have such facilities.

The Government of India has recently initiated an ambitious National Mission on Clean Ganga (NMCG), the largest river system in India. Vision for Ganga Rejuvenation

constitutes restoring the wholesomeness of the river defined in terms of ensuring "*Aviral Dhara*" (Continuous Flow), "*Nirmal Dhara*" (Unpolluted Flow), and maintaining her geologic and ecological integrity. The total estimated budget as on date is approximately ₹12,100 crore, while the sanctioned costs of various projects for NMCG across the five Gangatic states is ₹6,121 crore.

Considering the country's green and climate friendly growth trajectory, the Government of India has taken the above mentioned path-breaking decisions. Government of India is also hereby highlighting the need for financial support from bilateral and international donors as also the Green Climate Fund to achieve these targets.

4.3 Capacity Building Needs

India initiated the National Action Plan on Climate Change in 2008, which is monitored by the Prime Minister's Council on Climate Change. It has voluntarily announced a domestic goal for reducing the emission intensity of its GDP. Indian Network for Climate Change Assessment (INCCA) has been set up for making periodic assessment of climate variability and change. An Expert Group to evolve Low Carbon Strategies for Inclusive Growth was also set up which has made important recommendations for power, industry, transport, buildings and forestry sectors.

There are many capacity building needs for continuous preparation and reporting of GHG inventory as indicated in section 4.1 and table 4.1. There are also many capacity building needs for impact and vulnerability assessments across sectors and regions, sensitizing the vast Indian population vulnerable to these impacts, adaptation need assessments and their implementation, mitigation actions, and MRV systems. This is a continuous challenge requiring consistent support from international community, including appropriate financing. The capacity building needs as indicated in India's Second National Communication also stand.

India's efforts towards meeting the Intended Nationally Determined Contributions (INDC) alone will require proper training and upgrading of skills across sectors. While no firm assessments have been made, it is evident that substantial resources will be required to implement capacity building programmes both nationally and across the states to address climate change challenges.

4.4 Constraints and Gaps

4.4.1 Energy Sector

Energy sector is the largest emitter of greenhouse gases from India. It has a vast expanse covering different sectors, ministries and departments of the government, fuels, plants and their ownership patterns. There are also multiple policies, measures and programmes under implementation for mitigating GHG emissions from the Indian energy sector. Some of these have been enumerated in this document. The energy sector produces large volume of data that is relevant for GHG inventory reporting and accounting of mitigation actions. However, collating and analyzing such huge, scattered volume of information is a big challenge in itself. Government of India is planning to create a National Inventory Management System (NIMS) to cover these aspects as well. Establishing robust NIMS would require continued financial support from international resources.

4.4.2 IPPU Sector

Industrial processes and product use sector involves interaction with industry stakeholders and bodies. There are thousands of individual plants spread across India that are required to be mapped for their contribution to GHG emissions and also to document their contributions to GHG emission mitigation. There are also many Micro, Small and Medium Enterprises (MSME) sector players including micro household based businesses. Many of these are in un-organized sectors and information/data on these needs to be collected through primary surveys on a regular basis. It is a challenging task to establish such systems for timely and continuous estimation of GHG inventories from all the sub-sectors.

4.4.3 Agriculture Sector

Agriculture sector is a life-support system for the vast population in India for the food and livelihood requirements. Increasing food demand in the country, and the dependency of rural population for their livelihood on this sector, render it highly vulnerable to climate change. Change in rainfall patterns, temperature averages and several other factors such as deteriorating water and soil quality can severely affect agriculture. Such concerns have led to the launch of several programmes and projects over the years. However, any assurance of sustainable and adaptable agriculture in India is still a distant goal. Agricultural sector also provides

many mitigation opportunities synergistically with other objectives of the sector.

Data on country-specific emission factors for many fruit tree systems and crops is limited for Indian conditions. Little information is available on allometric equations and biomass expansion factors for horticultural species. Representative values for different agro-ecological regions are needed as these are distributed throughout the country, and their growth and biomass production are influenced by climate. Similarly detailed database on various farm inputs such as water, fertilizers (both inorganic and organic), off-road vehicles, and energy requires enhanced generation and assimilation. Data collection on livestock dung production and its collection, cattle feed and enteric fermentation also needs further enhancement and refinement.

4.4.4 Waste Sector

Waste sector is expanding in India, offering many opportunities for mitigating GHG emissions from waste. GHG inventory estimation from municipal solid waste requires estimation of waste collection at landfills over many years continuously. This information is currently not available. India has 59 cities that have population over one million as per national census of 2011. There are hundreds of smaller cities and towns that are generating wastes. Almost all states have laws on managing this waste on a regular basis. Some states and cities (Jaipur and Ahmedabad) have started collecting methane from waste water treatment plants and using it for industrial applications. Urban center level information and data is to be collected and analyzed from BUR and National Communication perspectives. Estimating GHG emissions from industrial waste water offers its own challenges.

4.4.5 Forestry Sector

Constraints and Gaps in creating GHG inventory

India plans to devolve increasing responsibility on the State Forest Departments (SFDs) to carry out the assessment and estimation of forest carbon stocks (FCS) in conjunction with the biennial exercise of assessment of forest and tree cover (FTC). This is considered essential to improve the precision level for estimation of FCS as the State Governments are in a better position to cover more number of sample points.

India is among the few countries to regularly use satellite-based remote sensing technology in detecting forest cover changes. The Forest Survey of India (FSI) has been assessing the forest cover on a two-year cycle since 1987. Over the years, there have been improvements both in the quality of remote sensing data and the accuracy of interpretation techniques. FSI is following the tier 2 and tier 3 of IPCC Good Practice Guidance (methodology) for carbon estimation in forests of India through a combination of remote sensing and ground-based forest carbon inventory. India plans to establish National Forest Inventory System as part of an overall National Inventory Management System, based on periodic assessments of carbon pools on permanent plots in different forest categories and sub-categories.

IPCC provides guidelines for three approaches for estimating and reporting activity data on area under different land categories and the conversions. Approach 1 was used during Initial National Communication (INC), and Approach 2 involving a land use change matrix was used in Second National Communication. In the future inventories, it is proposed to adopt Approach 3 which requires geo-referenced spatial distribution of land parcels belonging to each land category, sub-categories and land parcels subjected to conversion. This would require use of remote sensing and GIS for which country is well equipped.

CO_2 emissions and removal data is required for all the carbon pools, especially for above ground biomass and soil organic carbon for all land categories and land use change categories. For assessing the mitigation potential of the mitigation actions or REDD+, there is a need for estimation of the carbon stocks under the baseline or reference scenarios as well as annual carbon stock changes, post-implementation of the mitigation projects.

Long-term monitoring and estimation of GHG inventory in the AFOLU sector, and estimation of its mitigation potential would require several research, monitoring and capacity building programmes. A possible list of such research and monitoring programmes is given in Table 4.3.

Knowledge, Financial, Technical and Policy Gaps

There are numerous gaps and constraints which can affect implementation of mitigation activities in forest sector. The details of these gaps and constraints are summarized below:

Knowledge Gaps: Key knowledge gaps include the linkages between impacts of climate change and

Table 4.3: Potential research and monitoring programmes for GHG inventory in forest sector	
S. No	**Research theme/programme**
1	Initiate National Forest Inventory programme for long-term monitoring of different carbon pools in different forest categories and sub categories
2	Develop geo referenced spatial distribution of different land categories and sub-categories and area subjected to mitigation actions using remote sensing and GIS applications
3	Develop land use change matrix covering all the IPCC land categories
4	Initiate field studies to assess the changes or growth rates of different carbon pools in areas subjected to mitigation actions
5	Monitoring of carbon stocks and changes using remote sensing techniques
6	Establishment of QA/QC system
7	Establishment of a national MRV system for NAMAs, REDD+ and CDM projects
8	Develop carbon balance models for Indian land use systems
9	Monitoring of forest fires in different regions and the biomass burnt
10	Develop models for soil carbon dynamics in different land use systems
11	Studies to assess and project socio-economic pressures and drivers contributing to forest degradation and loss
12	Capacity building in different institutions involved in forest inventory, modelling and MRV

adaptation and mitigation options. More research is required to better understand climate change impacts and to come up with cost-effective solutions for mitigation at the local levels. Data on changes in baseline carbon stocks is required for estimation of mitigation potential. Further, carbon sequestration rate for different forest types and plantations is required for designing mitigation projects. Data on land area, potentially suitable for different REDD+ activities, too is not readily available.

Financial Gaps: There are several government policies relating to climate change. Significant efforts are being made for mainstreaming policies and acts in implementing relevant projects on ground. Additional financial allocations are necessary for designing and implementation of afforestation/reforestation projects. Green India Mission (GIM) aims to further increase the forest/tree cover to the extent of five million hectares (mha) and improve quality of forest/tree cover on another five mha of forest/non-forest lands along with providing livelihood support.

Technological and Capacity Building Gaps: The local capacity to collect LULUCF data at regional level requires strengthening. Before implementing technological advances in statistical data analysis and reporting, it is necessary to build adequate capacity for collection of data from primary sources. The capacity-building programmes should have a sustainable structure aiming at timely upgrade with the advancing technology. Implementation of REDD+ mechanism would require significant additional capacity for designing, implementation and MRV. India has the technical and institutional capacity, but it is dispersed in different institutions and regions.

India was among the first few countries in the world to provide for the protection and improvement of the environment in the national constitution, and it has taken several steps in designing policies and legislation to overcome environmental problems.

Current Capacity Building Situation in Forestry and Climate Change Issues

Various initiatives taken by the Ministry of Environment, Forest and Climate Change (MoEFCC), (Table 4.4) have helped in capacity building of State Forest Departments (SFDs), NGOs, civil society and other stakeholders to create an enabling environment for CDM afforestation/ reforestation projects in India. As a result, India is now a leading country in CDM afforestation/reforestation project activities in the world.

On the technical front, considerable capabilities have been developed in India in forest resource assessment, though a lot more needs to be done. The resolution of data generated through satellite imagery can be further enhanced to provide better results. Also, the resource assessment at the state and local levels is an area with scope for improvement.

Capacity building is required at all scales, from village level institutions to national organizations. Designing, implementation and MRV of mitigation projects, in particular CDM and REDD-plus projects will require building capacity at state and district level forest departments, research organisations and NGOs who will be involved in various activities.

Table 4.4: Current capacity building situation	
S. No	**Research theme/programme**
Training programmes	MoEFCC is regularly providing inputs on the subject of climate change and forestry to the officers of Indian Forest Service, trainees of Central Academy for State Forest Service (CASFOS) and scientists and technologists working in Government sector. REDD+ is another important area that, needs further capacity building endeavour.
Monitoring, reporting and Verification	India is among the few countries to regularly use satellite based remote sensing technology in detecting forest cover changes. This capacity could be applied for measuring, reporting and verification (MRV) activities. The 13th biennial cycle has been completed from digital interpretation of data for year 2010-11at 23.5 m resolution with a minimum mapping unit of 1 ha.
Local Capabilities	Institutions available at local level to deal with the forests include 'Gram Sabhas', Joint Forest Management Committees (JFMCs), Community Forest Management (CFM) groups (a large number in Odisha), 'Van Panchayats' (Uttarakhand), and village councils (North East).

CDM projects in Forest Sector

India has registered ten Afforestation/Reforestation projects in the forest sector. CDM projects provide opportunity to develop, implement, monitor, verify and report mitigation benefits in a very intensive and transparent manner, leading to capacity building in the implementing agencies.

4.5 Technology and Finance Needs

4.5.1 Renewable Energy

The Indian Government has ambitious plans for low carbon development and deployment of low carbon technologies. The most important decisions in recent times have been to scale up renewable power capacities — 175 GW cumulative capacity by 2022. National Solar Mission is scaled up from 20 GW to 100 GW by 2022 (4GW capacity already installed). In the same period, 60 GW wind power cumulative capacity is also planned.

As per present estimate, around ₹7.5 crore per MW funding is required for solar power projects. Therefore, total funds for 96 GW solar capacity addition will be ₹720,000 crore, or around US$ 110 billion. However, assuming that over the period solar power will become competitive mainly due to economies of scale, the funds required may be lesser at around US$ 90 billion. With regard to 36 GW of additional wind energy capacity, the total fund requirement would be around US$ 33 billion. In addition, expenditure to be incurred for upgrading/ redesigning grid infrastructure to support absorption of increased renewables during next seven years, up to 2022 will be of the order of ₹136,000 crore, or US$ 21 billion. It may be noted that the total financial requirements include the investments by public and private sectors put together. The government may normally provide viability gap funding to private investors and also generation based incentives as and when applicable.

To the present assessment the import bill for solar and wind capacity addition during 2015-2022 will be around US$ 50 billion (₹3,300 billion). As per the broad renewable energy industry trends, if these technologies are licensed for manufacturing in India, around 10% of the total cost may be chargeable as license fee. Total cost as on

technologies licensing itself will be around US $5 billion. This is only a broad assessment of the technology cost involved on the planned solar and wind deployment.

Apart from technology finance there is also the need of new technology advancements. Technology development is dynamic in nature. Broad technology needs for major renewables for India are provided in Table 4.5 Specific technologies required in the present context are given in Table 4.6.

4.5.2 Clean Coal Technology: Needs and Gaps

Technologies for coal based power plants have a history of about ten decades, while the modern power plant technology emerged only after 1950s. Super-critical technology dates back to this era only. In parallel, alternate energy conversion technologies like gasification (instead of combustion, as it takes place in coal boilers)

Table 4.5: Renewable Energy Technology Needs	
Solar PV	- Crystalline silicon photovoltaic cells of > 24 % cell efficiency - Hetero junction with Thin Interfacial (HIT) Module - High efficiency Concentrating PV (CPV) - PV technology based on p-type and n-type silicon wafers - Nano-related innovations - High temperature tolerance - Solar concentrators
Wind	- Composite materials: cheaper and lighter, also allowing larger wingspan - Offshore wind systems - Sensors related to extreme environments - Advanced blade coatings for offshore applications - Pitch-rotation/optimization of lift - Advanced control systems - Design capability for India specific wind turbines for low wind regime. - Indigenous LIDAR Development - Offshore wind resource measurements and design of offshore wind power plants. - Energy storage techniques in large windfarms. - Wind turbine blade testing facility as per international standards - Low Voltage Ride Through (LVRT) field testing - Forecasting and Scheduling of wind generation
Biomass	Advanced biomass gasification, second and third generation biofuel technologies
Small Hydro	Ultra low head technologies and in-stream turbine technology
Hydro	India is dependent on foreign countries for the import of equipment or services: i) Large capacity hydro turbines (above 200MW) ii) Large size integral runner casting (above 24 tonnes) iii) Turbine shaft (forged) (above 30 tonnes) iv) Generator shaft (forged) (above 30 tonnes) v) Gas insulated switchgear (GIS) components (up to 400 kVGIS now only being assembled and tested in India) vi) Extra high voltage (EHV) XLPE cables (400kV) vii) Split runner viii) Pump turbines above 60 mw x) CRGO steel for generators and transformers ix) Facilities for high voltage testing The import of above equipments increase the per unit cost of the electricity generated. Domestic knowhow and manufacturing is required to be developed in the above areas for which technology transfer is needed.
Hydrogen	• On-site hydrogen production-cum-storage-cum-dispensing systems • Polymer Electrolyte Membrane based electrolysers • Composite cylinders for on-board hydrogen storage
Energy Storage	• Bulk storage and RE integration • Frequency Regulation • Utility T&D grid support applications.

Table 4.6: Technology required and relevant information		
Solar PV Technologies		
Sl. No.	**Name of Technology**	**Relevant information about Technology**
1.	PV technology based on p-type silicon wafers	This technology leads to overall gain in efficiency between 2 and 3% absolute *i.e.* going from an average efficiency of 17% to 19 or 20%.
2.	PV technology based on n-type silicon wafers	The champion cells in this technology have reached over 24% and the modules made from these cells are at 21.5 % efficiency.
3.	Crystalline silicon photovoltaic cells	Manufacture of the patented cells of very high efficiency of >24%. In these modules the grid lines are not seen on the cell surface as both contacts are taken from rear. The cells use optical trapping and other patented concepts to achieve very high efficiencies.
4.	Hetero junction with Thin Interfacial (HIT) Module	This is another very high efficiency technology, with efficiencies reported more than 25%.
5.	Back Contact Back Junction (BCBJ) Modules	These cells are also known as PERL cells. These cells are manufactured by most prominent solar cell manufacturer in the world. The efficiencies are of the order of 19 to 20%. Very reliable with high through puts. The modules are of 17 to 18% efficiency.

Sl. No.	Name of Technology	Relevant information about Technology
6.	CdTe/Cds	This thin film technology has shown a very high promise as a potential alternate for wafer based crystalline silicon modules. The efficiency of these modules is of the order 14% on a production scale.
7.	Copper Indium Selenide (CIS)/ Copper Indium Gallium Diselenide (CIGS)	Among the thin film technologies highest efficiency cells of more than 20% for demonstration under R&D are using these materials. However, the module efficiency under production is about 14%. Efforts are still under progress to produce high efficiency modules using this technology.
8.	Micro-morphs	PV module based on hetro-junctions between micro- crystalline silicon and amorphous silicon hold promise because of the low cost. The cost per watt peak could be as low as ₹ 25 to 30. The efficiency of this module is about 10%. Although these modules are IEC 61215 and IEC 61730 qualified, the outdoor stability is still an issue, and research work is under progress.
9.	High efficiency Concentrating PV (CPV)	Gigawatt level high efficiency concentrating PV (CPV) installations; off-grid and micro-grid systems for small communities.
10.	High efficiency Concentrating PV (CPV)	High efficiency concentrating PV (CPV) for cogeneration. Flat glass concentrator with high efficiency silicon receiver. Utilizes a modular architecture for rapid scalability and ease of installation.
Hydrogen Energy and Fuel Cells Technology		
S. No.	**Name of Technology**	**Relevant Information about Technology**
1.	On-site hydrogen production-cum-storage-cum-dispensing systems	For providing hydrogen to demonstration vehicles, such facilities are being established in different parts of the world. Three facilities have already been set up in India. Two more facilities are under installation and commissioning. All these facilities have been set up with imported equipment. The requirement for such facilities is expected to grow in the coming years.
2.	Polymer Electrolyte Membrane based electrolysers	On-site hydrogen production can be accomplished using either alkaline electrolysers or by Polymer Electrolyte Membrane (PEM) based electrolysers. PEM Electrolysers are emerging as a new and efficient technology, compared to alkaline electrolysers.
3.	Composite cylinders for on-board hydrogen storage	Hydrogen is having very low density (about 14 times lower than air). For providing adequate driving range to vehicles before refuelling, pressure of on-board hydrogen is required to be raised either to 350 bar or 700 bar. In order to reduce the weight penalty, lighter composite materials are used for fabricating tanks for on-board hydrogen storage.
4.	Low temperature Polymer Electrolyte Membrane Fuel Cell (PEMFC) for stationary power generation and for vehicular applications	PEMFC are considered to be versatile fuel cells for both the applications because of their lower operating temperature of about 80°C. This makes quick start and stoppage very easy. PEMFC is being widely used for small capacity stationary power generation for backup power in telecom towers. Some of the technologies for this application are integrated with methanol reformer, which obviates the need for supplying hydrogen to remote locations where telecom towers are installed. It is relatively easy to handle and transport methanol.
5.	High temperature PEMFC	For improving durability of PEMFC, R&D efforts are also underway for developing high temperature PEMFC with operating temperature in the range of 120-180°C.
6.	Solid Oxide Fuel Cell (SOFC)	SOFCs are suitable for combined heat and power applications in view of their operating temperature of 600-1000°C.
7.	Molten Carbonate Fuel Cell (MCFC)	MCFC are high temperature fuel cells with operating temperature of about 600°C , that can be used in CHP mode of operation.
8.	Membranes for low temperature fuel cells	Membrane is a critical input material required for manufacture of low temperature fuel cells like PEMFC.
9.	Fuel Cell Buses	Fuel Cell buses are emerging as a clean urban mass transport technology.
10.	Traction motors for fuel cell buses	An important sub-system of fuel cell bus.

or pressurized combustion were tried. The motivation has generally been to establish coal as an alternate to oil due to generally high prices (post 1970s) or supply disruptions (during disturbances) in oil sector.

Two technology directions have been pursued:

i. Increasing steam temperature/pressures — using steam turbines: supercritical. Ultra-supercritical and Advanced Ultra-supercritical (AUSC) come out of this genere.

ii. Using high gas temperature directly — using gas turbines: IGCC, PFBC (pressurized fluidised combustion) fall in this approach.

Various Clean Coal Technologies with promise for the Indian energy sector including some being adopted/ proposed are:

- Supercritical Technology
- Ultra Supercritical Technology (USC)
- Advanced Ultra Supercritical (A-USC) Technology
- Integrated Gasification Combined Cycle (IGCC) Technology
- Pressurised Circulating Fluidised Bed Combustion technology
- Gas based Combined Cycle technology
- Solid Oxide Fuel Cell (SOFC), Integrated Gasifier Fuel Cell (IGFC) technology
- Underground Coal gasification (UCG) technology

The indigenous manufacturing capacity and technology transfer for Supercritical technology and Ultra-Supercritical technology are already being achieved with the involvement of indigenous manufacturers.

R&D funding in developed countries for AUSC, IGCC and PFBC technologies was reduced in the last 15 years owing to different reasons. In view of India's dependence on coal, despite full throttle renewable energy programme, there is need for re-activation of these technology directions. These technologies are in different stages of completion in various developed countries. Some went unto commercial plants (like coal IGCC), while others (PFBC) saw only relatively smaller demo-plants. Advanced Ultra supercritical (A-USC) has never been built so far. Internationally efforts are being made to develop A-USC technology with steam temperature of around 700°C. Typically a A-USC power plant having steam parameters of 300 kg/cm^2 pressure and 700°C steam temperature may have plant efficiencies of around 45%. Considering India's ambitious capacity addition programme, which may be largely based on coal, there is a need to develop Advanced Ultra Supercritical technology. However, there is technology gap and technology transfer/collaboration is required in this area.

IGCC is considered to be a potential technology for achieving very high efficiency using large size advanced class gas turbines. IGCC leads to very low emissions of sulphur and nitrogen oxides (SOx and NOx) and particulate matter (SPM). There is a technology gap and need of finance for developing IGCC Technology suitable for high ash content Indian coal. These technologies are highly capital and R&D intensive. This calls for a major undertaking and multi-national effort which will need to be enabled by governments of developed countries as the intellectual property developed so far remains with private companies which will need to be enabled to reactivate/ accelerate the efforts in this direction. Substantial efforts are also expected to be required to customize the technologies for Indian coals which have unique characteristics.

Earlier, Coal India Limited (CIL) had implemented a demonstration plant with the UNDP/GEF support for exploitation of coal mine methane (CMM) and utilization of the same successfully. Now, CIL is exploring and utilising coal bed methane (CBM) from their leasehold areas on commercial lines, and CIL has already conceived five CMM projects which will be taken up shortly. Exploitation of CBM/CMM would help in creating safe environment in mining coal and also in containing the emissions of more potent GHG, methane. While technology for development of CBM/CMM projects would be brought in by the bidders globally, the investments would also be by the successful bidder on revenue sharing basis as per the existing CBM policy.

Central Mine Planning and Design Institute is working on Ventilation Air Methane (VAM) project i.e. capture of methane from mines for generation of electricity in association with CSIRO, Australia.

Underground Coal Gasification (UCG) is another area under CCTs being pursued by CIL. Ministry of Coal is finalizing a policy for development of UCG in the country in order to harness the energy from the coal seams which cannot be worked through conventional methods though it is possible to gasify the same in-situ and produce syn gas which could be used for power generation or other industrial purposes. In this case also, technology has

to come from outside and blocks can be developed on revenue sharing model on similar lines of CBM policy.

4.5.3 Technology of Shale Gas

In order to harness hydrocarbon resources trapped in shale layers, policy guidelines for Exploration and Exploitation of Shale Gas and Oil by NOCs under nomination regime was announced on 14.10.2013. Oil and Natural Gas Corporation (ONGC) and Oil India Ltd. (OIL) have already identified, and permission has been granted for 50 and 5 blocks respectively under their Petroleum Exploratory Lease (PEL)/ Mining Lease (ML) acreages in the phase-I (spanning over 3 years). For subsequent two phases viz phase-II and phase-III, each spanning over three years each, ONGC and OIL have to identify additional 75 and 5 blocks respectively. Under phase-III of the assessment, ONGC and OIL have to identify 50 and 5 blocks respectively to carry out shale gas exploration and exploitation.

ONGC has in the meantime drilled 14 wells for shale gas exploration in its acreages. The results obtained are being analysed. OIL has undertaken detailed geological and geophysical (G and G) studies in five blocks identified in their PEL/ML acreages.

For shale gas exploration, ONGC is exploring the possibility of inducting wireline/pressure coring for better estimation of total gas content. Presently, conventional full closure coring is used ensuring good core recovery with minimum damage. Advanced logs such as ECS/ Lithoscanner for mineralogical analysis of shale and quick TOC computation, sonic scanner are being used for evaluating the stress profile and anisotropy studies. Moreover, geomechanical studies are being carried out for better design of hydrofracturing jobs.

4.5.4 Technology Gaps and Technology Transfer Needs in Hydro Projects

Following are the areas in Hydro Power sector where technology gaps exist and India is dependent on foreign countries for the import of equipment or services:

i) Large Capacity Hydro Turbines (above 200 MW)

ii) Large size Integral Runner Casting (above 24 tonnes)

iii) Turbine Shaft (Forged) (above 30 tonnes)

iv) Generator Shaft (Forged) (above 30 tonnes)

v) Gas Insulated Switchgear (GIS) components (up to 400 kV GIS now only being assembled and tested in India)

vi) Extra High Voltage (EHV) XLPE Cables (400kV)

vii) Split Runner

viii) Pump Turbines above 60 MW

ix) CRGO Steel for Generators and Transformers

x) Facilities for high voltage testing

The import of above equipment increases per unit cost of the electricity generated. Domestic know-how and manufacturing is required to be developed in these areas for which technology transfer is needed.

4.5.5 Technology Transfer Needs in Nuclear Power

For the first stage of Nuclear Power Programme, all Pressurized Heavy Water Reactors (PHWRs) set up are using indigenous PHWR technology. Nuclear Power Corporation of India Limited (NPCIL) proposes to construct another 16 PHWRs during the next two decades. For all these reactors, complete design, engineering, manufacturing of equipment / component, construction and operations are carried out by NPCIL.

As a part of second stage of nuclear power programme, a Prototype Fast Breeder Reactor (PFBR) of 500 MW capacity is under commissioning. All the technology related to the complete fuel cycle has been developed indigenously. Fast Reactor Fuel Cycle Facility (FRFCF) for reprocessing and fabrication of fuel for Fast Breeder Reactor (FBR) is under construction. This facility will reprocess fuel coming out of PFBR and also fabricate fuel for PFBR, thus working on the principle of solid-in and solid-out. Plans for setting up two units of Fast Breeder Reactor are under finalisation to be launched in the XIII Plan and correspondingly there will be augmentation of capacity of FRFCF to meet the requirement of FBR-Unit 1 and 2. For future FBRs, it is planned to set up reactors using metal fuel, for which it is planned to develop and test the prototypes in the test reactor.

For the third stage of nuclear power plant, a demonstration Advanced Heavy Water Plant of 300 MW capacity is planned to be launched shortly. This demonstration reactor will be the forerunner of future reactors utilising vast thorium resources in the country for clean energy production,

resulting in substantial reduction of greenhouse gases. A thorium research centre is being conceptualised for this purpose. All technologies required have been tested in the laboratory with prototype developments. While for the launch of the third stage nuclear power plants, large capacity deployment of Fast Breeder Reactors of second stage is required, all technological challenges are being attended to during the prototype developments in R&D centres. Department of Atomic Energy is also working on High Temperature Reactors for generation of hydrogen, as a future source of energy.

The reactors with foreign cooperation are planned to be set up on technical cooperation basis, with shared scope of work. Broadly, while the design and supply of major equipment would be from the partner country scope, the construction, equipment erection, commissioning, and supplies of some of the equipment would be in the Indian scope. Sites have been accorded 'in principle' approval and designated, where six reactors of each technology are planned to be set up in phases of twin units each.

In advanced technologies such as this, India desires to maximise the indigenous content by manufacturing of equipment designed by the foreign partner in the country. Different options are foreseen including the foreign partner setting up manufacturing facilities in India or tying up with an Indian manufacturer for joint or manufacture under license resulting in technology transfer for manufacture of nuclear equipment.

Other Climate Change Mitigation Activities in Atomic Energy

A broad-based Research, Development and Demonstration (RD&D) programme for development and promotion of technologies like solar thermal energy, hydrogen energy including hydrogen production and its storage, and fuel cell technologies is being pursued in Bhabha Atomic Research Centre (BARC). Demonstration plants have been set up with an option to scale up facilities for wider deployment with assistance from various agencies.

Various materials and technologies including nano-technology are being investigated to identify suitable systems for efficient hydrogen storage.

A number of materials which include oxide ion conducting electrolytes and corresponding cathodic and anodic materials for intermediate temperature (600 ^{0}C) solid oxide fuel cells have been prepared and characterised. Oxide proton conductors with enhanced stability and conductivity have also been investigated. In case of solid oxide fuel cells based on yttrium stabilized zirconia electrolyte, an open circuit voltage of 960 mV (mili Volt) with hydrogen/argon as fuel and air as oxidant has been demonstrated.

Most of these technologies are at demonstration level. Substantial finances are needed to scale up these plants for deployment across the country to realise their full potential in saving the environment.

Financing needs

The nuclear power projects have huge resource requirements given their inherently high capital costs. The projects are planned to be financed by a mix of debt and equity, with a ratio of about 70:30. While efforts to mobilise the equity are being made by the government companies considering the provisions of the Atomic Energy Act, the legislation for all activities related to atomic energy in the country, there is a need for mobilising the huge investment required.

Various mechanisms for credit from countries, multi-lateral lending institutions and financial institutions need to be evolved to ensure easy availability of debt for the nuclear power sector at competitive interest rates. Considering the large capital costs, the interest on debt has a huge bearing on the competitiveness of tariff of clean nuclear power.

4.5.6 Transport

Dedicated Freight Corridor

Indian Railways (IR) in an important component of infrastructure. The Golden Quadrilateral of IR and it's diagonals carry a major portion of freight and passenger traffic and have got over saturated (16% of route km carries 52% of passenger and 58% of freight). The effect of such operating environment is reflected in an average freight train speed of 25.8 km/h (BG Electric) and engine km per day of mere 474 km (BG Electric) and wagon km per wagon per day of 231.4 km (BG). This has led to a serious resource constraint in meeting the country's transport demand and steady decline of IR share in the total land transportation in the country from over 80% in the 1950s to about 36% today. Thus, to meet the ever increasing need of transportation, and recognizing the need for a quantum leap in the railway transportation capacity, Ministry of Railways has embarked upon a long term strategic plan to construct high capacity, high speed Dedicated Freight Corridors along the Golden Quadrilateral and its diagonals.

In the first phase, two corridors viz. 1520 km Mumbai-Delhi (Western Dedicated Freight Corridor) and 1856 km Ludhiana-Dankuni (Eastern Dedicated Freight Corridor) are being constructed. These corridors have very specific objectives, i.e. to reduce unit cost of transportation, create rail infrastructure to carry higher throughput per train, to offer Indian Railway customers guaranteed faster transit at economic tariff, to increase Indian Railway's share in the freight market and to improve overall transport efficiency of the rail network and to increase IR's share in the total land transportation in the country to 45%. These two corridors will be commissioned in phases from 2017 to 2019.

Both the corridors are being built with world class technology for heavy haul operation such as formation/ bridges designed for 32.5 tonne axle load, track consists of 60 kg long-welded rails, canted turnouts for high speed on loops, 2 x 25 kV OHE, TPWS (in WDFC), maximum speed of freight trains 100 km/h, average speed of 70 km/h, adoption of automatic signaling, mobile radio communication and no level crossings.

The financial resources required for Eastern and Western DFC network is about ₹70,000 crore. In addition, additional financial and technological resources would be required for higher throughput as planned.

Broad Guage network in North-Eastern States

As on 1st April 2015, 1114 km New line, 317 km gauge conversion and 465 km doubling projects are sanctioned which are yet to be commissioned. Out of this, 377 km of New line, 317 km of gauge conversion and 187 km of doubling is planned for commissioning by 2020.

Metro Rail Transport

Delhi Metro operates the largest metro of India transporting more than 2.6 million passengers daily. The total length of Delhi metro currently is 194 km. Delhi metro has set an ambitious target of increasing it's line length to more than 400 km in next few years thereby accommodating many more commuter to use a less GHG intensive mode of transport.

Construction of metro is a cost intensive activity. A number of technologies used by metro do not belong to host country, thereby making the use of latest technology expensive. Past experience of transferring technology (as in case of manufacturing of rolling stocks of Phase 2 in India by Bombardier) has proved that the project cost can be brought down substantially in the event the technology is deployed / available indigenously.

A few of the technologies being used by Delhi Metro are listed below. The cost of these can be brought down substantially in the event of technology transfer.

1. Rail for track
2. Most of signaling and telecom equipment
3. Rigid over head catenary systems, Gas Insulated substations, High voltage cables.
4. Tunnel ventilation system

However substantial technical assistance, capacity building and government incentives are required before the entities owning the technology agree to base their production units in India. The modalities of availability and deployment of funds for such capacity building is not clearly defined in the host country.

Successful technology transfer as witnessed in case of rolling stock will not only benefit Delhi Metro, but also the other upcoming metros. This will have two fold benefit:

(i) A nationwide impact on reduction of cost due to use of a more efficient mode of transport;

(ii) Reduction in cost of manufacturing.

Apart from technology as identified above, there is a need for building capacity of key decision makers, Metro officials and staff, that will help them identify more efficient technologies available world wide to reduce GHG emissions from operation of metros.

Due to its experience with CDM projects, Delhi Metro has developed a strong Monitoring, Reporting and Verification (MRV) culture. However, similar capacities need to be developed in all other existing and upcoming metros to accurately report GHG reductions that can be attributed to their operation.

Shipping and Inland Waterways

International Maritime Organization (IMO) adopted a resolution on Promotion of Technical Co-operation and Transfer of Technology relating to the improvement of energy efficiency of ships, and is focussing on its efforts on technical co-operation and capacity building to ensure smooth and effective implementation and enforcement of new regulations worldwide. India has been recognised as one of the ten Lead Pilot Country (LPC) to take forward all the aims on promotion of technical cooperation and transfer of technology related to reduction of GHG emissions.

India has an extensive network of inland waterways in the form of rivers, canals, backwaters and creeks. The total navigable length is 14,500 km, out of which about 5200 km of the river and 4000 km of canals can be used by mechanised crafts. Inland Waterways Authority of India (IWAI) is the statutory authority in charge of the waterways in India. There are six national waterways in India. Cargo transportation in an organised manner is confined to a few waterways in Goa, West Bengal, Assam and Kerala. The potential for freight movement through inland waterways is planned to be further strengthened.

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Chapter 5

Domestic Measurements, Reporting and Verification Arrangements

Domestic Measurements, Reporting and Verification Arrangements

5.1 Background

COP 13, through the Bali Action Plan, agreed to the principle of applying measurement, reporting and verification (MRV) to developing country Parties in the context of undertaking enhanced national/international action on mitigation of climate change (decision 1/CP.13). COP 19 adopted several decisions on the elements of the MRV framework. MRV occurs at the international level, but can also be voluntary at the national level. According to §3 of the annex to decision 21/CP.19 "Developing country Parties are encouraged to utilize existing domestic processes, arrangements or systems, including domestically available information, methodologies, experts and other aspects, for domestic measurement, reporting and verification. Otherwise, developing country Parties may wish to voluntarily establish domestic processes, arrangements or systems for the domestic measurement, reporting and verification of domestically supported Nationally Appropriate Mitigation Actions (NAMAs)". The definitions of MRV are provided in the box below.

Depending upon national circumstances, MRV provisions could build on existing experience from emissions reduction efforts, including MRV practices of CDM projects and procedures to quantify and account for emission reductions under carbon offset schemes.

Establishing an integrated domestic MRV system for GHG mitigation actions is a capacity building need for India. The MRV may be based upon listing of actions and their physical attributes, financial attributes as well as their emission reductions. This method of MRV of actions will build upon India's well established monitoring systems for financial monitoring across sectors, programmes and schemes. Currently, this monitoring and review is confined to various measurable financial and physical parameters that are embedded in the project design. There is no assessment of GHG emissions and mitigation achieved. The physical and financial targets, outputs and outcomes are however monitored in terms of their initial objectives and design at the project level. These ground level measures are aggregated within the implementing agency in a manner that they are consistent with the overall objective of the project and programme. Since many such actions are part of state level programmes (for example, distribution network upgrade and rural electrification), state level monitoring is also undertaken. On the other hand, for many of the programmes and projects that result in GHG mitigation, being national level programmes, regular monitoring is done at the national government level to ensure that goals, output targets and outcomes are met. Here also GHG emission estimation and resultant mitigation MRV is not done currently at any level. Finally, there is a mechanism for review and verification of the performance of these programmes at the Parliament level through debates/discussion, review by Parliamentary Committees like Public Accounts Committee, Standing Committees and Comptroller and Auditor General (CAG). In addition, all Ministries and agencies of Government are required to place their Annual Report before the Parliament.

Box: Definition of MRV

Measurement (M) is the first essential element in an overall assessment of the efficiency in implementing any mitigation action. It consists of the collection of essential data needed to conduct reporting and ultimately, verification.

Reporting (R) focuses on the specific installations under scrutiny and the emission sources and gases. The Reporting can be classified as: (1) Direct emissions reporting and (2) Indirect emissions reporting. Under direct emissions reporting the installation is usually required to install meters that report directly into a dedicated database, whereas the indirect emissions reporting usually relies on the registration of emissions that are verified before being released as final emissions data.

Verification (V), like monitoring, needs to be clearly defined and in line with the objectives of the mitigation programme. In many of the climate change mitigation programmes, the MRV frameworks use external independent verification (third party) to confirm that the monitoring and reporting is in line with the requirements.

India also has well established monitoring systems for measuring and reporting of energy efficiency, renewable energy, agriculture and forestry sector programmes and projects. These do not conduct any MRV for GHG emissions and mitigation, but have arrangements for MRV of different kinds of parameters (Table 5.1).

Some specific examples of existing MRV systems of different types and in different sectors are provided below. India does not have any GHG monitoring and mitigation assessment related domestic MRV arrangements presently.

5.2 MRV of Energy Efficiency: PAT (Perform, Achieve and Trade) Scheme

Perform, Achieve and Trade (PAT) is a market-based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy intensive large industries and facilities, through certification on energy savings that could be traded. The Ministry of Power, in March 2007 notified units in nine industrial sectors, namely Thermal Power Plants, Fertilizer, Cement, Pulp and Paper, Textiles, Chlor-Alkali, Iron and Steel, Aluminum and Railways, as

Table 5.1: Some existing sub-sectoral organizations contributing to domestic measurement and/or reporting and/or verification of different kinds of parameters (not GHG mitigation)

Sector	Parameters	Institution
Industry	All Industry end of pipe norms for air, water and solid waste, pollution (control) and disposal (over 100 industries)	CPCB (http://cpcb.nic.in/Industry_Specific_Standards.php)
	Disclosure for the conservation of energy reporting (Form A of Director's annual report by 21 industry types)	MCA (http://www.mca.gov.in/Ministry/actsbills/rules/CDoPitRoBoDR1988.pdf)
	CDM	National CDM Authority (http://www.cdmindia.gov.in/)
Transport	Pollution Under Control certificate for road vehicle exhaust	CPCB (http://cpcb.nic.in/Vehicular_Exhaust.php)
	Road Vehicle Engine Approval	ARAI (https://www.araiindia.com/services_standard_formulation_AIS.asp)
	Bharat Norms (various stages) for road vehicles of all types.	CPCB (http://cpcb.nic.in/Vehicular_Exhaust.php)
	Fuel quality specifications for diesel and gasoline	MoPNG (http://petroleum.nic.in/docs/autopol.pdf)
	Bio-diesel specifications and blending norms	MNRE (http://mnre.gov.in/file-manager/UserFiles/biofuel_policy.pdf)
	Railway engine specifications	IR (http://www.rdso.indianrailways.gov.in/works/uploads/File/FINAL%20DRAFT%20SPECIFICATIONS.pdf), and (http://www.indianrailways.gov.in/railwayboard/view_section.jsp?id=0,1,304,366,532,567)
	Shipping specifications and navigation	MoS (http://www.dgshipping.gov.in/)
	Aviation	DGCA (http://www.dgca.nic.in/)
Energy Efficiency	Perform, Achieve and Trade for eight energy intensive sectors such as power, steel, fertilizer, cement, pulp and paper etc	BEE (http://www.beeindia.in)
	Energy Labelling of electrical appliances such as airconditioners and refrigerators	
Forestry	Afforestation projects	MoEFCC and State governments
	Reforestation projects	
	Land-use area mapping	
	Species mapping	
Waste	Solid Waste management laws	Municipalities and CPCB/ SPCB
	Bio-Medical Waste disposal laws	CPCB/ SPCB
	Hazardous Waste disposal laws	CPCB/ SPCB
	Waste water treatment and disposal laws	Municipalities and CPCB/ SPCB

ARAI: Automotive Research Association of India; **CPCB:** Central Pollution Control Board; **SPCB:** State Polution Control Board; **MNRE:** Ministry of New and Renewable Energy; **MoPNG:** Ministry of Petroleum and Natural Gas; **IR:** Indian Railways; **MoS:** Ministry of Shipping; **DGCA:** Directorate General of Civil Aviation; **MCA:** Ministry of Corporate Affairs; **CDM:** Clean Development Mechanism; **BEE:** Bureau of Energy Efficiency

designated consumers (DCs). Railways is not included in the first cycle of PAT scheme. An ESCert will be an instrument issued by Ministry of Power/BEE for a one tonne of oil equivalent of energy savings achieved by the Designated Consumer. This scheme does not monitor GHG emissions and their mitigation.

The PAT programme is developed as a policy tool under the National Mission on Enhanced Energy Efficiency (NMEEE), one of the missions under the National Action Plan on Climate Change (NAPCC). The scheme has gained attention from industries as well as policy makers alike, for its capacity to bring down the energy related carbon emission and also to provide a basis for any future MRV in the energy efficiency sector.

As a national scheme success of the PAT scheme is critically dependent on the linkages between various agencies involved in its implementation. The overarching structure is provided by the specific functions that the Bureau of Energy Efficiency (BEE) has to perform under the Energy Conservation Act of 2001 and the guidance provided by the National Mission on Enhanced Energy Efficiency under the National Action Plan on Climate Change.

The process of PAT scheme includes sequential steps, namely goal setting, energy consumption reduction, review, certification and trade. The baseline SEC (Specific Energy Consumption) would be estimated based on the reported data of DCs (Designated Consumers) through the mandatory reporting system of annual energy consumption and quantity produced. As it is a self-declared data, this would form the basis of establishing baseline SEC. The reported data would get verified through Designated Energy Auditors (DENA). In principle, the M&V will be carried out by DENA based on the principles: consistency, transparency, and impartiality. DENA reports the results of their assessment through a validation report to BEE. Verification/ validation methods that DENA adopts are standard auditing techniques. Description of the operational mechanism of MRV in PAT scheme is provided in Figure 5.1.This is an example of large scale domestic MRV in India.

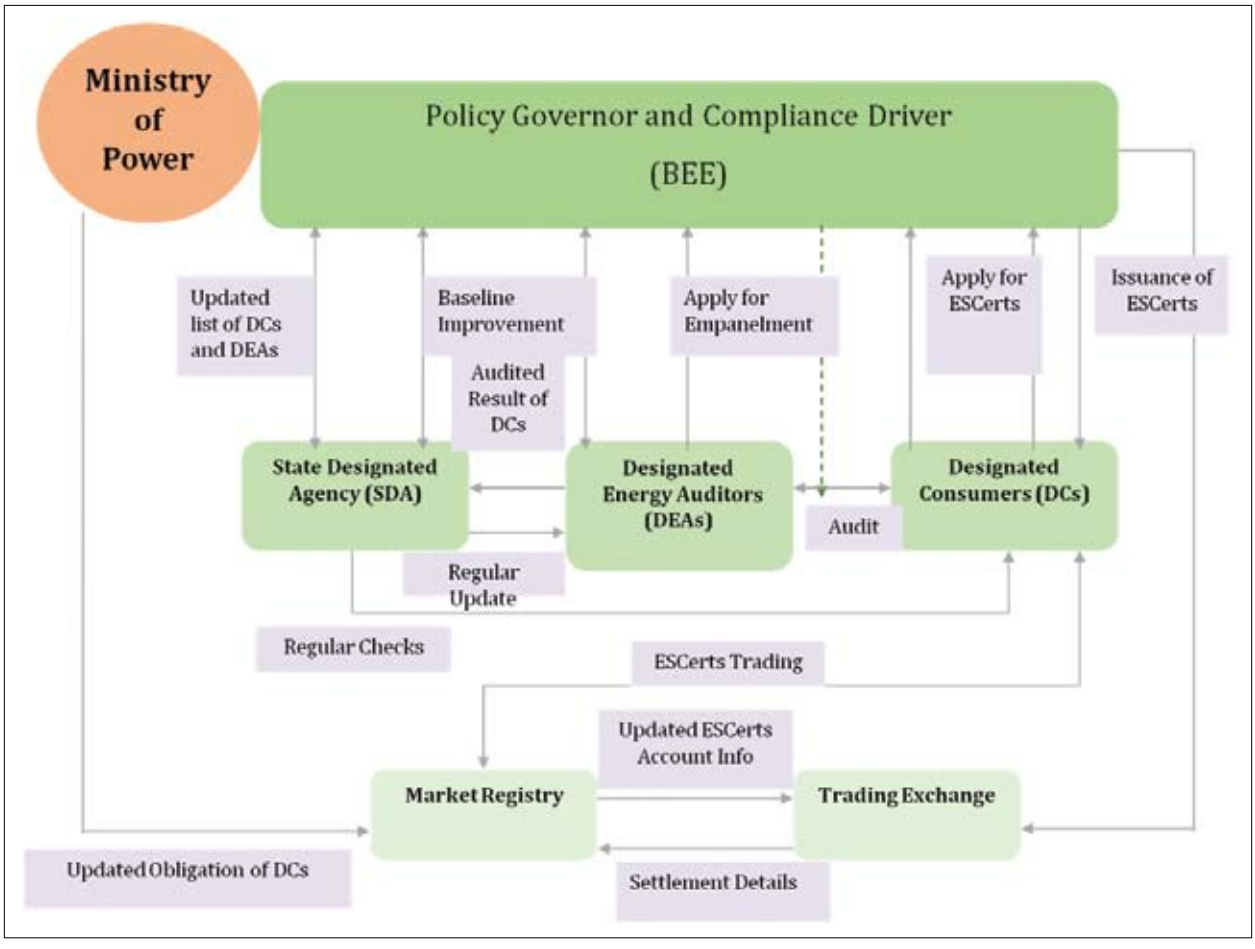

Figure 5.1: Operational MRV Mechanism of PAT

5.3 MRV of Renewable Purchase Obligation (RPO)

The Electricity Act, 2003 has brought about a substantial change in the way India approaches the expansion of Renewable Energy (RE) in the electricity supply mix. As compared to a framework driven by fiscal incentives and subsidies for generation projects, the Act emphasizes on market expansion of renewables by creating a quota for RE in the electricity procurement mix in the areas of the distribution licensees. This is known as the 'Renewable Purchase Obligations'. Section 86 (1) (e) of the Act requires the State Commission to fix the RPO in this regard. Subsequent to the Act, states, over a period of time, have formulated RPOs.

Regulation has created a pan-India market for renewables through the REC trading mechanism to bridge the gulf between RE resource deficit and resource rich states. The National Tariff Policy was amended in January 2011 to prescribe that solar-specific RPO be increased from a minimum of 0.25% in 2012 to 3% by 2022. This is another good example of large scale domestic MRV in India, although not for GHG emission mitigation directly.

5.4 Monitoring in Forest Sector

Forest Survey of India (FSI) makes assessment of the country's forest and tree resources on a regular basis and publishes the results biennially in 'India State of Forest Report'. The forest cover assessment is carried out using remote sensing technology on wall to wall basis, whereas the tree cover estimates are derived from a sample based methodology using both field inventory data of Trees Outside Forests (TOF) and high resolution remote sensing data. So far thirteen such reports have been published by FSI.

In addition State Forest Departments periodically conduct detailed forest inventories and assessments to prepare Working Plans. This exercise is carried out at a decentralized level as per the working plan code (Table 5.2).

Table 5.2: Components of the Working Plan code (2014)

Data	Details
Land use, land use change and forestry (LULUCF)	To track changes in the base year status of forest.
Trees outside forest area	Calculation of growing stock outside forest.
Shifting cultivation	Land tenurial details. Sustainability of shifting cultivation
Status of biodiversity conservation in forests	Status of implementation of the state guidelines/ strategic plan *in-situ* and *ex-situ* conservation efforts
Status of species prone to over exploitation	current harvesting practices of forest produce measures for conservation of biodiversity
Affected areas	Fire Natural Calamities Lopping practice Protected from grazing Invasive weed species Pest and Diseases
Forest degradation and its drivers	Unregulated removal of forest produce, encroachment, over grazing, mining, etc. along with the area description under different levels of degradation.
Carbon stock	Details of biomass for carbon stock assessment
Carbon sequestration/ mitigation	Enhanced carbon sequestration through recognised and innovative silvicultural practices, eco-restoration of degraded/ mined out forestlands, improved biomass productivity, etc. results in improving forest health and vitality.
Demand and supply of timber and important non-timber forest produce	Description of recorded removal for agricultural customs, local needs, market and marketable produce including that of forest development corporations and other agencies may be given. Consumption of wood by wood based industries and other end users may also be given.
Import and export of wood and wood products	Data on import and export of wood and wood products may be collected and analysed for the entire division.
Import and export of NTFPs	Data on import and export of NTFPs may be collected and analyzed for the entire division.
REDD-plus	Implementation of REDD-plus, requires efforts/mechanisms to measure forest carbon, interventions and payments to local people in addition to alternative activities such as fodder development to avoid lopping of tree branches, efficient cooking energy devices, etc.

The components of MRV in forest sector may include MRV systems for Deforestation, Degradation, Sustainable Management and Enhanced Carbon Stock. These components are divided into four main thematic areas: Land-Use Matrix, Soil Carbon, Estimating Biomass and GHG Inventory, the first three activities feeding into the last one (Table 5.3). India has a network of organizations involved in these monitoring and reporting activities. Apart from these, India also has Bhuvan, a geo-portal developed by Indian Space Research Organization (ISRO), which is a repository of spatial data sets varying from administrative boundaries, watershed boundaries to thematic services. The Bhuvan website allows users to not only view data along with statistics and information on land cover, soil, wasteland and water resources on the Indian subcontinent, but it also allows the users to superimpose administrative boundaries of their choice, from a selection of boundaries available on images as required and pursue their own analysis. Nowadays, Bhuvan through its open archive, allows the users to download various medium to low and medium resolution data sets like RESOURCESAT-1, LISS III, AWiFS, IMS-1 Hyper spectral, DEM of Cartosat 1 and Oceansat NDVI.

Further development of the MRV framework is likely to build upon the existing capacity in the country in this sector, build on inter-institutional partnerships, fulfill international reporting standards and be cost-effective.

5.5 Conclusion

India has been implementing a large number of programmes and policies in energy, transport, industry, agriculture and forest sectors, which also provide GHG mitigation. Some of the domestic programmes are commercial in nature such as PAT and RPO. These programmes involve systematic monitoring, evaluation and reporting of concerned parameters, and not GHG emissions per se. Similarly, India also has forest area monitoring using the latest remote sensing techniques, which is critical for implementing CDM and REDD-plus projects. However, appropriate institutional mechanisms and capacity building are required for establishment of integrated domestic MRV arrangements.

Table 5.3: Organizations undertaking monitoring and reporting of carbon and the land-use area

Activity	Organization	Carbon pools
Land-Use Matrix	National Remote Sensing Centre (NRSC)	Cropland, Grassland, Settlement and Other Land
	Forest Survey of India (FSI)	Forest Land
Soil Carbon	FSI	Forest soil
	Indian Council of Forestry Research and Education (ICFRE)	Forest soil
	Indian Council of Agriculture Research(ICAR)/ National Bureau of Soil Survey and Land Use Planning (NBSS-LUP)	Soil outside forest land
Estimating Biomass	FSI	AGB, BGB within forests
GHG Inventory	FSI	Forest Land

AGB: Above Ground Biomass; BGB: Below Ground Biomass

* * *

Chapter 6

Additional Information

Additional Information

6.1 Reforms and Greenhouse Gas Emissions

This chapter provides information additional to what is provided in chapters 1-5. It includes details of the reforms in different sectors and their potential implications for GHG emission reduction. Further, the chapter provides details of the policies and measures for different sectors, the targets for the specific measures, and the policy instruments at national and state levels that contribute directly or indirectly to GHG mitigation.

India has the world's second largest population and third largest economy. With the aim to reduce poverty, provide employment and ensure food and economic security to its vast population, economy-wide reforms have been initiated in India since 1991. Reforms also included various sectors like energy including electricity, hydrocarbons, and coal sectors and activities that emit GHGs as well as other pollutants.

An Expert Group on "Low Carbon Strategies for Inclusive Growth" was set up by Planning Commission which presented its final report in May 2014. Second National Communication had references to the Interim Report of this Expert Group which was released in May 2011. The interim report provided a menu of options that can make it possible for India to reduce emission intensity by 20-25% over 2005 levels by the year 2020. Final Report provided a more detailed and longer term assessment of these options, and the macro-economic and welfare implications of the low carbon strategy. In the low carbon strategy, high priority is given to inclusive growth. It is possible for India to attain high level of human well-being. The Expert Group had taken 2007 GHG inventory data as base and proposed a set of low carbon strategies. The Expert Group has made specific recommendations in different sectors.

The pursuit of low carbon development is consistent with growth and inclusion. In the low carbon strategy, energy efficiencies in households, buildings, industry and transport play important roles. At the same time, low carbon supply technologies, such as solar and wind in the power sector and greater use of public transport and non-motorized transport are critical. Increased sequestration through enhanced green cover through Green India Mission also helps.

6.1.1 Reforms in the Electricity Sector

The significant gaps that exist between power demand and supply, and what's planned versus what the power sector has delivered prompted the government to introduce reforms in the power sector from time to time. Governments encourage private sector participation with the objective of mobilizing additional resources for the sector. The National Electricity Policy (2005) aims at accelerated development of the power sector, providing supply of electricity to all areas and protecting interests of consumers and other stakeholders, keeping in view energy resource technology available to exploit these resources, economics of generation using different resources and energy security issues. The salient features of the policy are as under (National Electricity Policy, 2005):

- Access to Electricity: Available for all householders.
- Availability of Power: Demand to be fully met. Energy and peaking shortages to be overcome and spinning reserve to be available.
- Supply of reliable and quality power of specified standards in an efficient manner and at reasonable rates.
- Per capita availability of electricity to be increased to over 100 units.
- Minimum lifeline consumption of 1 unit/household/day as a merit good.
- Financial turn-around and commercial viability of electricity Sector.
- Protection of consumer's interests

The Electricity (Amendment) Act, 2007

The Electricity (Amendment) Act, 2007 amending provision of The Electricity Act, 2003 was enacted on 29th May 2007 and brought into effect from June 2007. Following are the main features of The Electricity (Amendment) Act, 2007:

- Central Government, jointly with the State Governments endeavors to provide access to electricity to all areas including villages and hamlets through rural electricity infrastructure and electrification of households.
- To encourage commissioning of captive power plants

now no license is required for sale from captive units.

- To reduce the thefts of electricity, definition of thefts expanded to cover use of tampered meters and use for unauthorized purpose. Stricter laws are kept in place and theft is made explicitly cognizable and non-bailable.
- To encourage efficient use of electricity, the amendment tries to reduce the provision of electricity subsidy.

Renovation and Modernization of Old Power Plants, and Distribution Reforms

The Central Electricity Authority (CEA) in consultation with state power utilities and other stakeholders have prepared a National Perspective Plan for Renovation and Modernisation (R&M) and Life Extension (LE) of thermal power stations upto the year 2016-17. The broad objectives of future R&M national plan include:

a) Identification of thermal units requiring LE during 11th and 12th Plans in order to extend their useful economic life for another 15-20 years beyond their designed economic life of 25 years.

b) Assessment of total investment required during 11th and 12th Plans for LE programme.

c) Identification of potential candidates for Energy Efficiency R&M programme and assessment about external funding and other sources of financing during the 11th and 12th Plan.

d) Providing a road map for smoother implementation of R&M/LE schemes.

e) Projection of expected benefits from these schemes.

Power Sector with a share of around 38% to India's total GHG emissions is the largest GHG emitting sector. There are several initiatives which would improve efficiency, and reduce pollution and carbon footprint from this sector.

6.1.2 Reforms in the Renewable Energy Sector

As mentioned before in section 3.3.8, Government of India has increased the overall renewable energy capacity target by more than five times from 32,000 MW to 1,75,000 MW by 2022, comprising 100,000 MW Solar energy, 60,000 MW Wind energy, 10,000 MW Biomass energy and 5,000 MW Small Hydro energy.

India's solar power capacity target under the Jawaharlal Nehru National Solar Mission (JNNSM) has been enhanced by five times, to reach 100 GW by 2022. The target will principally comprise 40 GW rooftop and 60 GW large and medium scale grid connected solar power projects.

The total investment in setting up 100 GW will be around ₹ 600,000 crore. In the first phase, the Government of India is providing ₹15,050 crore as capital subsidy to promote solar capacity addition in the country. This capital subsidy will be provided for Rooftop Solar projects in various cities and towns, for Viability Gap Funding (VGF) based projects to be developed through the Solar Energy Corporation of India (SECI) and for decentralized generation through small solar projects.

Apart from this, solar power projects with investment of about ₹90,000 crore would be developed using bundling mechanism with thermal power. Further investment will come from large Public Sector Undertakings and Independent Power Producers (IPPs). State Governments have also come out with State specific solar power policies to promote solar capacity addition.

The Government of India may also approach bilateral and international donors as also the Green Climate Fund for achieving this target. Solar power can contribute to the long term energy security of India, and reduce dependence on fossil fuels that put a strain on foreign reserves and the ecology as well. The solar manufacturing sector will get a boost with this long term trajectory of solar capacity addition. This may also help in creation of technology hubs for manufacturing. The increased manufacturing capacity and installation are expected to pave way for direct and indirect employment opportunities in both the skilled and unskilled sectors.

The new solar target of 100 GW is expected to abate over 170 million tonnes of CO_2 over its life cycle.

6.1.3 Reforms in the Hydrocarbons Sector

The hydrocarbons sector plays an important role in the economic growth of the country. The current levels of per capita energy consumption in India are extremely low as compared to the rest of the world. The current low level of per capita energy consumption is expected to grow at a healthy rate as India is experiencing rapid economic growth. Hydrocarbons are likely to continue to play a pre-eminent role in meeting the energy requirements of India in the coming future. Therefore, it is pertinent to have a robust hydrocarbon policy to ensure energy security.

The gap between demand and availability of crude oil, petroleum products as well as gas from indigenous sources has led to an increase in dependence on crude oil imports. Growing emphasis to exploration and production

sector is being given by Government of India to bridge the demand and supply gap. The objectives of the exploration policy are: (a) to undertake a total appraisal of Indian sedimentary basins for tapping the hydrocarbon potential and to optimize production of crude oil and natural gas in the most efficient manner so as to have Reserve Replacement Ratio of more than 1, (b) to keep pace with technological advancement and application and be at the technological forefront in the global exploration and production industry, (c) to achieve as near to zero impact, as possible, on environment.

Refining and Marketing is another important sector and its development is crucial for having self-sufficiency in petroleum products and in moving towards a consumer oriented competitive market. "India Hydrocarbon Vision 2025" laid out following objectives to improve petroleum products refining and marketing sector:

a) To maintain around 90% self-sufficiency of middle distillates in the sector with an appropriate mix of national oil companies, foreign players and private Indian players.

b) To develop a globally competitive industry.

c) To have a free market and healthy competition amongst players.

d) To develop appropriate infrastructure such as ports and pipelines for an efficient hydrocarbon industry.

e) To improve customer services through better retailing practices.

f) To make available un-adulterated quality products at reasonable prices.

g) To achieve free pricing for products while continuing subsidized prices.

A rational tariff and pricing policy is vital to ensure healthy growth of the hydrocarbon sector and to protect the consumers as well. To rationalize tariff and pricing for the petroleum products in India, following objective are set in the "India Hydrocarbon Vision 2025".

a) To provide incentives for cleaner, greener and quality fuels to promote environment friendly hydrocarbon sector.

b) To balance the need to boost Government revenue with need to align duties with Asia-Pacific countries and moving the prices to international levels.

c) To promote new investments, by ensuring adequate protection to domestic producers.

d) To remove subsidies and cross subsidies to promote efficient and optimal utilization of resources and also to eliminate adulteration.

The mitigation actions taken by oil and gas companies of public sector are presented in Table 6.1

Petroleum Product Pipeline Policy

Pipelines are major mode for transportation of white oil (MS, HSDO, SKO and ATF), carrying about 46% of POL products. At present, total existing pipeline network is about 39,239 km with 15,772 km gas pipeline. The existing product pipeline network is 14,083 km and crude pipeline is 9384 km. It is proposed to build another 15,000 km of gas pipeline to complete the national grid. Out of the proposed 15,000 km gas pipeline, 11,900 km is already authorized. To expedite the completion of national gas grid, three pipeline sections with a total length of 2,500 km have been identified for development in Public Private Partnership (PPP) mode.

Table 6.1 Mitigation actions taken by India's public sector units in Oil and Gas sector

Name of PSU	Mitigation Actions undertaken
Indian Oil Corporation Ltd. (IOCL)	• Installation of grid connected solar and wind power projects – a total of 74.3 MW installed and commissioned • Installation of Off-grid solar power units at refineries, installations and office buildings- 532 kW • Installation of Solar power units in 2610 Retail Outlets with total install capacity of about 8 MW • Implementation of Energy Conservation Projects at Refineries- Achieved 102800 Standard Refinery Fuel in Tonnes (SRFT) during 2013-14 • Installation of 16 organic waste converters, Biogas generators for conversion of kitchen and horticulture waste to manure and energy • Expansion of existing Pipeline network to reduce fuel consumption through rail/road transport, 51% carbon savings achieved during 2013-14
Bharat Petroleum Corporation Ltd. (BPCL)	• Long term "Renewable Energy Policy" adopted during 2014-15 to mitigate the risk arising out of fossil fuel business. • Generation of 10,273.46 MWh electricity through Solar & Wind Power Plants in 2013-14 leading to GHG reduction of 8,321.506 tCO_2e
Oil and Natural Gas Corporation (ONGC)	• ONGC is implementing 7 CDM project activities including Waste Heat Recovery, Gas Flare Reduction and Energy efficiency . • Emission reduction of 2,66,723 tCO_2e have been achieved through such project activities in last two years

Name of PSU	Mitigation Actions undertaken
Oil India Ltd. (OIL)	• Has implemented carbon footprinting and emission level calculation at various operational units. • Conservation of Fuels of all of its kind (viz: Crude Oil, Diesel, Natural Gas, Petrol, Condensate etc.)- Crude Oil of 2162 KL conserved; • Around 355, 24,91,683 kWh electricity saved during 2013-14 • Conservation of Low Pressure gas being monetized through hired Gas compression services on BOO (Build-Own-Operate)- Conservation of 86.8 MMSCMD of natural gas • Boosting of LP gas to OIL's gas distribution network- Conservation of 30,000 SCUM of Natural Gas. • High Pressure Gas from Baghjan EPS & Mechaki field- Conservation of 105.869 MMSCM gas at station no-5, Jagiroad in pipeline sphere of OIL • Renewable Energy projects commissioned- Wind Energy projects- Commissioned Wind Energy Projects of 67.6 MW ; Solar Power Projects- Commissioned Solar power with capacity of 5 MW; 9 MW in pipeline; 100kwp solar captive power plant commissioned in Rajasthan; 100 kWp Solar power plant commissioned in Assam; Commissioning of 20 kWp Solar Power Plant at Repeater • Deriving the Potential components from the left outs; • Adopting new Technologies in its Operational activities • Energy & Environment Auditing of the system
Hindustan Petroleum Corporation Ltd. (HPCL)	• Undertaken sustainability reporting. Three reports published at highest level of disclosure (A+) as per Global Reporting Initiatives • Renewable Energy- 50.5 MW wind power project installed; 642.4 kWp Solar PV Installed; 92 retail outlets are installed with 5.95 kWp Solar PV panels); • Energy efficiency projects at refineries saved 25535 of fuel in 2013-14; • 3 lakh trees planted in and around city of Vishakhapatnam
GAIL India Ltd.	• Voluntary sustainability targets in the form of Sustainability Aspirations 2020. Key targets include- 33% reduction in GHG emission intensity (Total GHG emission/Gross sale) in comparison to the baseline year FY 2010-11; 5% reduction in specific energy consumption in comparison to the baseline year FY 2010-11. • Renewable Energy: About 118 MW of Wind; 5 MW solar; 10kWp each solar powered system has been commissioned at six RR stations for supplying electrical power to installed instrumentation and burn natural gas for its operation. Solar PV plants (6 nos. of 10 kWp each) are expected to generate 86400 unit (kWh)/year of electricity which can save almost 1638 Tonnes of CO_2equivalent /year with replacement of existing power source operated on natural gas fuel. • Energy Efficiency: Technology up gradation project at various sites e.g. implementation of PLC control based burner management system at two gas processing units; Replacement of Natural Gas Based Closed Cycle Vapour Turbo generators (CCVTs) by Solar Power at O&M sites; Fuel gas saving initiative at two compressor stations by retrofitting.; Switching to LED lamps from conventional lamps. • Various initiatives on fuel and electricity saving have led to a saving of almost 56 kJ energy in FY 2013-14.
Chennai Petroleum Corporation Ltd. (CPCL)	Energy conservation measures, efficiency improvement measures and alternate green energy generation plans are identified and implemented continuously. 9840 MT fuel saved in the year 2013-14
Balmer Lawrie & Company (BL)	• A five year sustainability plan/strategic road map was developed for the company in the year 2012 in consultation with a leading global consulting firm E&Y (Ernst & Young) • Alternate Source of Energy (Solar, Wind, Biogas etc.):160 kWp of grid connected solar power plants; 20 Nos. 250W street lights are replaced with 70W Solar LED lights at Silvasa ; 5 Nos of light pipe installed to harvest day light at Grease & Lubes (G&L) Kolkata plant; Biofuel in place of Diesel in Thermic fluid heaters; Gas fired boilers used in oily sludge processing plant at Dikom Assam • Energy Efficiency, Improvement & Savings Measures: Three phase rectifier controlled energy efficient welding machines; Installed capacitor bank to improve power factor, star delta starter; Use of VFD controller
Bharat Oman Refineries Ltd. (BORL)	• Implementation of Energy Management System (ISO-50001: 2011). • Solar water heating systems at residential township; Solar Power based electric fencing on township boundary • LED lights at common locations of Refinery & Residential Township. • 5 star rating energy efficient fans at Residential Township. • Rain Water Harvesting System(10 numbers) in 12 acres area within refinery of Rain Water Harvesting Systems at residential township • Vermicomposting site at residential township • Development of greenbelt around refinery • Energy Saving Devices/Measures and savings in standard Refinery Fuel MT/year) • Implementation of low level heat recovery schemes in process plants-750 • Additional heat recovery from crude column overhead system-400 • Installation of ultrasonic flow measurement devices in delayed coker- 550 • Steam leak audits and rectifications- 1500 • Implementation of Leak Detection And Repair Program (LDAR)- 10 • Installation of Solar Water Heaters and LED light fittings- 10

6.1.4 Reforms in the Coal Sector

Coal is the mainstay of India's energy sector, accounting for over 50% of primary commercial energy supply in 2010-11. The gap between the demand and the domestic supply of coal has made it imperative to augment domestic production both in the public sector and the private sector and to expedite the reform process for realizing efficiency gains through increased competition in the sector. Given the importance of coal to India's energy security, the government now allocates coal blocks on the basis of competitive bidding. This will rationalize coal pricing, lead to efficient use of coal and result in emissions reduction.

Coal Washeries

Beneficiation of Coal is a mode of implementing Clean Coal Technology at pre-combustion state. Ash content has a large impact on CO_2 emissions. High ash reduces thermal efficiency. Excess water can also reduce efficiency and increase CO_2 emissions. Improved beneficiation of the coal could reduce greenhouse gases up to 5% as a result of the consequent increase in power station efficiency.

Coal India Limited has adopted a massive programme for setting up of Coal Beneficiation plant (washeries). Presently, CIL has 17 operating coal washeries with a total throughput capacity of 39.4 Mty which comprises of 13 coking coal washeries with a total throughput capacity of 24.90 Mty, and 4 non-coking coal washeries with a total throughput capacity of 14.50 Mty.

In addition to the above, CIL has identified 15 coal washeries in its different subsidiaries with a total throughput capacity of 112.6 Mty on Build-Operate-Maintain concept. This consists of six coking coal washeries with a total throughput capacity of 18.6 Mty and nine Non-coking coal washeries with a total throughput capacity of 94.0 Mty. After commissioning of all these washeries, the total washing capacity of CIL will be around 152.0 Mty. In Build-Operate-Maintain concept, global tendering process has been adopted to attract new and state-of-the-art technologies being practiced currently in the world. Thus successful bidder would provide latest technology. However, capital is being funded by CIL through its internal resources and the envisaged investment is of the order of around ₹2,500 crores.

CIL is also exploring possibilities of dry beneficiation of coal through its R&D endeavour for Indian coal due to scarcity of water being faced worldwide. Further, all the new open cast projects with a capacity of more than 2.5 mtpa are also being planned with an integrated coal washery.

The advantage of using beneficiated coal in terms of reduced CO_2 emissions can be indicated as follows.

A 500 MW coal based thermal power plant approximately consumes annually 2.5 million tonnes of un-washed coal with ash content of around 41% and produces 3 million tonnes of CO_2. However, in case the coal is washed to 34% ash, the requirement of coal will be reduced to 2 mtpa for generating the same amount of energy. This will approximately reduce the emission of CO_2 by 15%.

Clean Coal Technologies (CCTs)

Coal India Limited has taken up exploration and exploitation of Coal Bed Methane (CBM) and Coal Mine Methane (CMM). In association with ONGC, CIL has been allotted two CBM blocks, one each in Jharia and Raniganj coalfields. Field development plans for both these blocks have been approved. The envisaged ultimate production potential from these blocks is 1 MMSCMD and commercial exploitation is likely to start in a couple of years.

Ministry of Coal has notified coal gasification (surface and underground) and coal liquefaction (Coal to Liquids) as one of the end uses under Coal Mines (Nationalization) Act, 1993 for facilitating allotment of blocks to potential entrepreneurs. Though technologies for CTL are not indigenously available, yet, some industrial houses have shown interest for developing CTL using Indian coals.

Coal Cess

Government of India has imposed ₹200 per tonne of coal produced/imported as Clean Energy Cess and the amount received is kept at the disposal of Ministry of Finance for promoting innovative technologies for reducing GHG emissions. An inter-ministerial Group under the Chairmanship of Secretary (Expenditure) considers the proposals for extending support from the Clean Energy Fund as per the guidelines laid for the purpose.

Future Initiatives

In addition to pursuing the Clean Coal Technologies (CCTs), CIL has also taken up initiative for establishing Solar Thermal Power Plants and entered into MoU with Solar Energy Corporation of India (SECI) for establishing 1000 MW. SECI will implement the project as per the MoU and CIL will fund the investment through its internal resources.

The capacity building support would be required in carrying forward all the above mentioned areas. This can be established as the projects are implemented from time to time.

6.1.5 Reforms in Petroleum and Natural Gas sector

Bio-Fuel Policy: Ethanol Blending Programme

In July 2013 it was decided that Oil Marketing Companies (OMCs) will procure ethanol only from domestic sources to achieve the mandatory requirement of 5% ethanol blending in areas/parts of the country where sufficient quantity of ethanol is available. In other parts of the country, blending of ethanol may be increased progressively depending upon the availability of ethanol to reach the 5% mandatory level.

In order to improve the availability of ethanol, the Government has decided to fix the delivered price of ethanol in the range of ₹48.50/litre to ₹49.50/litre, depending upon the distance of distillery from the depot/ installation of OMCs.

As regards policy for purchase of bio-diesel, it has been decided that OMCs would purchase bio diesel, meeting the prescribed BIS standard, at a uniform price, as may be decided by the OMCs from time to time, for blending with High Speed Diesel to the extent of 5%, at identified 20 purchase centres across the country. OMCs have reviewed the procurement price of bio-diesel at various purchase centres and with effect from 7th November 2014, the declared price of bio-diesel is ₹41/litre.

Moreover, it has been decided to allow the direct sale of bio-diesel (B100) to all consumers by private manufacturers, their authorized dealers and Joint Ventures of OMCs authorized by MoPNG.

Compressed Natural Gas

In the year 2007, Government of India established Petroleum & Natural Gas Regulatory Board (PNGRB) under the PNGRB Act 2006. Under the act, PNGRB grants the authorization to the entities for developing City Gas Distribution (CGD) network in a specified Geographical Area (GA) of the country. CGD network supplies gas to four distinct segments viz Compressed Natural Gas (CNG) predominantly used as auto-fuel and Piped Natural Gas (PNG) used in domestic, commercial and industrial segments. At present, only authorized CGD entities under the PNGRB Act, 2006 can set up CNG stations in their respective Geographical Areas. PNGRB has, so far, held five rounds of bidding for awarding authorization to develop CGD networks. With these bidding rounds, there are now 58 GAs which have been covered under CGD network in 15 States and UTs of the country. PNGRB has planned to commence the sixth round of CGD bidding, so that almost all GAs in the country having existing natural gas pipeline connectivity would be covered. Country is having 1009 CNG stations catering to approximately 23 lakh vehicles. Government has placed CNG (transport) along with PNG (domestic) on top priority in domestic gas allocation. Presently the entire requirement of CGD entities for PNG (domestic) and CNG (transport) is being met through domestic gas at uniform base price based on preceding six months consumption data. Further, M/o PNG has allowed GAIL to supply 10% additional domestic gas in order to meet the daily fluctuation of PNG and CNG demand.

Petrol and Diesel Pricing

A major reform in the hydrocarbon sector is removal of subsidies from all products excepting domestic LPG and kerosene. This process was completed on 19th October 2014 when diesel subsidy was removed, following petrol subsidy removal on 26th June 2010. Their prices have been market determined since then. Subsidies for kerosene and LPG are also planned to be given through direct cash transfer, so that the distortions in prices are removed. Competitive pricing is critical to ensure efficient use of these resources and reduce waste and emissions. Also a cess on petrol and diesel is imposed to mobilize funds for renewable sources of energy.

Implicit Carbon Taxation on Petroleum Products

India has taken substantial actions to eliminate petroleum subsidies and gone beyond to impose substantial taxes on petroleum products. As per the Economic Survey 2014-15, p. 38 “These actions have taken India from a carbon subsidization regime to one of significant carbon taxation regime — from a negative price to an implicit positive price on carbon emissions. The effect of the recent actions since October 2014 has been a *de facto* carbon

tax equivalent to US$60 per tonne of CO_2 in the case of (unbranded) petrol and nearly US$ 42 per tonne in the case of (unbranded) diesel. In absolute terms, the implicit carbon tax (US$ 140 for petrol and US$ 64 for diesel) is substantially above what is now considered a reasonable initial tax on CO_2 emissions of US$ 25 per tonne".

6.1.6 Reforms in Transport Sector

Under National Highways Development Programme, 700 km of Ring Roads, Bypasses, Flyovers and other structures have to be constructed. These will decongest the urban traffic and reduce the vehicular emission substantially.

Government of India, based on the recommendation of an expert committee have decided to implement Passive Radio Frequency Identification based on EPC, Gen-2, ISO 18000-6C Standards for Electronic Toll Collection System "FASTag" at Toll Plazas on Highways. Interoperable Electronic Toll Collection [ETC] system is already operational on Delhi-Mumbai and Chennai-Bengaluru arm of Golden Quadrilateral. The system will reduce travel time, fuel consumption and emissions. Central Motor Vehicle Rules, 1989 have been amended to incorporate the provision of "FASTag". Government has also decided to install Weigh-in Motion system to prevent overloading which is also one of major factors for pollution by commercial vehicles.

The government has been promoting mutual cooperation with neighbouring countries for connectivity at the bilateral and multilateral levels. Bus services with two countries have been inaugurated and made operational recently in addition to existing bus services with Pakistan, Nepal and Bangladesh. These are Delhi - Kathmandu, Varanasi - Kathmandu, Kolkata- Agartala via Dhaka, and Guwahati-Dhaka. More such routes including Imphal— Mandalay with Myanmar, and Delhi - Pokhra with Nepal will soon become operational.

The Transport Ministers of Bangladesh, Bhutan, India and Nepal (BBIN) signed the BBIN Motor Vehicles Agreement (MVA) on 15th June, 2015 at Thimphu in Bhutan for regulating and enabling passenger, personal and cargo vehicle cross-border traffic in the four countries. This agreement will reduce cost and time consuming process and procedures existing at present and make cross border trade and transport in and through the North-East region of India to and from Bangladesh, Bhutan and Nepal more efficient. It will help enhance people to people contact, trade and regional integration.

Significant progress has been achieved for India-Myanmar- Thailand (IMT) Motor Vehicle Agreement – for connecting South Asia with South East Asia. This trilateral arrangement will ensure movement of passenger, persons and cargo traffic seamlessly across the borders of the three countries.

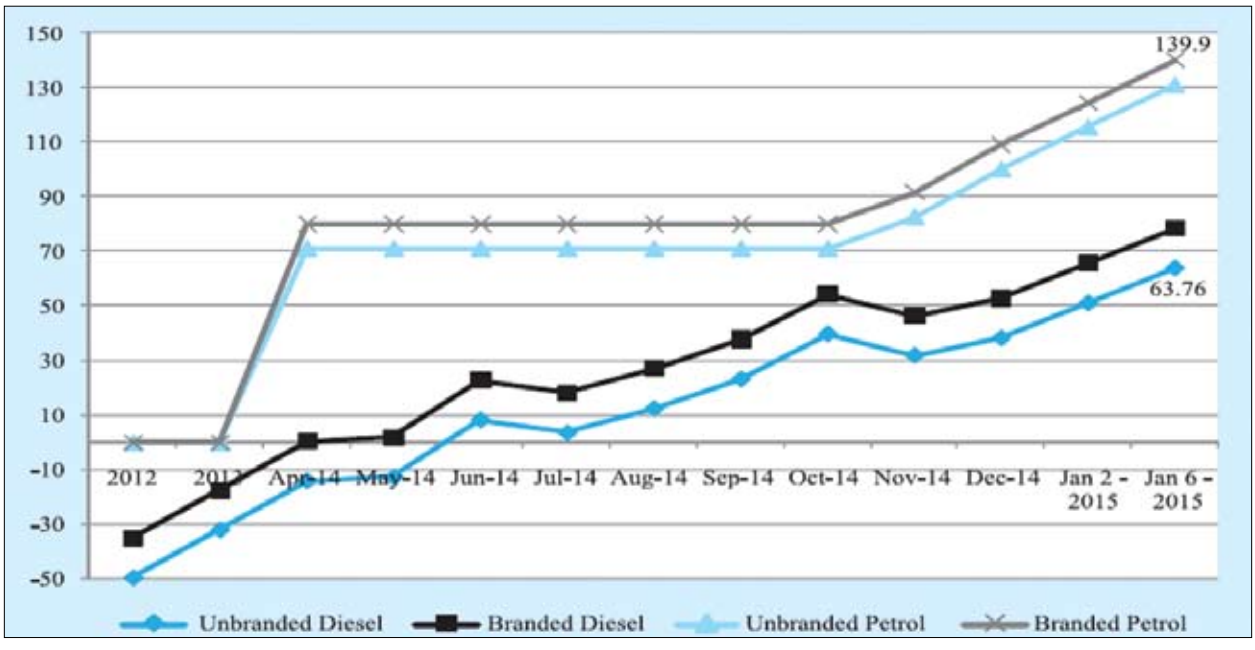

Figure 6.1: Implicit carbon taxation by increasing excise duty on petrol and diesel, 2012- January 2015 (USD/tCO2)

6.2 Citizens and Private Sector Contribution to Combating Climate Change

In addition to being involved in Government initiatives related to climate change and resource efficiency, **private sector** has also embarked on a number of voluntary actions. It plays a key role in sustainable development efforts in the country, some of which are enumerated below:

(1) Companies Act, 2013 directs companies having a certain level of profits, to spend 2% of their annual profit on **Corporate Social Responsibility (CSR)** activities

(2) The Indian industry has also participated in voluntary carbon disclosure programmes whereby the industries report their carbon management strategy and GHG emissions. Latest Report by **Carbon Disclosure Project, India** indicates a reduction of 165 million metric tonnes of CO_2 equivalent by Indian industries. "**India GHG Programme**" is another voluntary programme to support development of India-specific emission factors and for corporates to measure their carbon footprints.

(3) **Smart Power for Environmentally-sound Economic Development (SPEED)** is a program that aims at electrification of rural areas based on a decentralized renewable energy system.

(4) **GreenCo Rating System** is first of its kind in the world which assesses companies on their environmental performance across 10 different parameters to help them develop a roadmap to improve further.

(5) **New Ventures India (NVI)** is an initiative to support cleantech entrepreneurs in developing their business plans and access finance and markets.

6.3 Forest Policies, Afforestation and Forest Conservation

India is recognized as a mega biodiversity country, accounting for 7-8% of the recorded species, in just 2.4% of global land area, while supporting 17.5% of human population and the world's largest livestock population. The forest cover in India has increased from 14% in 1950-51 to 21.23% in 2010-11. This is a remarkable conservation achievement in the context of the following national circumstances:

1. **High population density and low per capita forest area:** India is a large developing country with a population density of 382/km^2. Even more significantly, the forest area is only 0.06 ha/capita, compared to world average of 0.62 ha/capita.
2. **High dependence of population on forests:** In India, nearly 196,000 villages are located in the forests or on the forest fringes. Fuelwood is a dominant source of cooking energy for rural population with forests contributing significantly to this. Apart from fuelwood,

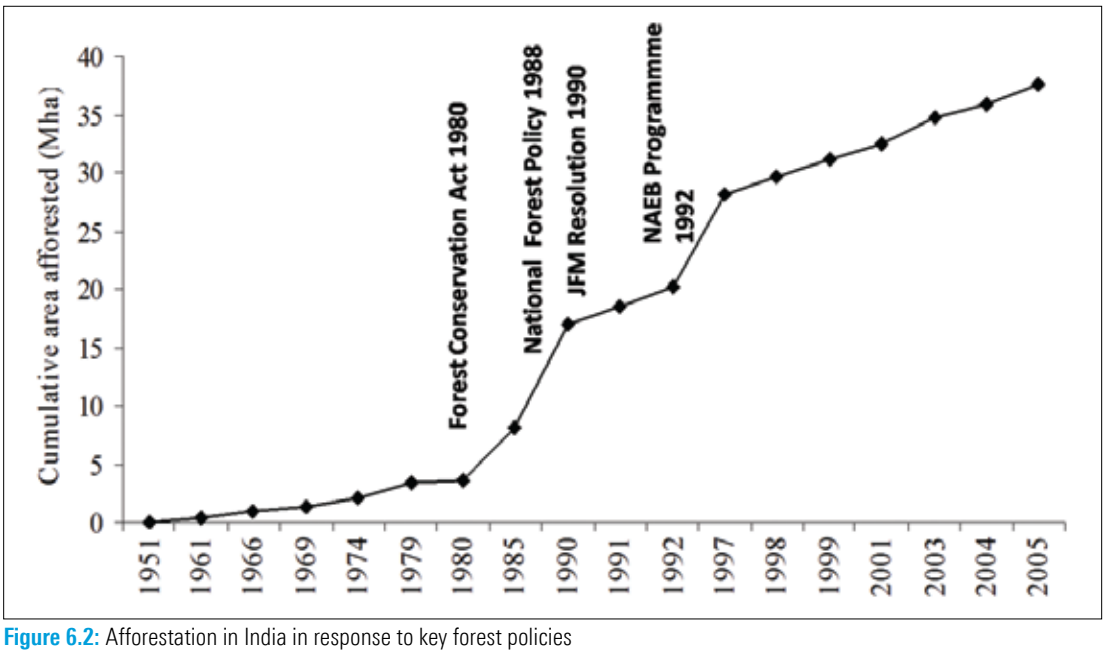

Figure 6.2: Afforestation in India in response to key forest policies

Note: JFM is Joint Forest Management and NAEB is National Afforestation and Eco-development Board

village communities depend on forests for small timber, bamboo and non-timber forest products.

3. **High livestock density:** India accounts for 2.4% of world's geographic area but it accounts for nearly 17% of the global livestock population. In India the livestock density on forest land is 7/hectare, which is one of the highest in the world.

Factors contributing to the stabilization of forest cover in India include progressive legislations, forest conservation and afforestation programmes, and community participation. **Forest Conservation Act, 1980** is one of the most effective legislations contributing to reduction in deforestation. This was enacted to reduce indiscriminate diversion of forest land for non-forestry purposes and to help regulate and control the recorded forest conversion. This Act also included provision for compensatory afforestation. **National Forest Policy, 1988,** envisaged people's participation in the development and protection of forests. **Joint Forest Management** was initiated in 1990, under which local communities and the forest department jointly plan and implement forest regeneration programmes, and the communities are rewarded for their efforts in protection and management.

India has succeeded in maintaining and enhancing the forest cover. Further, India has an ambitious plan to bring approximately 33% of its geographical area under forest cover. These monumental conservation achievements best illustrate India's commitment to climate change and sustainable development.

6.4 Policies and Measures for Sustainable Development and Mitigation of Climate Change

The guiding principles of India's development process have been: sustained economic growth; employment generation, poverty eradication; food security; education and shelter for all; health for the population; moderating population growth; infrastructure development; inclusive growth and environmental protection. A planned economic development envisions a low carbon economy for India, and the Indian government has taken significant steps towards initiating a low carbon economy across various sectors in the coming years. Many of the important developments have been covered in the previous sections of this report. Since India is an emerging economy, there is a continuously rising demand for energy and other resources. India therefore keeps sustainable development at the core of energy and climate change policies.

India's policies and measures that contribute to climate change mitigation actions directly and indirectly can be broadly classified as the following types of instruments {Table 6.2 (a) and (b)}:

1. Regulatory Measures
2. Economic and Fiscal Measures
3. Green Cover and Land use
4. Supportive Measures

The tables that follow represent only a sub-set of entire programmes, policies, measures and projects and do not cover the entire universe of all the programmes, policies, measures and projects being undertaken/ planned in the country. It is also noted that even though there may be only specific number of policies indicated in specific cells, there could be sub-policies under each policy. For instance, the one policy indicated under Power & Energy Acts is the Electricity Act of 2003 in Table 6.2 (a), which has a number of programmes and policies covered therein (http://www.cea.nic.in/reports/electricity_act2003.pdf).

Please refer to Tables 6.3 and 6.4 for further details of some of the above policy instruments covered. It may also be noted here that Tables 6.2 (a) and 6.2 (b) are not mapped one-to-one with Tables 6.3 and 6.4.

Table 6.2-(a):National Policies and Measures mapped for various sectors in India

	Regulatory Measures				Economic and Fiscal					Green Cover and Land use			Supportive Measures						Total
	Acts	Regulations/ Notifications/ Rules	Standards & Labels	System Efficiency Measures	Tax	Price	Directed Financial Incentives/ Subsidy	Emissions Trading	Quotas & Certificates	Afforestation/ Reforestation	Avoiding deforestation/ land reclamation	Others	Market Development	Cooperative Measures	Capacity Building	RD&D	Green Procurement	Information, education and public awareness	
Power & Energy	1	8	2	4	1	4	5	2	2				1		1	3	1	1	36
Renewable Energy		7				2	3						2			1		2	17
Alternate Fuels		3				2										1		1	7
Energy Efficiency & Conservation		1	1													3		2	7
Industry				6			1	1					4	1	1	4		1	19
Forestry	1	1								2	1	2						1	8
Transport		6		3			3									3		1	16
Agriculture				5									1		1	2		1	10
Cross Sectoral				2			2										3	2	9
Waste		4		3												1			8
Total	**2**	**30**	**3**	**23**	**1**	**8**	**14**	**3**	**2**	**2**	**1**	**2**	**8**	**1**	**3**	**18**	**4**	**12**	**137**

Table 6.2.(b): State Policies and Measures mapped for various sectors in India

	Regulatory Measures				Economic and Fiscal					Green Cover and Land use			Supportive Measures						Total
Sectors	Acts	Regulations/ Notifications/ Rules	Standards & Labels	System Efficiency Measures	Tax	Price	Directed Financial Incentives/ Subsidy	Emissions Trading	Quotas & Certificates	Afforestation/ Reforestation	Avoiding deforestation/ land reclamation	Others	Market Development	Cooperative Measures	Capacity Building	RD&D	Green Procurement	Information, education and public awareness	
Power & Energy		14		21		28	2		1				6		2	6	1	1	82
Renewable Energy													4			2		2	8
Alternate Fuels																1		1	2
Energy Efficiency & Conservation		2		4									3		1	3		2	15
Industry		28		23			6					1	15	3	2	5		1	84
Forestry		3								7	3	1						1	12
Transport		3		1														1	5
Agriculture		10		12								1	4		3	4		3	37
Waste		12		18									8						38
Total		**72**	**0**	**79**	**0**	**28**	**8**	**0**	**1**	**7**	**3**	**3**	**40**	**3**	**8**	**21**	**1**	**12**	**286**

Table 6.3 Mapping of some Programmes, Policies, Measures and Projects for climate change mitigation and related initiatives at national level

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
NATIONAL LEVEL POLICIES AND MEASURES						
National Solar Mission	Energy	National	Target of deploying 20,000 MW of grid connected solar power by 2022. It has been conditionally updated to 100 GW depending upon international financial and technological support provision.	Economic & Fiscal	Directed Financial Incentives	2010
National Mission on sustainable Habitat	Energy	National	Increasing energy efficiency in buildings: building bye laws and standards, energy performance monitoring, national standards for construction and recycling of construction waste Urban transport: norms integrating congestion charges, parking, etc., norms for pedestrian and cycling, integrating transport planning with spatial planning Water supply: mandatory rainwater harvesting, water and energy audits	Regulatory	Regulation/ Rules	2010
National Mission on Green India	Forestry	National	to increase forest & tree cover on 5 million ha area, improve quality of forest cover on another 5 million ha area	Regulatory	Regulation/ Rules	2014
National Mission for Sustaining the Himalayan Ecosystem	Cross sectoral	National	Strengthening institutional capacity Standardization of field and space observations Prediction/projection of future trends and assessment of possible impacts. Governance for Sustaining Himalayan Ecosystem (G-SHE)	Regulatory	Regulation/ Rules	2010
National Mission on Enhanced Energy Efficiency	Energy	National	Cumulative avoided electricity capacity addition of 19,000 MW	Regulatory	Regulation/ Rules	2010
	Energy	National	expected to save energy of approximately 6.6 Mtonnes of oil equivalent by the end of 2014-15	Regulatory	Regulation/ Rules	2010
National Water Mission	Water	National	Increasing water use efficiency by 20%	Regulatory	Regulation/ Rules	2011
National Mission on Sustainable Agriculture	Agriculture	National	Use of Genetic Engineering to produce carbon responsive crops Low input sustainable agriculture: enhanced water & nitrogen use efficiency Micro-irrigation for efficient use of water (40 Mha) Water conservation in 35 Mha of rain-fed areas (2009 – 2017) Utilizing large fallow lands (development of land lease markets)	Regulatory	Regulation/ Rules	2013
National Mission on Strategic Knowledge on CC	Cross Sectoral	National	Climate change research and fellowship programme Climate change professor chairs National Research Chairs Climate Research Institute Network of Climate Change research institutes and scientists	Supportive measures	Capacity Building	2010

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
National policy on Bio fuels	Alternate Fuels	National	Accelerated development and promotion of the cultivation, production and use of biofuels to increasingly substitute petrol and diesel for transport and be used in stationary and other applications	Regulatory	Regulation/ Rules	2009
Perform, Achieve and Trade (PAT)	Energy Efficiency	National	Energy efficiency enhancement	Regulatory	Regulation/ Rules	2012
Programmes/ Schemes in New Technology-New Projects/New initiatives	Renewable Energy	National	Programmes and Schemes: a) Chemical Sources of Energy b) Hydrogen Energy c) Geothermal Energy d) Ocean Energy	Research & Development stage. Economic and fiscal incentivesy	Research Grant	2010
Promotion of Solar Thermal Systems for Air Heating Steam Generating Applications	Renewable Energy	National	Financial support is provided for installation of solar air heating & solar steam generating systems, preparation of DPRs & construction of solar buildings and establishment of Akshay Urja Shops.	Economic & Fiscal	Directed Financial Incentives	2010
Promotion of Solar Thermal Systems for air-heating/Steam generating applications, Solar buildings and Akshay Urja Shops	Renewable Energy	National	To accelerate widespread use of solar thermal systems for air heating and steam generating applications, as well as use of solar passive techniques in building design, through a combination of financial and promotional incentives.	Regulatory	Regulation/ Rules	2005-06
Renewable purchase obligations (RPO)	Energy	State	Enhancing renewable power usage	Economic & Fiscal	Quotas and Certificates	2010
Standards & Labeling programme	Energy Efficiency	National	Create the appropriate legal and regulatory environment for energy efficient end use products.	Regulatory	Standards & Labels	2006
Promotion of Biomass Based Heat Generation Systems in India	Energy	National (PoA)	Promoting Biomass Based Heat Generation Systems in India	Supportive measures	Green Procurement	2010
First Solar PoA in India by SENES Consultants	Energy	National (PoA)	Bundled CPA on Grid Connected Solar Power Project in India	Supportive measures	Green Procurement	2011
Bachat Lamp Yojna (BLY)	Energy	National (PoA)	Promote energy efficient lighting in India	Supportive measures	Market Development	2009
Auto Fuel Policy	Alternate Fuels	National	Bharat Stage IV emission norms in 13 cities from 1st April, 2010 and Bharat stage-III norms by 1st April 2010 in the entire country	Regulatory	Regulation/ Rules	2002
Coastal shipping development policy	Transport	National	coastal shipping, it is proposed to setup jetties for the Ro-Ro Ferry service network in Gulf of Kutch, Gulf of Cambay and western/southern coastal states up to Kerala.	Regulatory	Regulation/ Rules	2012
Coastal shipping fund	Transport	National	to be used for an interest subsidy scheme for acquisition of coastal ships	Economic & Fiscal	Directed Financial Incentives	2007
Ethanol Blending Programme	Alternate Fuels	National	5% blending of ethanol	Regulatory	Regulation/ Rules	2009
Forest (Conservation) Act	Forestry	National	To check further deforestation, the Forest (Conservation) Act was enacted by Government of India	Regulatory	Act	1980

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
National Forest Policy	Forestry	National	National Forest Policy acknowledges the importance and primacy of local communities and provided for a sustainable management approach with maintenance of environmental stability as the prime objective	Regulatory	Vision document	1988
Participatory Forest Management/Joint Forest Management Programme (JFM)	Forestry	National	Joint Forest Management (JFM) has emerged as an important intervention in management of forest resources in India. The JFM approach optimizes the returns, minimizes conflicts and links the forestry development works with the overall development of land based resources. It also aims at building technical and managerial capability at the grassroots level.	Land use	Others	1990
National Afforestation Programme (NAP)	Forestry	National	The National Afforestation Programme (NAP) Scheme was initiated by scaling-up the Samnavit Gram Vanikaran Samridhi Yojana (SGVSY) project experience and converging all afforestation schemes of the 9th Plan period. The overall objective of the scheme is to develop the forest resources with people's participation, with focus on improvement in livelihoods of the forest fringe communities, especially the poor	Land use	Afforestation	2001
National Watershed Development Project for Rainfed Areas (NWDPRA)	Agriculture	National	Improving agricultural production in rainfed areas and to restore ecological balance	Regulatory	System Efficiency	1991
Pradhan Mantri Gram Sadak Yojna (PMGSY)	Transport	National	To provide all weather road connectivity in rural areas	Regulatory	Regulation/ Rules	2000
National Highway Development Project	Transport	National	To upgrade, rehabilitate and widen major highways	Regulatory	Regulation/ Rules	2000
National Road Transport Policy	Transport	National	Promote modern, energy efficient and environment friendly road transport	Regulatory	Regulation/ Rules	
	Transport	National	Central Road Fund through collection of cess from petrol and diesel. Presently, ₹2/- per litre is collected as cess on petrol and High Speed Diesel (HSD) Oil. The fund is distributed for development and maintenance of National Highways, State Roads, Rural Roads and for provision of road over brides/under bridges and other safety features at unmanned Railway Crossings as provided in Central Road Fund Act, 2000.	Regulatory	Regulation/ Rules	
	Transport	National	Promotion of public transport and creation of better roads, upgrading State road transport co-operations	Regulatory	Regulation/ Rules	
National Urban Transport Policy	Transport	National	Putting Public Transport and Non-motorized vehicle at forefront	Regulatory	Regulation/ Rules	2006
	Transport	National	Reducing pollution levels through changes in traveling practices, better enforcement, stricter norms, technological improvements	Regulatory	System Efficiency	2006

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
	Transport	National	Promoting the use of cleaner technologies	Regulatory	System Efficiency	2006
THE METRO RAILWAYS (AMENDMENT) Act, 2009	Transport	National	Extending the Delhi Metro Railway Act to other cities in order to facilitate the provision of Metro Rail based public Transport	Regulatory	System Efficiency	2009
Urban Transport Fund	Transport	National	Provisioned as part of National Urban Transport Policy	Economic & Fiscal	Directed Financial Incentives	2014
Energy Conservation Building Code	Urban	National	To provide minimum requirements for the energy-efficient designand construction of buildings. This aims at reducing the baseline energy consumption by supporting adoption and implementation of efficiency saving and saving in greenhouse gas emission. Introduced by Delhi government for all new government buildings; Other States initiating measures on similar lines	Regulatory	Standards & Labels	2007
Jawaharlal Nehru National Urban Renewal Mission (JNNURM)	Urban	National	Integrated development of infrastructure services in cities related to water supply and sanitation, sewerage, solid waste management, road network, urban transport, and redevelopment of old city areas with a view to upgrading infrastructure) and basic services to the urban poor	Economic & Fiscal	Directed Financial Incentives	2005
	Urban	National	Solid waste management projects-waste to compost, waste to energy, recycling of waste, sanitary landfills	Economic & Fiscal	Directed Financial Incentives	2005
	Urban	National	Waste water management: recycling of waste water	Economic & Fiscal	Directed Financial Incentives	2005
	Urban	National	It covers a wide gamut of urban transport matters, including promoting public transport (incl. mass transit), NMT, comprehensive and integrated land use and mobility plans, and Intelligent Transport System (ITS), and launching of awareness campaign in line with the NUTP, 2006	Economic & Fiscal	Directed Financial Incentives	2005
	Urban	National	Developing Comprehensive Mobility Plans (CMP)	Economic & Fiscal	Directed Financial Incentives	2005
National Building Code (NBC)	Urban	National	Energy conservation through appropriate design, usage and practices with regard to building materials and construction technologies	Regulatory	Standards & Labels	2005
Scheme on Energy Efficient/Green Buildings	Urban	National	All the Ministries/Government Bodies/PSUs of Central Government would design and construct all new buildings as per requirements of at-least GRIHA 3 Star Rating and to make efforts to reach GRIHA 4 Star Rating	Supportive measures	Green Procurement	2009

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
Solar Cities (MNRE)	Urban	National	Targets at minimum 10% reduction in projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources	Regulatory	System Efficiency	2008
Deen Dayal upadhyaya Gram Jyoti Yojana (earlier known as Rajeev Gandhi Grameen Vidyutikaran Yojana)	Energy	National	Aims at providing electricity to 100% rural households. It has the provision of decentralized distribution and generation (DDG)Through use of renewable energy sources	Regulatory	System Efficiency	2005
Remote Village Electrification Programme	Energy	National	To provide access to electricity through renewable energy to households in remote villages, which are not likely to get covered through grid extension through non-conventional energy sources such as solar energy, small hydro power, biomass, wind energy, hybrid systems, etc.	Regulatory	Regulation/ Rules	2006
Accelerated development and deployment of solar water heating systems for domestic and industrial companies	Renewable Energy	National	Soft loans @ 2% to domestic users, 3% to institutional users not availing accelerated depreciation; and, 5% to industrial/commercial users availing depreciation	Economic & Fiscal	Directed Financial Incentives	2005
Asia Pacific Partnership on Clean Development and Climate (APP)/ Global Superior Energy Performance (GSEP)	Industry	National	7 countries-USA, Australia, China, Canada, India, Japan and South Korea have joined together to promote energy efficiency measures through supply of technology/ equipment/ fund in various sectors of the economy, including iron & steel	Regulatory	System Efficiency	2006
	Industry	National	GSEP Partnership programme has been launched consequent upon the closer of APPCDC and its activities have been transferred to GSEP. Under GSEP also, there are Sectoral Working Groups on various sectors of economy and the Steel Working Group (SWG) caters to the iron and steel industry. India is a signatory to Clean Energy Ministerial (CEM) & GSEP and will continue to pursue the programmes under SWG for the benefit of Indian Steel Industry	Regulatory	System Efficiency	2006
Energy efficient clean technologies in Iron and Steel plants	Industry	National	Availing carbon credit by adopting energy efficient clean technologies	Economic & Fiscal	Emissions Trading	2012
Upscaling Energy efficient production in small scale steel industry in India	Industry	National	Scheme to scale up the diffusion of energy efficient low carbon technologies in secondary steel mills including re-rolling mills and induction furnace to bring down energy consumption, improve productivity, and cost competitiveness; together with a reduction in GHG emission and related pollution levels	Regulatory	System Efficiency	2013

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
Compensatory Afforestation fund Management and Planning Authority (CAMPA)	Forestry	National	Afforestation and Reforestation			2004
Accelerated Programme on Energy Recovery from Urban Wastes	Waste	National	To create conducive conditions and environment, with fiscal and financial regime, to develop, demonstrate and disseminate utilisation of wastes for recovery of energy;	Regulatory	System Efficiency	2005
National Biogas and Manure Management Programme	Waste	National	To provide clean biogas fuel for reducing use of liquefied petroleum gas (LPG) and other conventional fuels; mitigation of climate change by preventing black carbon and methane emissions	Regulatory	Regulation/ Rules	1981
National Mission for clean coal (Carbon) technologies	Industry	National	Development of advanced ultra-supercritical technology for coal based thermal power plants. MoU among Indira Gandhi Centre for Atomic Research (IGCAR), NTPC and BHEL for indigenous development of Advanced Ultra Supercritical Technology which will have substantially higher power plant efficiency resulting in 20% reduction in CO_2 emission with respect to conventional sub-critical plants.	Regulatory	System Efficiency	2010
Programme on Biomass Energy and Co-generation (non-bagasse) in Industry	Industry	National	Biomass gasifiers for thermal and electrical applications in industry	Supportive measures	Market Development	2005
	Industry	National	Biomass Co-generation Projects	Regulatory	System Efficiency	2005
	Industry	National	Industrial Co-generation Projects based on Conventional Fuels and their Rejects	Regulatory	System Efficiency	2005
	Industry	National	Incentives for the installation of co-generation projects based on conventional fuels and rejects	Economic & Fiscal	Directed Financial Incentives	2004
UNDP-GEF Steel Projects: Removal of Barriers to Energy Efficiency Improvement in the Steel Rerolling Mill Sector	Industry	National	Seeks to reduce GHG emissions by providing technical assistance to small and medium-sized steel rerolling mills in India that will enable them to adopt more energy efficient and environmentally friendly technologies.	Regulatory	System Efficiency	2004
	Industry	National	For capacity building and information dissemination, the Ministry of Steel will establish a center for training, information and capacity strengthening on a sustained basis.	Supportive measures	Capacity Building	2004
	Industry	National	It will also develop institutional linkages with energy-service companies for providing off-the-shelf technologies from international equipment vendors. These actions, together with investment support by the Banking Sector are expected to result in a transformed and efficient steel re-rolling sector	Supportive measures	Cooperative Measures	2004

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
National Program on Energy Recovery	Waste	National	Power generation from MSW involving RDF Power generation on high-rate biomethanation Power from MSW on gasification-pyrolysis & plasma arc Biomethanation technology for power generation from vegetable market waste, slaughterhouse waste above 250KW capacity	Regulatory	Regulation/ Rules	1995
Power generation at sewage treatment plants	Waste	National	Generation of power from biogas being produced at Sewage Treatment Plants. Project cost will include the cost of engine-genset, H_2S removal plant and other related equipment	Regulatory	Regulation/ Rules	
Programme on Recovery of Energy from Industrial Wastes	Waste	National	Central Financial Assistance in the form of capital subsidy and Grants-in-Aid in respect of thefollowing activities:	Economic & Fiscal	Directed Financial Incentives	1995
	Waste	National	(i) Industrial waste to biogas		Market Development	
	Waste	National	Biomethanation of low energy density and difficult industrial wastes (i.e. dairy, tannery, slaughter house, sugar (liquid), bagasse wash, textile (liquid), paper (liquid) and pharma. ind.).			
	Waste	National	Biomethanation of other industrial wastes			
	Waste	National	(ii) Power generation from biogas		System efficiency	
	Waste	National	Boiler + Steam Turbine Configuration			
	Waste	National	Biogas Engine/Turbine Configuration			
	Waste	National	(iii)Power generation from solid industrial waste.		System Efficiency	
	Waste	National	(iv) Promotional activities.		Capacity Building	
	Waste	National	(v) R&D, Resource assessment, technology upgradation and performance evaluation, etc.		R&D	
The Municipal Solid Wastes (Management and Handling) Rules, 2000	Waste	National	Provides for collection, storage, segregation, transportation, processing and disposal of solid wastes. Rules mandate that landfilling should be restricted to non-biodegradable and inert waste which is neither suitable for recycling nor for biological processing.	Regulatory	Regulation/ Rules	2000 (amended in 2006, 2007, 2008, 2011)
Sewage to Energy Projects	Waste	National	Power generation from MSW through high rate biomethanation technology	Regulatory	Regulation/ Rules	2005
UNDP/ GEF Assisted Project on development of high rate Biomethanation process	Waste	National	Setting up of demonstration sub projects for wastes from seven sectors namely Sewage, Slaughterhouse, Leather & Tannery, Pulp & Paper, Vegetable market yards, Fruit and Food Processing and Animal manure besides utilization of biogas for power generation and reduce GHG	Regulatory	Regulation/ Rules	2005

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
	Waste	National	16 biomethanation subprojects on Pulp and paper industry effluent, leather and abattoir industry waste, vegetable market yard waste, municipal waste water/sewage, biogas utilisation, animal/agro residues, fruit/ food processing waste. 13 projects have been completed.	Regulatory	Regulation/ Rules	2005
India Forest PLUS	Forestry	National	to develop systems for forest carbon measurement and monitoring, as well as conduct greenhouse gas inventories, and support the application of science and technology for improved and more cost-efficient management and monitoring systems	Fiscal	Grant	2012
National Policy on Agriculture	Agriculture	National	Attain output growth rate in excess of 4% per annum based on efficient use of resources	Regulatory	Regulation/ Rules	2000
National Mission on Sustainable Agriculture	Agriculture	National	Objectives: Use of Bio- technology, Dry land (Rain-fed) Agriculture, Risk Management, Access to Information	Regulatory	System Efficiency	2011-12
National Project on Management of Soil Health & Fertility (NPMSF)	Agriculture	National	Facilitate and promote Integrated Nutrient Management (INM) through judicious use of chemical fertilizers in conjunction withorganic manures and bio-fertilizers	Regulatory	System Efficiency	2007
National Project on Organic Farming (NPOF)	Agriculture	National	Aims to promote production, promotion and market development of organic farming in the country	Supportive measures	Market Development	2004
Bharat Nirman	Cross Sectoral	National	To create and augment basic rural infrastructure including Irrigation, Rural Roads, Rural Housing, Rural Drinking Water Supply, Rural Electrification and Telephone Connectivity	Economic & Fiscal	Directed Financial Incentives	2005
Mahatma Gandhi National Rural Employment Guarantee Scheme	Cross Sectoral	National	The programme aims at enhancing livelihood security of the rural poor by providing at least 100 days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work	Economic & Fiscal	Directed Financial Incentives	2005
Restructured Accelerated Power Development and Reform Programme	Energy	National	The focus of the programme is on actual, demonstrable performance in terms of AT&C loss reduction. The coverage of programme is urban areas–towns and cities with population more than 30,000 (10,000 for special category states). Private distribution utilities are not covered under the programme.	Regulatory Measures	System Efficiency	2008
Electrification of Railways	Transport	National	By March 2012, electrification on Indian Railways has been extended to 22224 RKMs which includes 25 RKMs of Kolkatta Metro. This constitutes 34.48% of the total Railway Network and 40.27% of the BG system respectively.	Regulatory Measures	System Efficiency	1925

Description of programmes, policies, measures and projects	Sector	Span	Target	Type of Instrument		Start Year
One Nation-One Grid	Energy	National	Integration of regional grids, and thereby establishment of National Grid. Synchronization of all regional grids will help in optimal utilization of scarce natural resources by transfer of power from Resource centric regions to Load centric regions. This shall also pave way for establishment of vibrant Electricity market facilitating trading of power across regions. One Nation One Grid shall synchronously connect all the regional grids and there will be one national frequency	Regulatory Measures	System Efficiency	1991
Bus Rapid Transit Projects	Transport	National	Operational in 8 cities, plans to expand this to 24 cities	Supportive measures	Market Development	2007
Mass Rapid Transit Projects	Transport	National	Operational in 6 cities, plans to expand this to 28 cities	Supportive measures	Market Development	1984
Monorail Projects	Transport	National	Monorail projects already operational in 4 cities, plans to expand this to 18 cities	Supportive measures	Market Development	2008
Lightrail Projects	Transport	National	Being planned for Delhi and Kolkata as of now	Supportive measures	Market Development	Under planning
Energy Supply Sector CDM Projects	Renewable Energy	National	Projects includingBiomass Energy, Wind, Solar PV, Hydro, Fossil fuel switch, EE own generation and EE supply-side.	Economic & Fiscal	Emissions Trading	
Building Sector CDM Projects	Energy	National	Projects incluidng EE households, EE service, Solar cooking and Solar water heating	Economic & Fiscal	Emissions Trading	

Table 6.4 Mapping of Programmes, Policies, Measures and Projects for climate change mitigation and related initiatives at state level

STATE LEVEL POLICIES AND MEASURES

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Wind Power Policy 2007	Renewable Energy	Gujarat	To have investment in Clean and Green Energy to reduce CO_2 emissions.	Supportive measures	Market Development	2007
Solar Power Policy 2009	Renewable Energy	Gujarat	Promoting Clean and Green power using solar energy, to place appropriate climate investment, that could leverage the CDM project	Supportive measures	Market Development	2009
Green Solar Projects	Renewable Energy	Gujarat	Installation of solar (PV) power operated grids; connected or stand alone decentralized power plants with higher geographical dispersion.	Regulatory	Regulation/Rules	2010-11
Solar and Carbon Neutral City (Gandhinagar)	Renewable Energy	Gujarat	Introduced Solar street lighting and load management, Design and construction of carbon neutral CC complex in Gandhinagar, Systems like Solar power packs, solar water heaters, solar air conditioners to be installed in government owned and government aided institutions and organizations	Regulatory	System Efficiency	2010-11

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Rooftop solar power plant policy	Renewable Energy	Gujarat	To encourage people to produce their own electricity and earn by selling the surplus power to the state grid. The Gujarat government had initiated 5 MW rooftop program in Gandhinagarand now being extended to five more cities and towns	Regulatory	Regulation/Rules	2012
Gujarat Solar Park (Under solar power policy)	Renewable Energy	Gujarat	The solar power park (Asia's largest solar park) with a power generation capacity of 600 MW, covering ~3,000 acres of wasteland bordering the Rann of Kutch, will generate two-thirds of India's total 900 MW of solar power production.	Regulatory	Regulation/Rules	2012
SAUNI Yojana (Saurashtra Narmada Avataran Irrigation Project)	Energy	Gujarat	To fill 115 irrigation dams of all districts of Saurashtra with Narmada Water	Regulatory	Regulation/Rules	2012
Haryana Energy Efficiency Programme	Energy	Haryana	Mandatory use of CFL in Government Buildings/Government Aided Institutions/ Boards/Corporations	Regulatory	System Efficiency	2009
LED Village Lighting Project at Shimla, Molana, Panipat	Energy	Haryana	Converting conventional bulbs and tube lights by LED lamps/ tubelights	Regulatory	System Efficiency	
LED Street Lighting Demo Project for Kalka Town	Energy	Haryana	Replacement of 900 nos. of 40W tube lights with 24W LED Street lights, replacement of 150-250W HPSV lamps with 120W LED street lights with 7 microprocessor timers	Regulatory	System Efficiency	2009
Poultry Litter Based Power Generation	Renewable Energy	State (Haryana)	Power generation from poultry droppings in Barwala area (Panchkula district)	Supportive measures	Market Development	2010
Wind-Solar Hybrid Technology For Village Electrification	Renewable Energy	State (Haryana)	Green energy solutions to meet the energy demands of the local inhabitants	Supportive measures	Market Development	2008
Programme on Battery Operated Vehicles (BOVs)	Transport	State (Haryana)	Promote BOVs, which are non-polluting and quiet in operation, conserve petroleum products and curb environmental pollution	Regulatory	System Efficiency	
Generation of power from solar energy	Renewable Energy	Haryana	To invite and pre-register the solar power project under Jawaharlal Nehru National Solar mission	Regulatory	Regulation/Rules	2012
Biomass cogeneration Power projects	Renewable Energy	Haryana	Awareness among the industries specifically rice shellers to adopt this technology, Preparation of feasibility-cum-detailed project report and approval of MNRE for sanction of CFA	Regulatory	Regulation/Rules	2012
Biomass Power projects	Renewable Energy	Haryana	Awareness among the industries/ developers to set up biomass power projects, Preparation of feasibility-cum-detailed project report and approval of State Govt	Regulatory	Regulation/Rules	2012

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Energy Efficiency Mission	Energy	Haryana	Solar water heating projects, Enhance EE municipal water pumping, Improvement of Demand Side EE appliances in residential and commercial sectors	Regulatory	System Efficiency	2012
Atal Bijli Bachat Yojna	Energy	Himachal Pradesh	Connected load for interior lighting and space conditioning through solar photovoltaics).	Regulatory	System Efficiency	2008
Karnataka Renewable Energy Policy	Renewable Energy	Karnataka	Increase renewable energy power generation from 2400MW to about 6600 MW by 2014 (nearly tripling RE generation within 5 yrs)	Regulatory	Regulation/Rules	2009
Karnataka Energy Conservation Programmes	Energy	Karnataka	Regulate activities for enforcing Energy Conservation Act in State, Developing Energy Efficiency/DSM programmes, Delivery Mechanism for Energy Efficiency programmes	Regulatory	Regulation/Rules	2009
Home Bright	Energy	Karnataka	Residential High-Efficiency Lighting Programme, CFL/LED/Electronic chokes	Regulatory	Regulation/Rules	2009
Public Buildings Partnership Programme	Energy	Karnataka	Energy Efficiency implementation in public buildings using ESCOMs route.	Regulatory	System Efficiency	2009
Solar/LPG Water Heating Programme	Renewable Energy	Karnataka	Mandatory use of Solar/LPG Water Heaters	Regulatory	Regulation/Rules	2009
SME Programme	Energy	Karnataka	Energy efficiency improvement in small and medium enterprises.	Regulatory	System Efficiency	2011
Work Bright Programme	Energy	Karnataka	Commercial High-Efficiency Lighting Programme, CFL/LED/Solar Lighting.	Regulatory	System Efficiency	2011
Bright Streets Programme	Energy	Karnataka	Municipal Street Lighting Programme Using advanced technology,CFL/LED/ Solar/On-Off Timer.	Regulatory	System Efficiency	2011
Green Buildings Programme	Energy	Karnataka	Construct one or two new Green Buildings in each district of the state, ECBC Code. The Green Building concept will be mandatory for all corporate buildings and the buildings constructed by the developers in all the city corporation limits of the state under the suitable amendment to building bye-laws.	Supportive measures	Market Development	2011
Belaku Scheme	Energy	Karnataka	Each household could exchange up to 4 incandescent bulbs for CFLs at a subsidized rate of ₹ 15 per lamp in entire state by September, 2011	Regulatory	System Efficiency	2011
Scale up renewables contribution	Renewable Energy	Karnataka	Efficient scale up of capacity and technological innovation to drive down the cost, Off-grid decentralized application will be advantageous from rural electrification perspective and meeting other energy needs, Removal of implementation barriers of renewable/solar/biomass based generation with regulatory incentives for its promotion	Regulatory	System Efficiency	2008

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Enhancing efficiency in generation of power	Energy	Madhya Pradesh		Regulatory	System Efficiency	
Undertake demand side management to improve efficiency and reduce GHG emissions	Energy	Madhya Pradesh		Regulatory	System Efficiency	
Market Transformation for Energy Efficiency	Energy	Madhya Pradesh		Regulatory	System Efficiency	
Development of Low Carbon Society Pathway	Energy	Madhya Pradesh	Formulation of policies to promote Low Carbon Society	Regulatory	Regulation/Rules	
Building Institutional mechanism for CC	Energy	Madhya Pradesh	Create Climate Change division in the department, Energy sector	Regulatory	Regulation/Rules	
Increase the mix of renewable energy in total energy consumption	Renewable Energy	Madhya Pradesh	Favorable policies to attract investors to invest in RE sector	Regulatory	Regulation/Rules	
Building Institutional mechanism for Climate Change Action Plan	Energy	Madhya Pradesh	Create CC division in the department, New and Renewable Energy sector	Regulatory	Regulation/Rules	
Increase renewable energy generation share in the state	Renewable Energy	Mizoram	Promoting Micro hydro power (100 kW) generation	Regulatory	Regulation/Rules	2010
Increase renewable energy generation share in the state	Renewable Energy	Mizoram	Maximizing use of solar energy resources by Implementati on of 1 MWp Grid interactive Solar PV	Regulatory	Regulation/Rules	2010
Promoting off grid renewable energy applications	Renewable Energy	Mizoram	Incorporation of 100 systems of both 100 LPD and 200 LPD solar water heating systems in the state	Regulatory	Regulation/Rules	2010
Promoting off grid renewable energy applications	Renewable Energy	Mizoram	Pilot project installation of 100 no. of 250 Wp solar PV power pack systems	Regulatory	Regulation/Rules	2010
Promoting off grid renewable energy applications	Renewable Energy	Mizoram	Implementation of 100 KW standalone solar PV power plants	Regulatory	Regulation/Rules	2010
Reduce anticipated energy and peak demand in the BAU scenario	Energy	Mizoram	Penetration of energy efficient devices in domestic sector facilitated by financial, supply chain and market incentives	Regulatory	System Efficiency	2010
Reduce anticipated energy and peak demand in the BAU scenario	Energy	Mizoram	Deployment of energy efficient lighting for public lighting facilitated by financing and supply chains	Regulatory	System Efficiency	2010
Reduce anticipated energy and peak demand in the BAU scenario	Energy	Mizoram	Implementation of pilot energy efficient projects and IGEA	Regulatory	System Efficiency	2010
Institutional development of State Energy Departments and Awareness Creation	Energy	Mizoram	Capacity building of the state designated agency, energy departments	Supportive measures	Capacity Building	2010
Institutional development of State Energy Departments and Awareness Creation	Energy	Mizoram	Awareness creation of users and other citizens on energy efficiency measures and renewable energy application	Regulatory	System Efficiency	2010

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Re-structured Accelerated Power Development Reforms Project	Energy	Nagaland	A T & C Loss Reduction	Regulatory	System Efficiency	2012
MNRE's Small Hydro Programme	Energy	Nagaland	Explore Small Hydro Projects	Regulatory	Regulation/ Rules	2012
National Solar Mission	Renewable Energy	Nagaland	Commissioning and operationalizing Grid Interactive Solar PV and Solar-Wind Hybrid Project- 10 MW and implementing Solar City Project	Regulatory	Regulation/ Rules	2012
National Bio-mass Gassification Projects	Energy	Nagaland	Commissioning and operationalizing Grid Interactive Biomass gasification-10 to 15 MW	Regulatory	Regulation/ Rules	2012
National Hydro Policy	Energy	Nagaland	Commission of Major Hydro project	Regulatory	Regulation/ Rules	2012
National Solar Mission – Off Grid Projects	Energy	Nagaland	Commissioning of 5 MW of Off-Grid Projects under the Remote Village Electrification Project	Regulatory	Regulation/ Rules	2012
Research and Development budgetary head of MNRE	Renewable Energy	Nagaland	Creating off-Grid Solutions through the development and deployment of Pico Hydro projects	Regulatory	Regulation/ Rules	2012
Rajasthan Solar Energy Policy 2014	Renewable Energy	Rajasthan	To create an enabling environment for installation of 25,000 MW of solar power through state or private enterprises or through PPP or through individual efforts	Regulatory	Regulation/ Rules	2014
Policy for promotion of electricity generation from Wind, 2012	Renewable Energy	Rajasthan	Support wind power generation based on wind resource studies and assessment and attract investment in the state	Regulatory	Regulation/ Rules	2012
Policy for promotion of electricity generation from Biomass, 2010	Renewable Energy	Rajasthan	Promoting the generation of Electricity from biomass and facilitate its development by the developers, investors, and utilities	Regulatory	Regulation/ Rules	2010
Demand side measures including energy efficiency (short term)	Renewable Energy	Rajasthan	Studies of the increment in peak demands during summers and winters, formulate different schemes/ policies for the promotion of ECB directives and usage of solar water heaters	Regulatory	Regulation/ Rules	2012
Reduction of transmission and distribution losses	Energy	Rajasthan	All sub stations should be modernized automated and instrumented to improve quality and minimize energy losses.	Regulatory	Regulation/ Rules	
Developing renewable energy technologies	Energy	Sikkim	Rapid assessment and Identification of high fuel wood villages in all eco region, Facilitate Improved LPG distribution facilities in rural area	Regulatory	Regulation/ Rules	2011
Developing renewable energy technologies	Renewable Energy	Sikkim	Initiation of state renewable energy mission	Regulatory	Regulation/ Rules	2011
MNRE Programmes for Wind, Biomass, Solar	Renewable Energy	West Bengal	Produce 2000 MW and 3000 MW from renewable sources by 2021 and 2031 respectively	Regulatory	Regulation/ Rules	2013
MNRE Programme for NVVN	Energy	West Bengal	Incentives for Green Energy Producers, Material and Device manufacturing Industries	Supportive measures	Market Development	2012
MNRE Programmes for Wind, Biomass, Solar	Energy	West Bengal	Incentives for off-grid and stand-alone Decentralized Generation Systems	Economic & Fiscal	Directed Financial Incentives	2012

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
MNRE Programmesfor Wind, Biomass, Solar	Energy	West Bengal	R&D for improved green energy assessment (solar, wind and biomass), technology and Operations	Supportive measures	R&D	2013
Metro Rail Delhi	Transport	Delhi		Regulatory	Regulation/Rules	2011
Modal Shift from Road to Train for transportation of cars	Transport	Haryana		Regulatory	Regulation/Rules	2011
Mumbai Metro One, India	Transport	Maharashtra		Regulatory	Regulation/Rules	2011
"Blended cement with increased blend" at Orient cement's Devapur and Jalgaon plants in India	Industry	Maharashtra & Andhra Pradesh	Clinker replacement	Regulatory	System Efficiency	2002
"Optimal Utilization of Clinker" project at Dalmia Cement (Bharat) Limited (DCBL),Dalmiapuram ,Tamilnadu.	Industry	Tamil Nadu	Clinker replacement	Regulatory	System Efficiency	2000
"Optimal Utilization of Clinker" project at Shree Cement Limited (SCL), Beawar, Rajasthan	Industry	Rajasthan	Clinker replacement	Regulatory	System Efficiency	2000
ACC Blended cement projects at New Wadi Plant, Tikaria Cement Plant, Chanda Cement Works, Kymore Cement Works, Lakheri Cement Works and Chaibasa Cement Works	Industry	Karnataka & Maharashtra & Madhya Pradesh and Rajasthan & Jharkhand	Clinker replacement	Regulatory	Regulation/Rules	2004
Alternate arrangement for preheating fuel NG	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2005
Amine Circulation Pumps Energy Efficiency at Hazira works of ONGC	Industry	Gujarat	Energy Efficiency	Regulatory	Regulation/Rules	2009
Avoidance of GHG emissions in rigid Poly Urethane Foam (PUF) manufacturing by LIL	Industry	Tamil Nadu	HFC134a	Regulatory	Regulation/Rules	2009
Avoidance of HFC-134a emissions in rigid Poly Urethane Foam (PUF)	Industry	Maharashtra	HFC134a	Regulatory	Regulation/Rules	2010
Avoidance of HFC-134a emissions in rigid Poly Urethane Foam (PUF) manufacturing by Acme TelePower Limited (ATPL)	Industry	Uttarakhand	HFC134a	Regulatory	Regulation/Rules	2009

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Avoidance of methane gas emission to atmosphere from C-03 washing tower by effictively utilizing the C-O3 off gas as fuel in primary reformer at Indo Gulf Fertilisers, (a unit of Aditya Birla Nuvo Limited) Jagdishpur	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2006
Biomass based thermal energy generation at Saber Papers Limited	Renewable Energy	Himachal Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2010
Century Textiles and Industries Ltd blended cement projects at: • Century cement • Manikgarh cement • Maihar cement	Industry	Chhattisgarh & Maharashtra & Madhya Pradesh	Clinker replacement	Regulatory	Regulation/Rules	2006
Demand side energy conservation &reduction measures at IPCL – Gandhar Complex	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2005
Demand side energy conservation and reduction measures at ITC Tribeni Unit	Industry	West Bengal	Energy Efficiency	Regulatory	System Efficiency	2006
Demand side energy efficiency programmes at ITC Bhadrachalam pulp and paper making facility in India	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2006
Demand side energy efficiency projects at RIL-PG.	Industry	Maharashtra	Energy Efficiency	Regulatory	System Efficiency	2007
Demand-side energy efficiency programme in the 'Humidification Towers' of Jaya Shree Textiles	Industry	West Bengal	Energy Efficiency	Regulatory	System Efficiency	2000
Destruction of HFC-23 at refrigerant (HCFC-22) manufacturing facility of Chemplast Sanmar Ltd	Industry	Tamil Nadu	HFC23	Regulatory	System Efficiency	2007
Effective utilization of waste heat by installing vacuum pre-concentrator in urea section at Indo Gulf Fertilisers (A Unit of Aditya Birla Group), Jagdishpur.	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	System Efficiency	2007
Efficient utilisation of waste heat and natural gas at Dahej complex of GACL	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2003

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Energy efficiency and fuel switch project at Welspun India Limited	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2008
Energy Efficiency Improvement in Electric Arc Furnace at Indian Seamless Metal Tube Limited (ISMT), Jejuri, Maharashtra	Industry	Maharashtra	Energy Efficiency	Regulatory	System Efficiency	2006
Energy efficiency improvement in power generation at Sajjan India Limited, Ankhleshwar, Gujarat	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2008
Energy efficiency improvement in the Electric Arc Furnace	Industry	Chhattisgarh	Energy Efficiency	Regulatory	System Efficiency	2010
Energy efficiency improvement of the existing Frame V Gas Turbine by steam injection and change of drive (from steam to electricity) of Ammonia cooling water pumps at NFCL	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2009
Energy Efficiency Measures At Paper Production Plant	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2000
Energy efficiency projects-Steam system upgradation at the manufacturing unit of Birla tyres.	Industry	Odisha	Energy Efficiency	Regulatory	System Efficiency	2006
Energy efficiency through installation of modified CO_2 removal system in Ammonia Plant	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	System Efficiency	2003
Energy efficiency through steam optimisation projects at RIL, Hazira,	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2004
Enhancing energy efficiency by replacing batch smelter by continuous smelter at Karaikal, Pondicherry	Industry	Tamil Nadu	Energy Efficiency	Regulatory	System Efficiency	2008
Flare Gas Recovery and Utilization of Recovered Flare Gas for process furnace and other heating applications	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2009
Flare Gas Recovery and Utilization of Recovered Flare Gas for process heating requirements at IOCL, Haldia Refinery	Industry	West Bengal	Energy Efficiency	Regulatory	System Efficiency	2009

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Flare Gas Recovery and Utilization of Recovered Flare Gas for thermal requirements in IOCL, Guwahati Refinery	Industry	Assam	Energy Efficiency	Regulatory	System Efficiency	2010
Flare Gas Recovery system (FGRS) at Barauni Refinery of Indian Oil Corporation Limited	Industry	Bihar	Energy Efficiency	Regulatory	System Efficiency	2009
Fuel efficiency improvement in glass melting	Industry	Puducherry & West Bengal & Haryana	Energy Efficiency	Regulatory	System Efficiency	2004
Fuel Switch, process improvement and energy efficiency initiatives at brick manufacturing plant in Golan, Gujarat, India	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2012
GACL Blended Cement Projects in India	Industry	Maharashtra & Gujarat & Himachal Pradesh & Punjab & Rajasthan	Clinker replacement	Regulatory	System Efficiency	2004
GHG emission reduction by thermal oxidation of HFC 23 at Navin Fluorine International Limited (NFIL), Surat, Gujarat, India	Industry	Gujarat	HFC23	Regulatory	Regulation/Rules	2007
GHG emission reduction by thermal oxidation of HFC 23 at refrigerant (HCFC-22) manufacturing facility of HFL Ltd.	Industry	Andhra Pradesh	HFC23	Regulatory	Regulation/Rules	2008
GHG emission reduction by thermal oxidation of HFC 23 at refrigerant (HCFC-22) manufacturing facility of SRF Ltd	Industry	Rajasthan	HFC23	Regulatory	Regulation/Rules	2004
GHG emission reduction by thermal oxidation of HFC 23 in Gujarat	Industry	Gujarat	HFC23	Regulatory	Regulation/Rules	2006
GHG emission reduction through the installation of energy efficient vacuum creating system in the vacuum distillation column of petroleum refinery	Industry	Gujarat	Energy Efficiency	Regulatory	Regulation/Rules	2008

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
GHG emission reductions through pre-heat train optimization in the CDU and VDU of Digboi Refinery,, Indian Oil Corporation Limited (Assam Oil Division)	Industry	Assam	Energy Efficiency	Regulatory	Regulation/Rules	2008
GHG Emissions Reduction through Energy Efficiency Improvements	Industry	West Bengal	Energy Efficiency	Regulatory	Regulation/Rules	2000
Grasim Cement: Energy efficiency by up-gradation of clinker cooler in cement manufacturing	Industry	Chhattisgarh	Energy Efficiency	Regulatory	Regulation/Rules	2004
Greenhouse gas (GHG) reduction by implementing energy efficient plough share mixer (PSM) technology in soap manufacturing at Hindustan Lever Limited (HLL), India	Industry	Goa & Gujarat & Maharashtra	Energy Efficiency	Regulatory	Regulation/Rules	2007
Gujarat Narmada Valley Fertilizer Company (GNFC) Nitrous Oxide Abatement Project	Industry	Gujarat	Nitric acid	Regulatory	Regulation/Rules	2009
India - Vertical Shaft Brick Kiln Cluster Project	Industry	Madhya Pradesh, Chhattisgarh, Rajasthan &Odisha	Energy Efficiency	Regulatory	Regulation/Rules	2004
India-FaL-G Brick and Blocks Project No.1	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2004
India-FaL-G Brick and Blocks Project No.2.	Industry	Tamil Nadu	Energy Efficiency	Regulatory	Regulation/Rules	2011
Installation of Additional Urea Trays in Urea Reactors (11/21- R01)	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2004
Installation of Plate Type Heat Exchanger for preheating combustion air of primary reformer and reducing heat loss to atmosphere through flue gases at Indo Gulf Fertilisers (A Unit of Aditya Birla Group), Jagdishpur.	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	Regulation/Rules	2007
Low Grade Ore (LGO) beneficiation by Rajasthan State Mines & Minerals Limited	Industry	Rajasthan	Energy Efficiency	Regulatory	Regulation/Rules	2004

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Modification of clinker cooler for energy efficiency improvement in cement manufacturing at Binani Cement Limited	Industry	Rajasthan	Energy Efficiency	Regulatory	Regulation/Rules	2001
Mysore Cements Limited Portland Slag Cement project	Industry	Karnataka	Clinker replacement	Regulatory	Regulation/Rules	2001
N_2O abatement in HP Nitric Acid plants at Rashtriya Chemicals & Fertilizers Limited, India	Industry	Maharashtra	Nitric acid	Regulatory	Regulation/Rules	2009
N_2O abatement in MP Nitric Acid plants at Rashtriya Chemicals & Fertilizers Limited, India	Industry	Maharashtra	Nitric acid	Regulatory	Regulation/Rules	2009
N_2O reduction project at the WNA I nitric acid plant of Deepak Fertilisers& Petrochemicals Corporation Ltd. ("Deepak"), India	Industry	Maharashtra	Nitric acid	Regulatory	Regulation/Rules	2010
N2O reduction project at the WNA III nitric acid plant of Deepak Fertilisers& Petrochemicals Corporation Ltd. ("Deepak"), India	Industry	Maharashtra	Nitric acid	Regulatory	Regulation/Rules	2010
Optimal Utilization of Clinker in PPC manufacturing at Birla Corporation Limited, Raebareli Unit	Industry	Uttar Pradesh	Clinker replacement	Regulatory	System Efficiency	2001
Optimal utilization of clinker: Substitution of Clinker by Fly ash in Portland Pozzolana Cement blend at OCL, India	Industry	Odisha	Clinker replacement	Regulatory	System Efficiency	2001
Optimal utilization of clinker: Substitution of Clinker by Slag in Portland Slag Cement at OCL, Rajgangpur, Sundargarh, Odisha.	Industry	Odisha	Clinker replacement	Regulatory	System Efficiency	2001
Optimisation of steam generation and distribution systems through various energy efficiency measures at Anil Products Limited, Ahmedabad	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2009

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Optimization of steam consumption at the evaporator	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2002
Optimization of steam consumption by applying retrofit measures in blow heat recovery system	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2003
"Optimal Utilization of Clinker" project at Dalmia Cement (Bharat) Limited (DCBL), Dalmiapuram, Tamil Nadu.	Industry	Tamil Nadu	Clinker replacement	Regulatory	System Efficiency	2000
Optimum utilisation of clinker by PPC production at Binani Cement Limited, Rajasthan	Industry	Rajasthan	Clinker replacement	Regulatory	System Efficiency	2003
Optimum utilisation of clinker by production of Pozzolana Cement at UltraTech Cement Ltd. (UTCL), Andhra Pradesh	Industry	Andhra Pradesh	Clinker replacement	Regulatory	System Efficiency	2000
Reducing heat loss into atmosphere along with the flue gases by utilizing it for preheating of combustion air of service boiler at Indo-Gulf Fertilisers (A unit of Aditya Birla Nuvo Limited), Jagdishpur	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	System Efficiency	2007
Reduction in GHGs emission from primary aluminium smelter at Hindalco, Hirakud India	Industry	Odisha	PFCs	Regulatory	System Efficiency	2010
Reduction in specific steam consumption ratio of Process Air Compressor of Ammonia plant at Indo Gulf Fertilisers, (A unit of Aditya Birla Nuvo Limited) Jagdishpur.	Industry	Uttar Pradesh	Energy Efficiency	Regulatory	System Efficiency	2009
Reduction in steam consumption in stripper reboilers through process modifications	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2004
Reduction in Steam Consumption through Revamping of Ammonia Plant of Indian Farmers Fertiliser Cooperative Ltd (IFFCO) plants	Industry	Uttar Pradesh & Gujarat	Energy Efficiency	Regulatory	System Efficiency	2007

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Steam Optimization in Cooking Process in Paper Plant	Industry	Andhra Pradesh	Energy Efficiency	Regulatory	System Efficiency	2007
Substitution of clinker with fly ash in Portland Pozzolana Cement (Blended Cement) at Lafarge India Pvt. Ltd. - Arasmeta Cement Plant	Industry	Chhattisgarh	Clinker replacement	Regulatory	System Efficiency	2002
Up-gradation of Gas Turbine 1 (GT 1) and Gas Turbine 2 (GT 2) at co-generation plant of Hazira Gas Processing Complex (HGPC) of Oil and Natural Gas Corporation Limited (ONGC)	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2007
Vikram Cement (VC): Energy efficiency improvement by up gradation of preheater in cement manufacturing	Industry	Madhya Pradesh	Energy Efficiency	Regulatory	System Efficiency	2004
Waste heat recovery from Process Gas Compressors (PGCs), Mumbai high south (offshore platform) and using the recovered heat to heat process heating oil	Industry	Maharashtra	Energy Efficiency	Regulatory	System Efficiency	2007
Waste heat recovery project based on technology up-gradation at Apollo Tyres, Vadodara, India	Industry	Gujarat	Energy Efficiency	Regulatory	System Efficiency	2005
Waste heat utilization for charge pre-heating in a sponge iron manufacturing facility of HKMPL, India	Industry	Karnataka	Energy Efficiency	Regulatory	System Efficiency	2011
Araku Valley Livelihood Project	Forestry	State	turn a low carbon landscape into a high carbon multiple use landscape improving food security and generating additional income for the community	Regulatory	Regulation/Rules	2010

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Development of Forest including Consolidations-NCT of Delhi	Forestry	State	Proposed for Plantation on vacant forest/non-forest land available/ to be made available (15 lakh saplings), maintenance, planting and development of existing Nurseries, development and maintenance of City Forests, development of new city forests, survey, demarcation, consolidation of forest land & mapping, development of water bodies in forest areas, construction of Boundary Wall & providing fencing of Forest areas, construction of Watch Tower for protection, Ecorestoration of Riverine, Eco- system at Garhi Mandu, soil & water conservation measures, maintenance of forest road and inspection paths	Regulatory	Regulation/Rules	2012
Monitoring of Greening Activities in Delhi	Forestry	State	The scheme aims at increasing the forest and tree cover including protection of existing forest and taking measures for improvement of the soil/moisture regime, quality as green lung for the metro.	Regulatory	Regulation/Rules	2012
			The scheme also aims at monitoring/ evaluation of the gains made in greening and other activities through independent agency.	Regulatory	Regulation/Rules	
Rehabilitation of Degraded Wastelands at Deramandi in Southern District of National Capital Territory of Delhi through Reforestation	Forestry	State	Provide credible carbon sequestration through reforestation of 365.7 hectares of land	Land use	Others	2008
Bagepalli CDM Reforestation Programme	Forestry	Karnataka	Reforestation	Land use	Afforestation/ reforestation	2008
Improving Rural Livelihoods Through Carbon Sequestration By Adopting Environment Friendly Technology based Agroforestry Practices	Forestry	Odisha& Andhra Pradesh & Chhattisgarh	Reforestation	Land use	Afforestation/ Reforestation	2004
India: Himachal Pradesh Reforestation Project – Improving Livelihoods and Watersheds	Forestry	Himachal Pradesh	Reforestation	Land use	Afforestation/ Reforestation	2006
Reforestation of degraded land by MTPL in India	Forestry	Odisha& Andhra Pradesh & Chhattisgarh	Reforestation	Land use	Afforestation/ Reforestation	2001
Reforestation of severely degraded landmass in Khammam District of Andhra Pradesh, India under ITC Social Forestry Project	Forestry	Andhra Pradesh	Reforestation	Land use	Afforestation/ Reforestation	2001

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Small Scale Cooperative Afforestation CDM Pilot Project Activity on Private Lands Affected by Shifting Sand Dunes in Sirsa, Haryana	Forestry	Haryana	Afforestation	Land use	Afforestation/ Reforestation	2009
The International Small Group and Tree Planting Programme (TIST), Tamil Nadu, India	Forestry	Tamil Nadu	Reforestation	Land use	Afforestation/ Reforestation	2004
Rajasthan Urban Solid Waste Composting Programme, India	Waste	Rajasthan	Landfill composting	Regulatory	Regulation/Rules	2009
"Methane Avoidance by Municipal Solid Waste Processing in the city of Chandigarh, India"	Waste	Himachal Pradesh	Landfill power	Regulatory	System Efficiency	2007
(ABGSPL): Methane recovery in waste water treatment & Methane/Biomass Energy Generation Project	Waste	Punjab	Methane avoidance	Regulatory	System Efficiency	2011
Accion Fraterna Biogas CDM project for rural communities in Anantapur, Andhra Pradesh	Waste	Andhra Pradesh	Methane avoidance	Regulatory	System Efficiency	2012
Avoidance of methane emissions from Municipal Solid Waste and Food Waste through Composting	Waste	Odisha	Landfill composting	Regulatory	System Efficiency	2009
Avoidance of Wastewater and On-site Energy Use Emissions and Renewable Energy Generation in IFB Agro Distillery	Waste	West Bengal	Methane avoidance	Regulatory	System Efficiency	2007
Bagepalli CDM Biogas Programme	Waste	Karnataka	Methane avoidance	Regulatory	Regulation/Rules	2006
Biogas and biomass based co-generation project at CDBL	Waste	Punjab	Methane avoidance	Regulatory	Regulation/Rules	2008
Biogas CDM Project of Bagepalli Coolie Sangha	Waste	Karnataka	Methane avoidance	Regulatory	Regulation/Rules	2010
Bundled Waste Processing Facilities in India	Waste	Punjab & Kerala & Karnataka	Landfill composting	Regulatory	Regulation/Rules	2010
Establishment of Compost Production Unit of 100 TPD at Lalganj	Waste	Uttar Pradesh	Landfill composting	Regulatory	Regulation/Rules	2009
Expansion of Nature and Waste Bhalaswa Composting Plant at Delhi	Waste	Delhi	Combustion of MSW	Regulatory	Regulation/Rules	2010

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Gorai Landfill closure and Gas Capture Project, Mumbai, India	Waste	Maharashtra	Landfill power	Regulatory	Regulation/Rules	2010
Installation of Bundled Composting Project in the state of Tamil Nadu	Waste	Tamil Nadu	Landfill composting	Regulatory	Regulation/Rules	2010
Integrated Municipal Waste Processing Complex at Ghazipur, Delhi	Waste	Delhi	Combustion of MSW	Regulatory	Regulation/Rules	2010
Kolar Biogas Project	Waste	Karnataka	Methane avoidance	Regulatory	Regulation/Rules	2011
Kollam Solid Waste Composting Project	Waste	Kerala	Methane avoidance	Regulatory	Regulation/Rules	2012
Methane abatement and household biogas utilization programme in India	Waste	India	Methane avoidance	Regulatory	Regulation/Rules	2010
Methane Capture and use as fuel at Rajaram Maize Products, Chattisgarh	Waste	Chhattisgarh	Methane avoidance	Regulatory	System Efficiency	2007
Methane extraction and energy generation project activity at Shirala, Maharasthra	Waste	Maharashtra	Methane avoidance	Regulatory	System Efficiency	2009
Methane Extraction and Fuel Conservation Project at Tamil Nadu Newsprint and Paper Limited (TNPL), Kagithapuram, Karur District, Tamil Nadu	Waste	Tamil Nadu	Methane avoidance	Regulatory	System Efficiency	2003
Methane recovery and power generation in a distillery plant	Waste	Andhra Pradesh	Methane avoidance	Regulatory	System Efficiency	2006
Methane recovery from waste water generated from wheat straw wash at Paper manufacturing unit of Shreyans Industries Limited (SIL)	Waste	Punjab	Methane avoidance	Regulatory	System Efficiency	2007
Methane recovery from wastewater generated at Paper manufacturing unit of Sree Sakthi Paper Mills Ltd., Kerala	Waste	Kerala	Methane avoidance	Regulatory	System Efficiency	2009
Methane recovery from wastewater treatment at Dwarikesh Sugar Industries Limited (DSIL)	Waste	Uttar Pradesh	Methane avoidance	Regulatory	System Efficiency	2010
Methane Recovery from wastewater treatment in Seafood Industry in Maharashtra	Waste	Maharashtra	Methane avoidance	Regulatory	System Efficiency	2011

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Municipal Solid Waste based Composting at Kolhapur, Maharashtra	Waste	Maharashtra	Landfill composting	Regulatory	System Efficiency	2009
Off gases utilisation from C – 03 washing tower in Primary Reformer as fuel	Waste	Uttar Pradesh	Methane avoidance	Regulatory	System Efficiency	2004
SESL 6 MW Municipal Solid Waste Based Power Project at Vijayawada & Guntur, Andhra Pradesh	Waste	Andhra Pradesh	Landfill power	Regulatory	System Efficiency	2004
SIDPL Methane extraction and Power generation project	Waste	Maharashtra	Methane avoidance	Regulatory	System Efficiency	2002
SKG Sangha Biodigester PoA	Waste	India	Methane avoidance	Regulatory	Regulation/Rules	2012
Social Education and Development Society (SEDS) Biogas CDM project for the rural poor	Waste	Andhra Pradesh	Methane avoidance	Regulatory	Regulation/Rules	2011
The TIMARPUR-OKHLA Waste Management Company PvtLtd's (TOWMCL) integrated waste to energy project in Delhi	Waste	Haryana	Integrated solid waste management	Regulatory	Regulation/Rules	2009
Upgradation and expansion of A.P.M.C compost plant at Tikri, Delhi	Waste	Delhi	Landfill composting	Regulatory	Regulation/Rules	2009
Upgradation, Operation and Maintenance of 200 TPD Composting facility at Okhla, Delhi	Waste	Delhi	Landfill composting	Regulatory	Regulation/Rules	2009
Demand Side Management Application	Energy and Agriculture	Various States	Reducing inductive losses on load side appliances to be done	Regulatory	Regulation/Rules	
	Energy and Agriculture		Meter Installation for pump sets to be done in phases	Regulatory	Regulation/Rules	
	Energy and Agriculture		Rural 3 phase feeder separation to be done in phases	Regulatory	Regulation/Rules	
	Energy and Agriculture		Reducing aggregate technical and commercial losses (AT&C)	Regulatory	Regulation/Rules	
	Energy and Agriculture		More mechanization to increase energy efficiency of agriculture, including off-road vehicles (e.g. tractors, machines etc) - to be done in phases	Regulatory	Regulation/Rules	
	Energy and Agriculture		Solar pump sets	Regulatory	Regulation/Rules	
	Energy and Agriculture		Biomass based power generation (using rice straw)	Regulatory	Regulation/Rules	
	Energy and Agriculture		Drip irrigation systems for increasing water-energy efficiency	Regulatory	Regulation/Rules	

Description of programmes, policies, measures and projects	Sector	States	Target	Type of Instrument		Start year
Scheme on energy conservation in agriculture sector	Energy and Agriculture	Various States	All the farmers of Haryana who are taking new tubewells connection or opting for higher capacity pump sets will be encouraged to install at least 4 star rated (BEE Star rating) pump sets and will be eligible for the state subsidy. Farmers having old non ISI motors and want to replace these with Latest 4 star rated motors will also be eligible under this scheme.	Regulatory	Regulation/Rules	
	Energy and Agriculture		Replacement of all/remaining inefficient pump sets with 4/5 star rated (BEE star rating) and the installment of new pump sets in order to double the agricultural production	Regulatory	Regulation/Rules	

Note: The programmes, policies, measures and projects mentioned in the tables 6.3 and 6.4 are only on representative basis and their full scope and coverage in different states is not mentioned here.

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Annexures

Annexure I- Abbreviations

Acronym	Expansion
BEE	Bureau of Energy Efficiency
BUR	Biennial Update Report
CAGR	Compounded Annual Growth Rate
CDM	Clean Development Mechanism
CERC	Central Electricity Regulatory Commission
CH_4	Methane
CII	Confederation of Indian Industry
CIMFR	Central Institute of Mining and Fuel Research
CNG	Compressed Natural Gas
CO_2eq	Carbon dioxide equivalent
COP	Conference of Parties to UNFCCC
CPCB	Central Pollution Control Board
CRRI	Central Road Research Institute
CSIR	Council of Scientific and Industrial Research
DST	Department of Science and Technology
FICCI	Federation of Indian Chamber of Commerce and Industry
FSI	Forest Survey of India
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GIS	Geographic Information System
GOI	Government of India
GWP	Global Warming Potential
INC	Initial National Communication
IPCC	Inter-governmental Panel on Climate Change
JFM	Joint Forest Management
LED	Light Emitting Diode
LNG	Liquefied Natural Gas
LULUCF	Land Use, Land-use Change and Forestry
MRV	Measurement, Reporting and Verification
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MNRE	Ministry of New and Renewable Energy
MoC	Ministry of Coal
MoEA	Ministry of External Affairs
MoEF&CC	Ministry of Environment, Forest and Climate Change
MSW	Municipal Solid Waste
N	Nitrogen
N_2O	Nitrous Oxide
NAPCC	National Action Plan on Climate Change
NATCOM	National Communication
NCR	National Capital Region
NGO	Non- Governmental Organization
NMVOC	Non Methane Volatile Organic Compound
NOx	Nitrogen Oxides
NPD	National Project Director
NPL	National Physical Laboratory
NRSC	National Remote Sensing Centre
NSC	National Steering Committee
NTFP	Non-Timber Forest Product
NTPC	National Thermal Power Corporation
OC	Organic Carbon
PAT	Perform Achieve and Trade
PC	Planning Commission
PFC	Perfluorocarbon
PMU	Project Management Unit
PSU	Public Sector Undertaking
PV	Photovoltaic
R&D	Research and Development
R&M	Renovation and Modernization
REDD	Reduced Emission from Deforestation and Degradation
RET	Renewable Energy Technology
SEB	State Electricity Board
SERC	State Electricity Regulatory Commission
SF_6	Sulphur Hexa-fluouride
SNC	Second National Communication
SO_2	Sulfur Dioxide
SPV	Solar Photo Voltaic
T&D	Transmission and Distribution
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compound

Units and Quantities

BCM	Billion Cubic Meter (equals 1km^3)
C	Celsius
Gg	Giga gram
GW	Giga Watt
GWh	Giga Watt hour
ha	Hectare
km	Kilometer
km^2	Square kilometer
km^3	Cubic kilometer
kW	kilo Watts
kWp	kilo Watts peak
M	Million
m^3	Cubic meter
Mha	Million hectare
MJ	Mega Joule
Mt	Million tonne
Mt-CO_2	Million tonnes of Carbon dioxide
Mt-CO_2 eq.	Million tonnes of Carbon dioxide equivalent
MW	Mega Watts
t	tonne
Tg	Tera gram
TJ	Tera Joule
toe	tonnes of oil equivalent

Conversion Table

1 Giga gram (Gg)	=	1000 tonnes
	=	10^9g
1 Tera gram (Tg)	=	1 Million tonnes
	=	1000 Gg
	=	10^6 tonne = 10^{12}g
1 Tera Joule (TJ)	=	10^3 GJ
	=	10^{12} Joules
1 Calorie	=	4.18 J
1 Lakh	=	100,000 = 10^5
1 Crore	=	10,000,000 = 10^7

ANNEXURE II- Institutional Arrangements

Composition of the National Steering Committee (NSC) for India's Third National Communication (TNC), International Consultationand Analysis (ICA) and Biennial Update Reports (BUR) to the United Nations Framework Conventionon Climate Change (UNFCCC)

1.	Secretary Ministry of Environment, Forest and Climate Change Indira Paryavaran Bhawan, Ali Ganj, Jor Bagh Road, New Delhi-110003	Chairman
2.	Additional Secretary (Climate Change) Ministry of Environment, Forest and Climate Change New Delhi-110003	Member
3.	Secretary or his representative NITI Aayog Yojna Bhawan, Parliament Street New Delhi – 110 001	Member
4.	Secretary or his representative Department of Agriculture, Research and Education Ministry of Agriculture Krishi Bhawan, New Delhi – 110 001	Member
5.	Secretary or his representative Department of Agriculture and Cooperation Ministry of Agriculture Krishi Bhawan, New Delhi – 110 001	Member
6.	Secretary or his representative Department of Economic Affairs Ministry of Finance North Block, New Delhi – 110 001	Member
7.	Secretary or his representative Ministry of New and Renewable Energy Block-14, CGO Complex Lodi Road, New Delhi – 110 003	Member
8.	Secretary or his representative Department of Science and Technology Technology Bhawan New Mehrauli Road, New Delhi – 110 016	Member
9.	Secretary or his representative Department of Coal Shastri Bhawan, New Delhi – 110 001	Member
10.	Secretary or his representative Ministry of Power Shram Shakti Bhawan New Delhi – 110 001	Member
11.	Secretary or his representative Department of Heavy Industry Ministry of Heavy Industries and Public Enterprises Udyog Bhawan, New Delhi-110 001	Member

12.	Secretary or his representative Department of Public Enterprises Ministry of Heavy Industries and Public Enterprises CGO Complex, New Delhi – 110 003	Member
13.	Secretary or his representative Department of Road Transport and Highways Parivahan Bhawan, New Delhi – 110 003	Member
14.	Secretary or his representative Ministry of Shipping Parivahan Bhawan, New Delhi – 110 003	Member
15.	Secretary or his representative Ministry of Petroleum and Natural Gas Shastri Bhawan, New Delhi – 110 001	Member
16.	Secretary or his representative Ministry of Water Resources, River Development and Ganga Rejuvenation Shram Shakti Bhawan New Delhi- 110 003	Member
17.	Secretary or his representative Ministry of Health and Family Welfare Nirman Bhawan, New Delhi – 110 011	Member
18.	Secretary or his representative Ministry of Earth Sciences Prithvi Bhawan New Delhi	Member
19.	Secretary or his representative Ministry of Rural Development Krishi Bhawan, New Delhi – 110 001	Member
20.	Secretary or his representative Department of Chemicals and Petrochemicals Shastri Bhawan, New Delhi – 110 001	Member
21.	Secretary or his representative Department of Fertilizers Shastri Bhawan, New Delhi – 110 001	Member
22.	Secretary or his representative Department of Industrial Policy and Promotion Ministry of Commerce and Industry Udyog Bhawan, New Delhi – 110 011	Member
23.	Secretary or his representative Ministry of Steel Udyog Bhawan, New Delhi – 110 011	Member
24.	D.G. or his representative Indian Meteorological Department IMD Campus, Lodi Road New Delhi-110 003	Member
25.	Joint Secretary (UN) Ministry of External Affairs South Block, New Delhi – 110 001	Member
26.	Representative United Nations Development Programme 55 Lodi Estate New Delhi – 110 003	Member
27.	Joint Secretary Ministry of Environment, Forest and Climate Change New Delhi-110003	Member
28.	Adviser (Climate Change) Ministry of Environment, Forest and Climate Change New Delhi-110003	Member Secretary

Composition of the Expert Advisory Committee for Biennial Update Report to the United Nations Framework Conventionon Climate Change (EAC – BUR)

1.	Secretary Ministry of Environment, Forest and Climate Change Indira Paryavaran Bhawan, Ali Ganj, Jor Bagh Road New Delhi-110003	Chairman
2.	Additional Secretary (Climate Change) Ministry of Environment, Forest and Climate Change Indira Paryavaran Bhawan, Ali Ganj, Jor Bagh Road New Delhi-110003	Member
3.	Advisor (E and F) Planning Commission (NITI Aayog) Yojna Bhawan, Parliament Street New Delhi – 110 001	Member
4.	Additional Secretary Ministry of Power Shram Shakti Bhawan New Delhi – 110 003	Member
5.	Deputy Director General (NRM) Indian Council of Agricultural Research (ICAR) New Delhi	Member
6.	Director General Bureau of Energy Efficiency (BEE) Ministry of Power New Delhi.	Member
7.	Director General Forest Survey of India Dehradun Uttarakhand	Member
8.	Director National Remote Sensing Centre Hyderabad.	Member
9.	Director National Environmental Engineering Research Institute Nagpur.	Member
10.	Prof. Amit Garg Indian Institute of Management Ahmedabad, Gujarat.	Member
11.	Dr. Seema Arora Confederation of Indian Industries New Delhi.	Member
12.	Prof. N.H. Ravindranath Centre for Sustainable Technologies Indian Institute of Science Bengaluru.	Member
13.	Joint Secretary Ministry of Environment, Forest and Climate Change New Delhi-110003	Member
14.	Adviser (Climate Change) Ministry of Environment, Forest and Climate Change New Delhi-110003	Member Secretary

Contributors to India's First Biennial Update Report

Project Management Unit

Dr. J.R. Bhatt
National Project Director, NATCOM
Scientist-G Ministry of Environment, Forest and Climate Change
Government of India, Indira Paryavaran Bhavan
Jor Bagh Road, New Delhi
Telefax No.+91-11-24695293
E-mail: jrbhatt@nic.in

Lokesh Chandra Dube
Programme Officer
Project Management Unit, NATCOM
"India's Third National Communication and Other New Information to the UNFCCC"
Second Floor, S-212
Panchsheel Park, New Delhi
Phone: +91-11-26013869
Fax: +91-11-26013876
E-mail: lokesh@inspirenetwork.org

Gargi Sharma
Project Associate
Project Management Unit, NATCOM
"India's Third National Communication and Other New Information to the UNFCCC"
Second Floor, S-212
Panchsheel Park, New Delhi
Tele-fax: +91-11-26013876
E-mail: gargi@inspirenetwork.org

Participating Institutions and Experts

Universities/ Educational institutions

Indian Institute of Management Ahmedabad (IIM A)
Vastrapur, Ahmedabad - 380015, India
Ph:91 79 6632 4952

Prof. Amit Garg
Prof. P. R. Shukla
Mr. Bhushan Kankal
Mr. R. Parmeswaran
Ms. Abha Sharma
Mr. Jaypal Singh Chauhan

Indian Institute of Science (IISc)

CV Raman Road,
Bangalore - 560 012
Phone: 91 - 80 - 2334 1838

Prof. N.H. Ravindranath
Dr. Rajiv Kumar Chaturvedi
Ms. Indu K Murthy
Ms. Shruthi B V Rajesh

Laboratories of the Council for Scientific and Industrial Research (CSIR)

Central Institute of Mining and Fuel Research (CIMFR)

Barwa Road, Dhanbad – 826001,
Phone: 91-326-2296023

Dr. S. Biswas
Dr. Ajay Kumar Singh
Dr. Pinaki Sarkar
Mr. Jaywardhan Kumar

Central Road Research Institute (CRRI)

Delhi-Mathura Road,
PO. CRRI, New Delhi – 110025
Tel:91-11-26921830

Dr. Anil Kumar Singh

Indian Institute of Petroleum (IIP)

Mohkampur, I I P, Rajpur Road,
Dehradun – 248001
Phone: 91-135-2660203

Dr. S.K. Singhal
Dr. Sunil Pathak

National Physical Laboratory (NPL)
Dr. K. S. Krishnan Road
New Delhi – 110012
Tel.:91-11-45609387

Dr. Chhemendra Sharma

National Environmental Engineering Research Institute (NEERI)
Nehru Marg, Nagpur – 440 020
Tel: 91-712-2249755

Dr. J.K. Bhattacharya
Dr. Atul Vaidya
Dr. Mahendra P. Patil

Institutes of Indian Council of Agricultural Research (ICAR)

Central Research Institute of Dryland Agriculture (CRIDA)

Santoshnagar, Hyderabad - 500 059
Ph : 91-40-24530177

Dr. M. Maheswari
Dr. J.V.N.S. Prasad
Dr. K.V. Rao
Dr. C.A. Rama Rao,
Dr. Ch. Srinivasa Rao,
Dr. B. Bapuji Rao
Dr. V.U.M. Rao
Dr. Y.G. Prasad
Dr. A.K. Sikka

Indian Agricultural Research Institute (IARI)

Pusa Road, New Delhi – 110 012
Tele: 91-11-25841490

Dr. H. Pathak
Dr. Niveta Jain
Dr. Arti Bhatia

National Dairy Research Institute (NDRI)

Karnal – 132001
Ph.: 91-184-2259088

Dr. Madhu Mohini
Dr. S Thakur
Dr. Goutam Mondal
Mr. Babar Ali
Ms. Reena Kashyap

Bodies of Ministry of Environment, Forest and Climate Change

Forest Survey of India (FSI)

Kaulagarh Road, PO-IPE, Deharadun – 248194
Tel.: 91-135-2756139

Dr. Anmol Kumar
Mr. Rajesh Kumar

Indian Council of Forestry Research and Education (ICFRE)

PO- New Forest, Dehradun – 248006
Phone: +91-135-2750296

Dr. T. P. Singh
Mr. V.R.S. Rawat
Dr. R.S. Rawat
Dr. Ajeet Kaur

Other Institutions

Energy Efficiency Services Limited (EESL)

A-13, IWAI Building
4th Floor, Sector - 1
Noida – 201301
Tel: 91-120-4908002

Mr. Saurabh Kumar
Ms. Neelima Jain
Ms. Mayuri Chaukhande

National Remote Sensing Centre (NRSC)

CRF Colony, Balanagar, Hyderabad, Telangana
91-40-23884000

Dr. C.S. Jha

Non-governmental research organizations

Confederation of Indian Industry (CII)

Thapar House, 2nd Floor, 124 Janpath,
New Delhi – 110001 India
Phone: +91 11 41502307

Dr. Seema Arora
Mr. Kamal Sharma

Integrated Research for Action and Development (IRADe)

C-80, Shivalik, Malviya Nagar
New Delhi – 110017
Ph. 91 11 2667 6181

Dr. Jyoti Parikh
Mr. Chandrashekhar Singh
Ms. Gayatri Khedkar
Ms. Arshi Vimal
Ms. Asha Kaushik

The Energy and Resources Institute (TERI)

Habitat Place, Lodhi Road
New Delhi – 110003
Tel: 91 11 24682100

Ms. Nimisha Panday
Dr. Arindam Datta
Ms. Neha Pahuja

Other participating organizations

University of Agricultural Sciences, Bangalore

Iora Ecological Solutions

Suggestions and inputs from Experts

Prof. Raman Sukumar
CES, Indian Institute of Science, Bangalore

Prof. A. K. Bhatnagar
Formerly Head Department of Botany
University of Delhi, Delhi

Dr. K. J. Ramesh
Ministry of Earth Sciences, New Delhi

Dr. S. D. Attri
India Meterological Deparment, New Delhi

Dr P. C. Maithani
Ministry of New and Renewable Energy, New Delhi

Shri Sanjay Pande
National Thermal Power Corpration Ltd.

Dr. Narender Singh
Central Electricity Authority, New Delhi

Shri Karan Mangotra
UNDP-GEF-BEE Project, New Delhi

Dr. Subrata Bose
Ministry of Environment, Forest and Climate Change, New Delhi

Shri Ajay Raghava
Ministry of Environment, Forest and Climate Change, New Delhi

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India: Preparation of Third National Communication and other New Information to the UNFCCC

Annexure-III

List of events /consultative meetings




1. First meeting of the National Steering Committee for India's Third National Communication and other new information to the UNFCCC; 7th August 2013 at Paryavaran Bhawan, New Delhi.

2. Consultation meeting on GHG inventory for LULUCF sector for India's first BUR; 29th January 2014 at Paryavaran Bhawan, New Delhi.

3. Workshop on GHG inventory for Energy and IPPU sectors for India's first BUR; 12-13th March 2014 at IIM, Ahmedabad.

4. Consultation meeting for coordination of network of institutes for all studies under the first BUR; 19th March 2014 at Paryavaran Bhawan, New Delhi.

5. Meeting of forestry expert group on LULUCF inventory preparation for BUR; 20th March 2014 at IISc, Bangalore.

6. Meeting on progress of GHG inventory preparation of Agriculture and Waste sectors under India's first BUR; 29th April 2014 at NATCOM Project Management Unit, New Delhi.

7. Meeting to review the activities towards preparation of India's first BUR- "National Circumstances, Mitigation Actions, Constraints and Gaps"; 15th May 2014 at NATCOM Project Management Unit, New Delhi.

8. Meeting to review the activities towards preparation of India's first BUR to UNFCCC- "GHG Inventory for BUR"; 16th May 2014 at NATCOM Project Management Unit, New Delhi.

9. Expert group meeting for LULUCF sector GHG Inventory on 3rd September 2014 at MoEF&CC, New Delhi.

10. Expert group meeting for Waste and Agriculture sector GHG inventories on 10th September 2014 at MoEF&CC, New Delhi.

11. Expert group meeting for Energy and IPPU sector GHG inventories on 11th September 2014 at MoEF&CC, New Delhi.

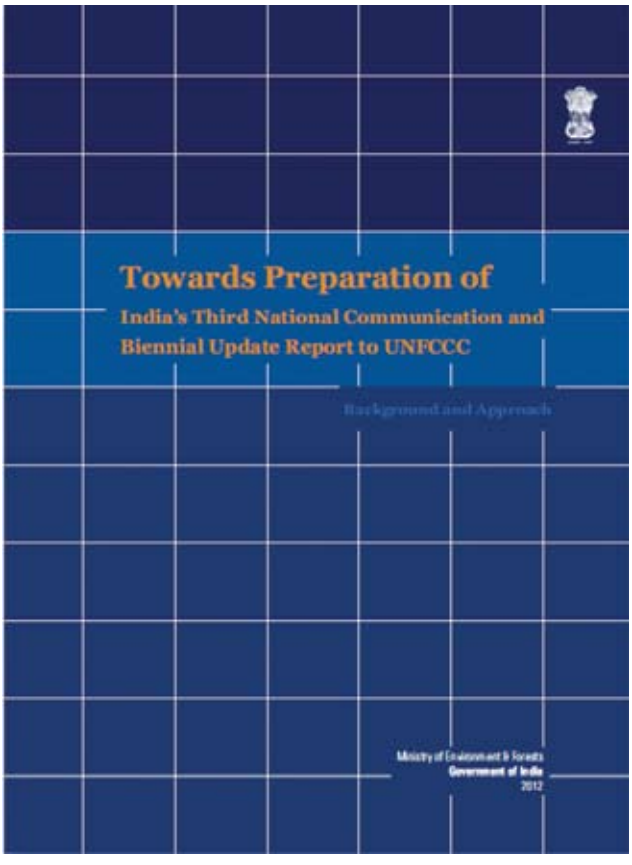
12. Meeting on GHG Inventory for BUR chaired by Secretary, MoEFCC on 11th November 2014.

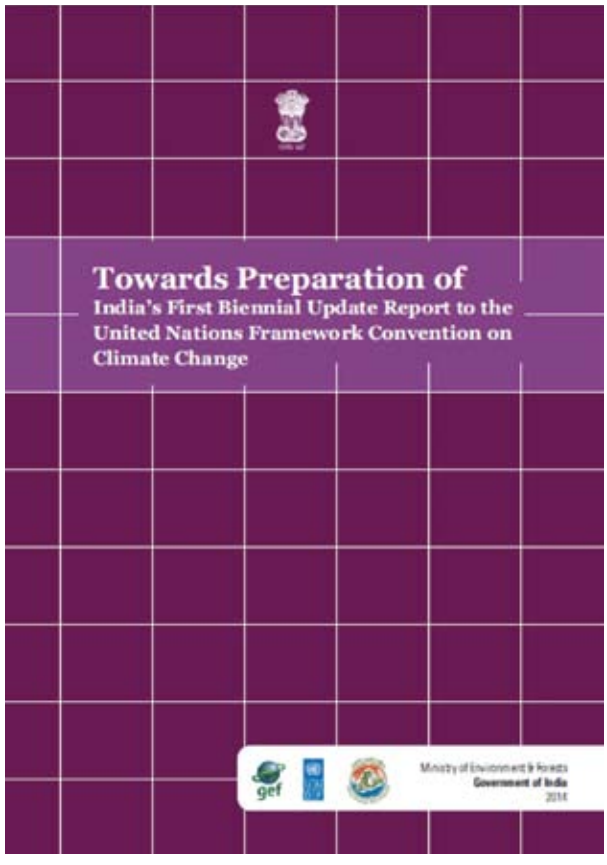
13. Meeting of the Expert Advisory Committee chaired by Additional Secretary, MoEFCC at Indira Paryavaran Bhawan, New Delhi on 24th April 2015.

14. Second Meeting of the National Steering Committee chaired by Secretary, MoEFCC at Indira Paryavaran Bhawan, New Delhi on 30th April 2015.

Annexure-IV

Publications under the aegis of India's first BUR





Notes