MITIGATION AND ADAPTATION INFORMATION NETWORK FOR SUSTAINABLE COMMUNITIES

CLIMATE CHANGE MITIGATION IN INDIA

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Environmental Knowledge for Change

Development Alternatives

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Preface

The present publication “Climate Change Mitigation in India” has been prepared as a part of project “Developing a knowledge base for decentralized renewable energy and efficiency in India” under the umbrella of “MAIN - Mitigation and Adaptation Information Network” for Sustainable communities by Development Alternatives (DA) in association with UNEP/GRID-Arendal.

MAIN is an Information & Communication Technology (ICT) based network designed for exchange of information and experience, promoting innovation, capacity building, and empowerment by and for local communities. The objective of MAIN is to bring together expertise, knowledge and local experiences in a common network that empowers communities across the globe to create, share, use and store knowledge to support sustainable living.

The publication focuses on the efforts taken up by the Government of India towards climate change mitigation and how the environmental concerns have been integrated in Indian planning process. The work also provides insights on Clean Development Mechanism (CDM) as an important mechanism for funding mitigation efforts for developing countries like India and through some light on Post Kyoto regime. Though India has been one of the highest recipients of CDM finances, uncertainty with respect to Post-Kyoto regime is (currently) probably the most significant barrier for investments in CDM.

Contributions By

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1. Introduction

India is a large developing country with a nearly 700 million rural population directly depending on climate sensitive sectors (like agriculture, forests and fisheries) and natural resources (such as water, biodiversity, mangroves, coastal zones, grasslands) for their subsistence and livelihoods. Climate change is likely to impact all the natural ecosystems as well as socio-economic systems as per the National Communications Report of India to the UNFCCC. In fact, developing countries like India are facing the dual burden of climate change and globalization.

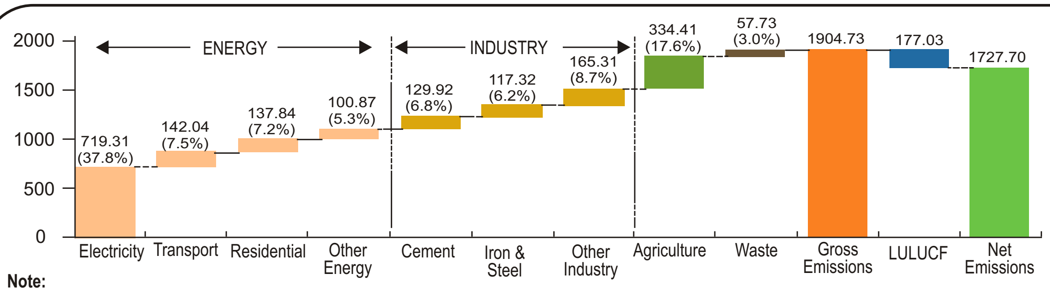
The potential impacts of climate change are often diverse and the immediate need to address these adverse impacts is widely recognized. Similarly, different regions have differential vulnerabilities to climate change, therefore different approaches need to be applied that are context and region-specific. While traditionally, climate change experts have focused on mitigation measures, adaptation measures have also been acknowledged of late as effective and equitable means to deal with climate change impacts. Most of the mitigation measures are high in terms of technology and capital. Therefore, while developed economies choose to mitigate climate change by making heavy investments, developing economies choose to adapt. However, allocating responsibilities for mitigation is a complex task and involves international negotiations. It has been increasingly recognized that a joint approach addressing the issues of adaptation and mitigation together is the most appropriate one for countries like India.

1.1 Green House Gas Emissions in India

In recent years, development planning in India has increasingly incorporated measurable goals for enhancement of human wellbeing, beyond mere expansion of production of goods and services and the consequent growth of per capita income. India has many future developmental targets, several of which are directly or indirectly linked to energy consumption and therefore to green house gas (GHG) emissions.

According to a recent study by the Ministry of Environment and Forests (MoEF), the net GHG emissions from India, including Land Use Land Use Change and Forestry (LULUCF), in 2007 was 1727.71 million tonnes of CO_2 equivalent ($MtCO_2eq$). The key findings from the assessments indicate that a GHG emission from energy is 58 per cent, industry 22 per cent, agriculture 17 per cent, and waste 3 per cent of the net CO_2eq emissions. The per capita CO_2eq emissions for India including LULUCF were 1.5 tonnes per capita in 2007. The energy sector emitted 1100.06 $MtCO_2eq$ of which 719.31 $MtCO_2eq$ were emitted from electricity generation and 142.04 $MtCO_2eq$ from the transport sector. Industry sector emitted 412.55 $MtCO_2eq$. The LULUCF sector was a net sink, sequestering 177.03 $MtCO_2eq$ (Figure 1).

Figure 1: Sectoral GHG emissions (MtCO2eq) in 2007



Note:

Other Energy: includes GHG emissions from petroleum refining. manufacturing of solid fuel commercial & institutional sector, agriculture & fisheries and fugitive emissions from mining, transport and storage of coal, oil and natural gas.

Other Industry: includes GHG emissions from production of glass and ceramics, soda ash, ammonia, nitric acid carbides, titanium dioxide, methanol, ethylene oxide, acrylonitrile, carbon black, caprolactam, ferro alloys, aluminum, lead zinc, copper pulp and paper, food processing, textile, leather, mining and quarrying. non specific industries and use of lubricants and paraffin wax.

Agriculture: includes CHG emissions from livestock, rice cultivation, agricultural soils and burning of crop residue.

Waste: includes CHG emissions from municipal solid waste (MSW), industrial and domestic waste water.

LULUCF: Includes CHG emissions and removals from changes in forest land, crop land, glass land, wet land, settlements and combustion of fuel wood in forests.

Source: India: Greenhouse Gas Emissions-2007 (May 2010), Indian Network for Climate Change Assessment, MoEF, Govt. of India

Comparison between the GHG emissions estimates for 1994 and 2007 clearly indicates that total GHG emissions without LULUCF have grown from 1251.95 Mt in 1994 to 1904.73 $MtCO_2eq$ in 2007 at a compounded annual growth rate (CAGR) of 3.3 per cent and with LULUCF the CAGR is 2.9 per cent. Between 1994 and 2007, some of the sectors indicate significant growth in GHG emissions such as cement production (six per cent), electricity generation (5.6 per cent) and transport (4.5 per cent). The comparative analysis of GHG emissions by different sectors is presented in the Table 1.

Table 1: Comparison of Sectoral GHG emissions of 1994 and 2007 ($MtCO_2eq$)

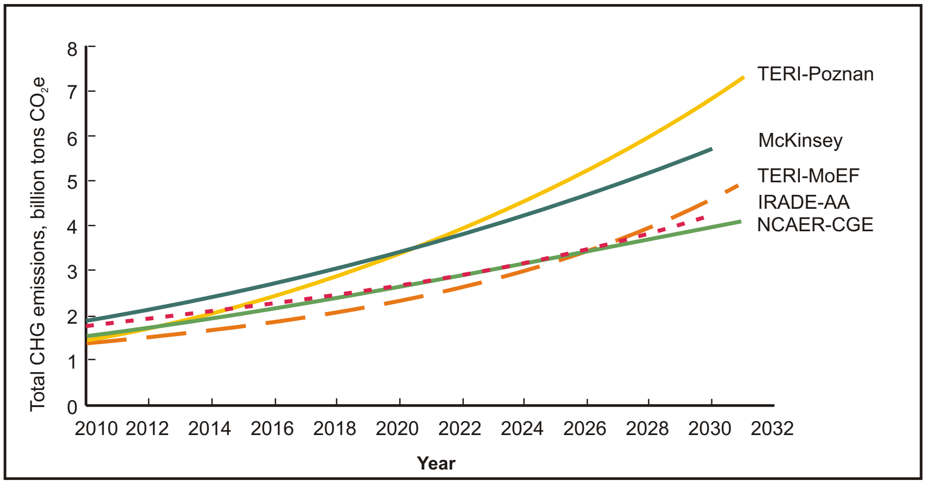
	1994		2007		Compound Annual Growth Rate (Per Cent)
	$MtCO_2e$	$MtCO_2e$	$MtCO_2e$	$MtCO_2e$	
Electricity	355.03	28.04	719.30	37.8	5.6
Transport	80.28	6.4	142.04	7.5	4.5
Residential	78.89	6.3	137.64	7.2	4.4
Other Energy	78.93	6.3	100.67	5.3	1.9
Cement	60.87	4.9	129.92	6.8	6.0
Iron & Steel	90.53	7.2	117.32	6.2	2.0
Other Industry	125.41	10.0	165.31	8.7	2.2
Agriculture	344.48	27.6	334.41	17.6	-0.2
Waste	23.23	1.9	57.73	3.0	7.3
Total without LULUCF	1251.95	-	1904.73	-	3.3
LULUCF	14.29	-	-177.03	-	-
Total with LULUCF	1228.54	-	1727.71	-	2.9

Source: India: Greenhouse Gas Emissions-2007 (May 2010), Indian Network for Climate Change Assessment, MoEF, Govt. of India

In 2007, India's population had reached 1.15 billion, representing 17 per cent of the global population (UNSTAT, 2007). The per capita GHG emission without LULUCF is estimated to be 1.7 tCO_2eq per capita and with LULUCF it is 1.5 tCO_2eq per capita. In comparison, the 1994 population was 897 million, comprising 15.8 per cent of world population. Accordingly, the per capita GHG emissions in 1994 were 1.4 tCO_2eq.

Future GHG Emissions: A recent study by the Government of India estimates future GHG emissions, using different models. The study concludes that the estimates of India's per capita GHG emissions in 2030-31 vary from 2.77 to 5 tCO_2eq, with four of the five studies estimating that India's per capita GHG emission will stay below 4 tonnes per capita. This may be compared to the 2005 global per capita GHG emission average of 4.22 tCO_2eq. In other words, four out of five models project that even two decades from now, India's per capita GHG emissions would be well below the global average 25 years earlier. In absolute terms, this indicates that estimates of India's GHG emissions in 2031 vary from 4.0 to 7.3 $BtCO_2eq$, with four of the five studies estimating that even two decades from now, India's total GHG emissions will remain under six $BtCO_2eq$. Thus, majority of the studies depict that there will be a substantial and continuous decline in India's energy intensity and CO_2 intensity of GDP. The key drivers of the range of these estimates are the assumptions pertaining to GDP growth rates, penetration of clean energy, assumed energy efficiency improvements, etc (Figure 2).

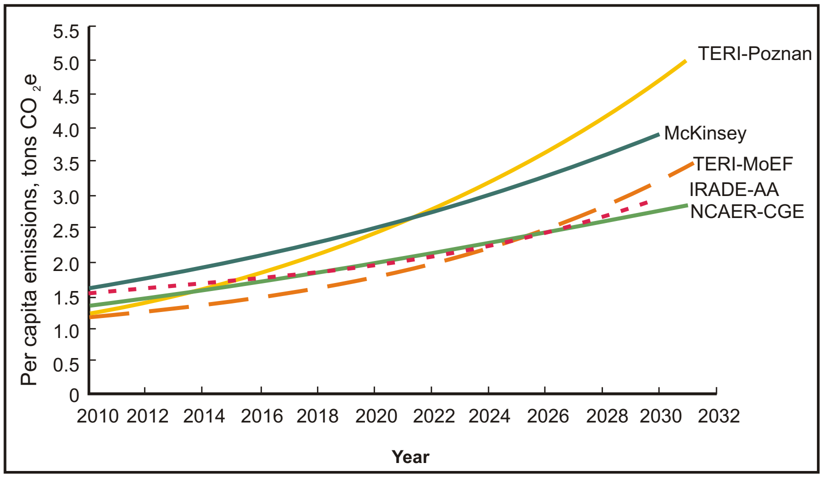
Figure 2: Total GHG emissions projections for India from 5 studies in illustrative scenarios (2010-2031)



Source: Climate modeling forum, India's GHG Emissions Profile, MoEF, 2009

Per capita GHG emissions are estimated to be 2.1 tCO_2eq in the year 2020 and 3.5 tCO_2eq in the year 2030 (Figure 3). For comparison, it is notable that the estimated per capita emissions of India in 2020 are expected to be well below those of the developed countries; even if the developed countries were to take ambitious emission reduction targets (25-40 per cent) as recommended by the Intergovernmental Panel on Climate Change (IPCC) for the mid-term.

Figure 3 : Per capita GHG emissions projections for India from 5 studies in illustrative scenarios (2010-2031)



Source: Climate modeling forum, India's GHG Emissions Profile, MoEF, 2009

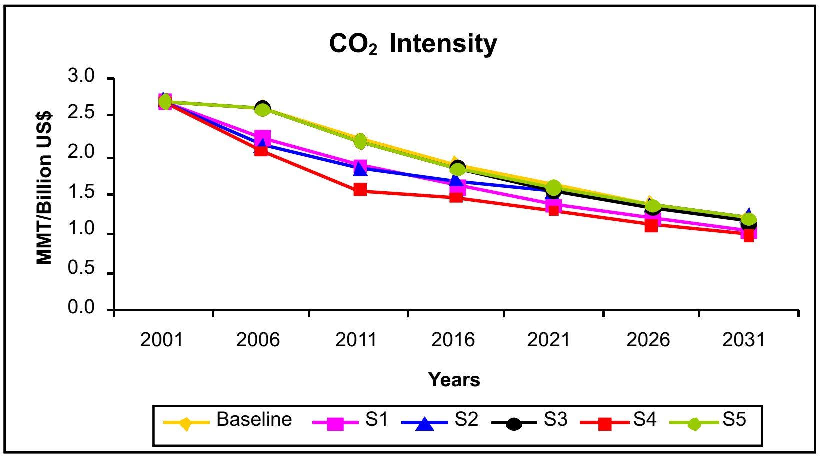
2. Government of India's Response

Currently, the topmost priority for India is economic development and poverty alleviation. Meeting these national imperatives would certainly create pressure on energy demand, which would lead to increased carbon emissions. Energy is needed for economic growth, for improving the quality of life and increasing opportunities for development. Some 600 million Indians do not have access to electricity and about 700 million use biomass as primary energy resource for cooking. Ensuring a regular supply of clean energy is essential for nurturing inclusive growth, meeting the millennium development goals and raising India's human development index. The biggest challenge facing our country is that besides ensuring energy security of the nation, India also needs to develop its infrastructure and enhance its industrial production and reduce the GHG emissions from these sectors as well.

India's primary energy use is projected to expand massively to deliver a sustained GDP growth rate of nine per cent through 2031-32, even after allowing for substantial reduction in the energy intensity. In order to fuel this on a sustained basis, a growth of around 5.8 per cent per annum in primary energy supply would be required. Commercial energy supply would need to grow at about 6.8 per cent per annum as it will replace non-commercial energy. But, this too involves a reduction of around 20 per cent in energy use per unit of GDP over a period of ten years. This growth should ideally be attained in a sustainable manner while addressing climate change concerns. It has been estimated that for India the CO_2 emissions will continue to grow for some time, because there is a need to increase the currently low per capita levels of energy use to support growth and reach the Millennium Development Goals. Most of the available projections indicate that India's CO_2 intensity per unit of GDP is likely to continue to decline through 2030-2050. India is a relatively low carbon economy by global comparison in terms of two measures - per capita CO_2 emissions and CO_2 emissions per unit of GDP in PPP terms.

Figure 4 represents the trend of CO_2 intensity, based on the five scenarios simulated by MARKAL (2001-2031), and shows a decreasing trend. It is worth mentioning that the carbon emission intensity of India is amongst the lowest in the world and has always been low. Both the energy intensity of the Indian economy, as well as the CO_2eq intensity of the Indian economy, will fall continuously till 2030-31. Even without any new policy for GHG abatement and the present structure of the Indian economy, its current and projected GHG growth rates and energy endowments, there can be no apprehension that its GHG emissions will increase in a runaway manner over time. India's energy use patterns and GHG emission profile will continue to be among the most sustainable in the world for the next generation (MoEF, 2009).

Figure 4: Change in India's CO2 intensity as a result of Government Policy initiatives



Source: Results of policy scenarios from MARKAL, TERI, 2005

Box 1: Eleventh Five Year Plan (2007-2012) - Highlights Energy Sector

- Additional sources of energy such as Coal Bed Methane (CBM) must be fully exploited.
- To reduce the energy intensity per unit of GHG by 20 per cent from the period 2007-08 to 2016-17 and initiate action to increase easy access to cleaner and renewable energy.
- Renewable energy contribution to increase by 23 per cent.
- Content of ethanol in petrol to increase up to ten per cent.
- Depending upon the bio-diesel production and availability, the entire country may be progressively covered with sale of five per cent bio-diesel blended diesel.
- EURO IV equivalent norms in identified cities and EURO III equivalent norms in the entire country was introduced in 1 April, 2010.
- Setting up of a National Energy Fund (NEF) for supporting R&D in energy sector.
- Encouragement through suitable fiscal concessions to be provided for manufacture and assembly of fuel-efficient and hybrid vehicles and for use of alternative fuels for promoting energy conservation and environmental protection.
- Ten per cent increase of installed capacity in renewable (Wind, small-hydro and biomass)
- Achieve 10,000 MW of avoided capacity by 2012 through standards and labeling of appliances, building energy efficiency, efficient lighting, Municipal and Agricultural Demand side management (DSM).

In recent years, the government has rightly recognized the energy security concerns of the nation and more importance is being placed on energy independence. Government of India has taken various initiatives towards diversification of energy sources, energy efficient technologies, energy conservation measures, regulatory frameworks, etc. to meet the national goals, while simultaneously addressing climate change concerns. India is probably the only country in the world with a full-fledged ministry dedicated to the production of energy from renewable energy sources. Additionally, India is emerging as a growing market for solar, wind and hydroelectric power. The Government of India has an ambitious mission of 'Power for all by 2012'. Most of the policy initiatives formulated by the Government of India to ensure energy security also have a great potential to reduce GHG emissions and thus help in mitigation, energy conservation, along with building codes, and programmes to diversify energy sources based on renewable energy. On the other hand, any policy/programme formulated to ensure access to energy would lead to better adaptive capacity of the area/community.

2.1 Improving Energy Efficiency

The reduced energy intensity of the Indian economy (since 2004) has been marked by over nine per cent per annum economic growth rate. This reduced energy intensity, at the relatively low level of India's per-capita GDP, has been made possible by a range of factors, including India's historically sustainable patterns of consumption, enhanced competitiveness, proactive policies to promote energy efficiency, and more recently, the use of the Clean Development Mechanism to accelerate the adoption of clean energy technologies.

In order to move towards an energy efficient pathway, the National Action Plan on Climate Change (NAPCC) has put forward the National Mission for Enhanced Energy Efficiency (NMEEE) with the objective of promoting innovative policy and regulatory regimes, financing mechanisms, and business models which not only create, but also sustain, markets for energy efficiency in a transparent manner with clear time bound deliverables (NAPCC). Apart from creating markets, the mission intends to reduce the country's annual energy usage by five per cent by 2015, and CO_2 emissions by 100 Mt every year. By 2012, the NMEEE mission aims at a 10,000 MW reduction of the country's total energy usage". The mission provides for a Perform, Achieve and Trade (PAT) mechanism to set targets on energy efficiency improvement for energy-intensive industries and encourage the trade of energy savings' certificates called ESCerts, the certificates can be earned by industries which surpass their energy-efficiency targets (UNESCAP, 2009).

Besides this overarching mission, there are two more missions that aim to work towards energy efficiency - the Jawaharlal Nehru National Solar Mission and the National Mission on Sustainable Habitat (NATCOM - 1). While the Solar Mission has ambitious plans for increasing solar energy sources, the National Mission on Sustainable Habitat promotes efficiency in the residential and commercial sectors. Preliminary assessments indicate the tremendous potential for energy savings in space conditioning, refrigeration, and lighting. Capacity building of key stakeholders (builders etc.), involved in construction sector on energy saving options and technologies, is required. ESCOs (Energy Service Companies) need to be promoted as vehicles to deliver energy-efficiency improvements, in particular because of the 'split incentives' problem, to facilitate access to carbon finance through bundled CDM projects (NAPCC, GoI).

The focus on increasing energy efficiency has to be in modifying usage patterns and ensuring that the energy needs of the last mile are met. In light of the current climate change challenges, the energy demand cannot be simply met with traditional sources, as it would need additional sources (renewable) and diversification of energy sources.

Box 2: Costs of Changing Energy Strategy for India

- India is fifth worldwide in total existing wind power capacity and is rapidly expanding many forms of rural renewables such as biogas and solar PV
- India was among the top five countries for renewable power capacity in 2009, including small hydropower.
- India added nearly 130 MW of hydropower in 2009, for a total of more than 2.5 GW of small hydro, and the total domestic hydropower capacity reached 37 GW by early 2010
- In India, about 20,000 solar hot water systems are installed each year
- India's current five-year plan targets 12.5 GW of added renewables by 2012 (including wind, small hydro, and bio- mass power), and in 2009, the country adopted targets for solar power of one GW by 2013 and 20 GW by 2022 (including one GW of off-grid solar PV by 2017)
- India is home to some four million biogas systems, according to recent figures from the Ministry of New and Renewable Energy Sources
- In India, today there are approximately 7,000 solar-powered irrigation pumps

National Targets for Renewable Energy

- Renewable capacity: 12.5 GW added 20072012; 15 per cent share of added power capacity (2002-2022)
- Solar PV and CSP: 1.1 GW by 2013, 10 GW by 2017, 20 GW by 2022
- Wind power: nine GW added (2007-2012)
- Small hydro: 1.4 GW added (2007-2012)
- Biomass/cogeneration: 1.7 GW added (2007-2012)
- Waste-to-energy: 0.4 GW added (2007-2012)
- Solar hot water: 15 million m2 by 2017; 20 million m2 by 2022
- Rural lighting systems: 20 million by 2022

Source: Renewables 2010 Global Status Report

2.2 Diversification of Energy Sources

In order to meet the challenge of increasing power requirements, India will need to pursue all available forms of energy. The current energy share of coal is 53 per cent, 31 per cent of oil, 9 per cent of natural gas and 6 per cent of hydropower, whereas the share of nuclear energy is merely 1 per cent. If this mix remains the same then it is estimated that by 2030-31, India would have to import 66 per cent of its coal, 90 per cent of its oil and 60 per cent of its natural gas (UNESCAP, 2009).

Dependence on foreign energy imports in India is ever increasing, which exposes the country to external price shocks and potential supply disruptions. Not only does India depend on 75 per cent of imported oil, about three-fourth of the supplies originate in the Middle-East and Persian Gulf (UNESCAP, 2009). The energy crunch and the growing crude oil consumption may affect the economic engines due to high prices beyond USD100 per barrel (Pandey, 2010). Managing the increasing cost of smooth and uninterrupted fossil fuel inflows from overseas will be a pressing challenge (UNESCAP, 2009).

Conventional wisdom in meeting the energy deficit would lead to establishment of new power plants, inevitably dependent on import of highly volatile fossil fuels. To tackle this crisis, solutions lay in the judicious utilization of abundant renewable energy resources, such as biomass, solar energy, wind energy and geothermal energy. Renewable resources will help India in mitigating climate change, through reduction in dependence on power generation by coal and mineral oil based power plants, which contribute heavily to greenhouse gas emissions (Soparkar, 2008). Renewable energy sector is expected to contribute nearly six times its existing emission reduction capability in future (Table 2).

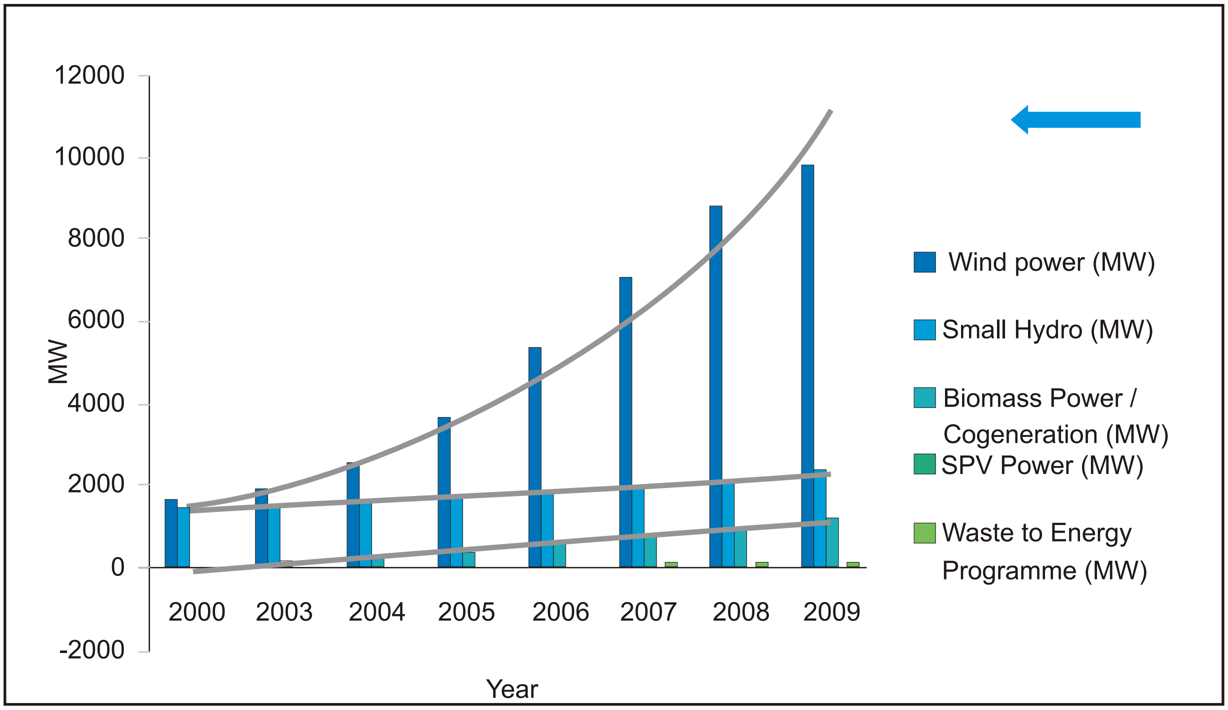
Table 2: Climate Change Mitigation Potential of India in the renewable energy sector

Technology	Achievement	Emission reduction tonnes CO2	Total Potential by 2032	Emission reduction potential tonnes CO2
Wind	12009 MW	20.7 Million	48500 MW	83.6 Million
Biomass	901.1 MW	5.0 Million	16881 MW	82.1 Million
Hydro	2767 MW	7.0 Million	15000 MW	38.0 Million
Cogeneration	1411 MW	6.4 Million	5000 MW	19.4 Million
WTE	72 MW	0.5 Million	2700 MW	10.5 Million
Solar	12 MW	0.024 Million	20000 MW**	31.9 Million
Biogas units (2m3)	4.2 million units	3.6 Million (assuming 50% operational)		
SHS+ Solar Lanterns	1.4 Million units	0.10 Million		
SWH	3.53 Million	1.4 Million		
Total		**45 Million tons**		**265.5 Million**

Source: The Ministry of New and Renewable Energy, Govt of India

Fossil fuel based production of electricity is inadequate not only because of the cost and climatic issues but also due to the exponential industrial growth and high living standards. While on paper, India does not have a renewable energy (RE) policy or a national law on the subject, a policy document has been drafted on new and RE, aiming to raise RE capacity to 100,000 MW by 2050 (NATCOM-1).

Figure 5: Renewable energy growth (2002-2009) in India



Source: The Ministry of New and Renewable Energy, Govt of India

An indication of the way to progress can be micro-generation, which can act as a catalyst and evidence for cultural changes in consumer attitude regarding energy production and use. It is both a form of clean energy production and a cultural movement that is gathering momentum worldwide. These technologies include small wind turbines, biomass gasifiers, solar power, micro-hydro, or a combination of these. Up front, renewable energy may appear more expensive than the conventional sources, but it has the potential to provide benefits of continuous power availability and climate change mitigation (Soparkar, 2008).

2.3 Modifying Industrial Processes

After the power sector, industry is the largest consumer of primary commercial energy in India, accounting for about 42 per cent of the total commercial energy use (NATCOM-1). The top six industries in India in terms of energy consumption are aluminum, cement, fertilizer, iron and steel, paper and glass, which together account for about 40 per cent of total industrial fuel consumption (Bhattacharya & Cropper, 2010). The high consumption of energy within the sector implies emissions from fossil fuel combustion, and the emissions from various processes adopted to manufacture industrial goods (NATCOM-1).

The inherent paradox with this situation is that while industrial development significantly contributes towards economic growth, it also brings along a host of environmental problems (NATCOM-1). The environmental resources of our earth like air, water, land, flora and fauna are deteriorating every day. The illegal environmental activities such as massive expansion and careless siting of industries have inadvertently affected our environmental resources that has lead to the unfavourable impacts on human settlements and health of people (NATCOM-1).

To lower the energy consumption in industry, certain initiatives have been taken which will have to be further augmented. Some of the successful ones, for instance, are the Bureau of Energy Efficiency's (BEE) 'star labeling' programme for appliances, and promotion of compact fluorescent lighting (CFL). In the transport sector, it translates to mandatory fuel efficiency norms. In heavy Industry, it means increasing reductions in line with the trends. The need is for an energy efficient industry, as energy intensive industries are estimated to generate emissions of up to 1.7 tones $BtCO_2eq$ by 2030 (Mckinsey, 2009).

With respect to certain industrial development projects, it is not only necessary to install suitable pollution control equipment but also to identify appropriate sites for their location. Moreover, in modifying the current industrial practices, the values of environmental conservation and protection should be incorporated in the industrial strategy. A step towards this is the Ministry of Environment & Forests (MoEF) charter on “Corporate Responsibility for Environmental Protection (CREP)”, launched in March 2003. The charter indicates a direction for the industry to look at alternatives beyond the compliance of regulatory norms for prevention and control of pollution through measures like waste minimization, in-plant process control and adoption of clean technologies. It has set targets with reference to the conservation of water, energy, recovery of chemicals, reduction in pollution, elimination of toxic pollutants, process and management of residues which should be disposed ensuring environment consciousness (NATCOM -1).

2.2 National Action Plan on Climate Change - A Multipronged Strategy for Sustainable Development

Recognizing the importance of climate change issues, a Council on Climate Change was established in June 2007, under the chairmanship of the Prime Minister of India, to co-ordinate national action for assessment, adaptation, and mitigation of climate change.

NAPCC identifies a number of measures to promote India's development objectives, while also yielding co-benefits for addressing climate change effectively. NAPCC outlines eight national missions based on the principles of protection of poor and vulnerable sections; enhancement of ecological sustainability; efficient and cost-effective strategies for end-use demand side management; deployment of appropriate technologies for both adaptation and mitigation of greenhouse gas emissions; development of market; regulatory and voluntary mechanisms to promote sustainable development; participation of various stakeholders and building international cooperation, mainly for research and development; and also sharing and transfer of cost-effective and innovative technologies. The eight national missions under the action plan are presented in Table 3. Out of the eight missions, five national missions focus on adaptation and two missions focus on mitigation. The national mission on Strategic Knowledge for Climate Change is a cross-cutting mission for adaptation and mitigation.

Table 3: Missions of the National Action Plan on Climate Change

National Missions on Climate Change	Objective
National Solar Mission	20,000 MW of Solar power by 2020
National Mission for Enhanced Energy Efficiency	10,000 MW of energy savings by the end of 11th FYP in 2012
National Mission on Sustainable Habitat	Energy efficient buildings, transport, waste management systems, energy efficiency as an integral component of urban planning, improving the resilience of infrastructure, community based disaster management, capacity building
National Water Mission	Increasing water use efficiency by 20 per cent through regulatory mechanisms with differential entitlements and pricing; formulating basin level management strategies; and establishing water conservation measures
National Mission for Sustaining the Himalayan Ecosystem	Understand the glacial changes through glacial monitoring, participatory management of Himalayan ecosystems
National Mission for a Green India	Six million hectares of afforestation over degraded land by the end of the 12th Five year plan (2017)
National Mission for Sustainable Agriculture	Drought proofing, climate risk management, improving productivity of rain fed agriculture
National Mission on Strategic Knowledge for Climate Change	Assess vulnerability and identify responses to climate change through high quality and focused R&D

3. Clean Development Mechanism (CDM) in India

India ratified the Kyoto Protocol in August 2002, with the objective of implementation of Clean Development Mechanism (CDM) projects in India in accordance with national sustainable priorities. India is a key focus area for most of the private funding groups and has a very supportive policy environment. The funding groups consider investing in India as an integral part of their strategy for their present and future funds.

In developing countries like India, CDM played a very important role in funding mitigation efforts. It has provided three times more funding for renewable energy and energy efficiency efforts than ODA projects (USAID, 2009). Though India has been one of the highest recipients of CDM finances, uncertainty with respect to Post-Kyoto regime is (currently) probably the most significant barrier for investments in CDM.

3.1 CDM Potential in India

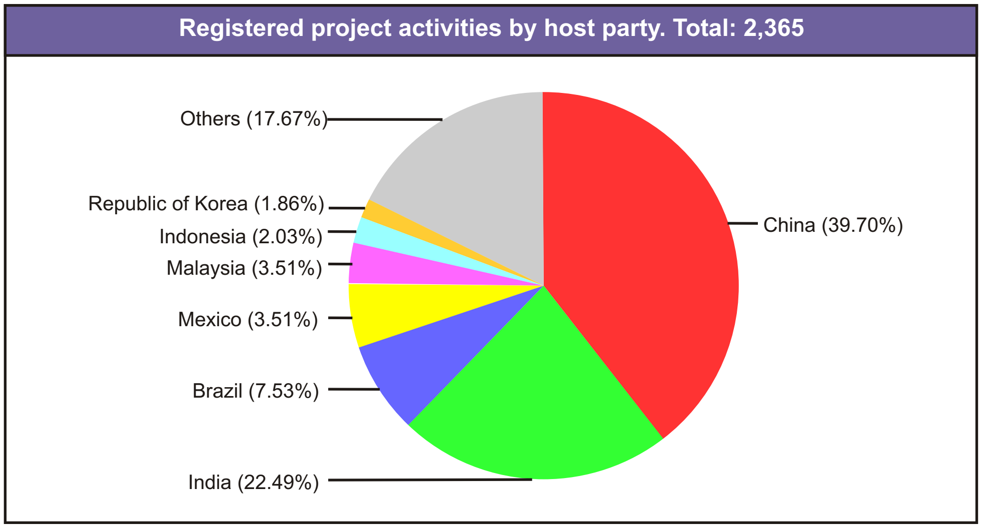
India has strengthened its position as a leader in terms of Host Country Approved CDM projects. The total number of CDM projects registered at the Clean Development Mechanism Executive Board (CDM EB) as on September 2012 is 532 (Figure 6). The National Clean Development Mechanism Authority (NCDMA) has accorded Host Country Approval to 1226 projects, facilitating an investment of more than USD 3,405. The most of the projects are in sectors like energy efficiency, fuel switching, industrial processes, municipal solid waste and renewable energy. It is estimated, if all these projects get registered by the CDM Executive Board, they have the potential to generate a total 573 million Certified Emission Reductions (CERs) by the year 2012. At a conservative price of USD 10 per CER, it corresponds to an overall inflow of approximately USD 5.73 billion in the country by the year 2012 . As far as voluntary market is concerned the geographical distribution of projects differs in comparison to CDM projects. In case of CDM market while China and India dominate, the voluntary market is dominated by projects in the US and Canada.

Box 3: Renewable Energy and CDM

The CDM increases the revenues for renewable energy generation. Most of the renewable energy projects in the CDM involve electricity-generating technologies. The basic economic barrier is the relatively higher electricity generation costs for Renewable Energy Technology (RET), although the scale of the difference varies from technology to technology and from country to country. The revenues attained from selling CERs from a CDM project can help compensate for this price difference to an extent. Nevertheless, renewable energy projects do not get as much out of the CDM as other project types.

The carbon markets focus more on reducing the potent GHGs like hydrofluorocarbon (HFC), nitrous oxide (N_2O), and methane (CH_4) due to the high global warming potential of these gases. Renewable energy projects thus receive a disproportionately small financial benefit from the CDM. At current CER prices, the increase in the internal rate of return from the sale of CERs from a CO_2 based renewable energy project is estimated at about two per cent.

Figure 6: Registered Project Activities by UNFCCC



Source: UNFCCC, 2010

Table 4 below shows CDM utilization in renewable energy sector in India.

Table 4: CDM Utilization in Renewable Energy Projects in India

Technology	Total Reg. Projects	Capacity in MW reg.	Total CER potential - 2012	Total CER issued - till date	CER Monetary value (USD)	Total capital investment	% of CERs in investment till date	Potential CER share by 2012	Share of small scale projects in total
Biomass	157	1,339.4	8,378,6920	6,720,400	1,512 million	1,506 million	10%	1,885 million	15.9%
Hydro	65	1,081	54,776,200	1,859,670	41 million	1,216 million	3%	1,232 million	35.4%
Solar	3	0.5	1,880,880	0	0	0		42 million	33.3%
Wind	108	2,572.4	103,746,950	7,437,320	167 million	2,893 crores	6%	2,333 million	19.4%

Source: www.cdmpipeline.org

CDM Financing: The CERs generated under the CDM projects are transacted in the carbon market. Number of funds have been launched by various agencies like that of World Bank (Community Development Carbon Fund, Bio-Carbon Fund). Besides, countries like Japan, Netherlands and countries from Europe have also established the CDM funds (Table 5). Now a day, bilateral transactions are also emerging.

Table 4 : List of CER Procurement Funds

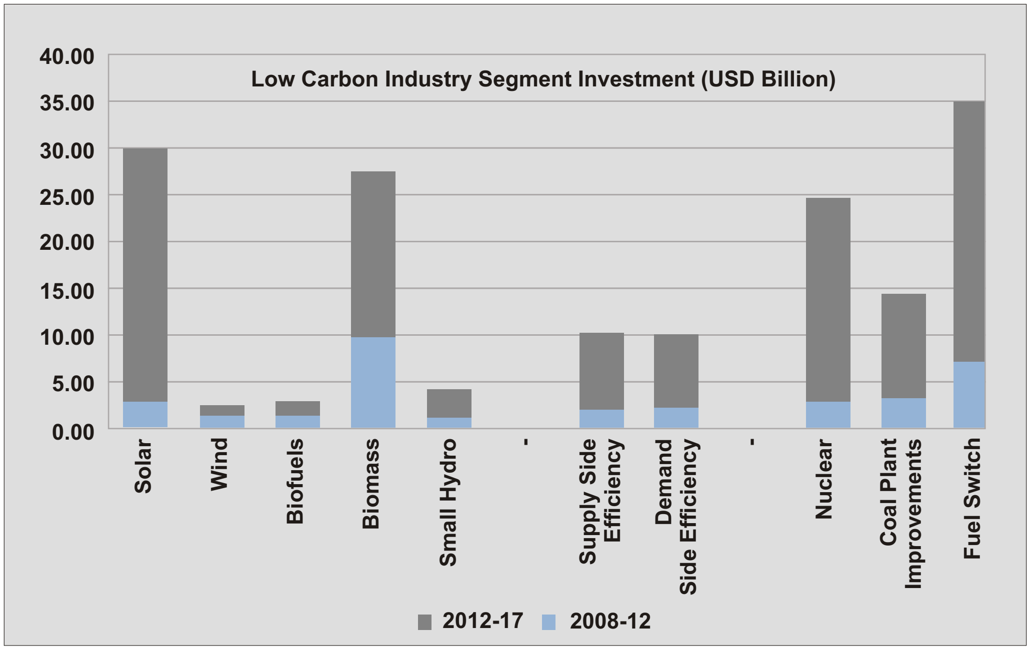
Multilateral Funds	• Prototype Carbon Fund (US$ 180 million) • Community Development Carbon Fund (US$ 100 million • Bio-Carbon Fund (US$ 100 million)
Government Funds	• Dutch Government's Certified Emission Reduction Unit Procurement Tender (CERUPT) Program • Finish CDM/JI Pilot Program (Euro 20 million) • Sweden International Climate Investment Program CDM • Spanish Carbon Fund • Austria JI/CDM Procurement Program
Own Tenders (through Commercial/Development Banks)	• Rabbo Bank (Dutch Government) • Japanese Bank of Industrial Cooperation (Japan CDM Fund 4 billion Yen) • Development Bank of Japan (Japan CDM fund 3 billion Yen)
Own Tenders (through multilateral institutions)	• World Bank (The Netherlands Clean Development Facility Euro 70 million) • IFC (IFC-Nethrlands Carbon Facility Euro 44 million)
Bilateral Transactions	• Canadian Government with Colombia and Chile • Dutch Government with Bolivia, Coloumbia, Uruguay and Ecuador

Source: Clean Development Mechanism, K.S. Kavi Kumar. Dissemination Paper 13. India)
Centre of Excellence in Environmental Economics, Madras School of Economics

The private sector in India has been rather aggressive to seize and take commercial advantage of the unfolding global and national low carbon development opportunities. Private sector investments for low carbon initiatives have come from a range of sources like self-financing, private equity investments, venture capital and carbon finance, where ever available. A small number of banks in India have been supporting low carbon businesses. A potential market of more than USD15 billion by 2015 in the 'energy efficiency' business is available as estimated by the Indian Banks Association and the Climate Group (2010), In recent times, carbon finance has also played a very significant role, particularly in renewable energy sector, waste management, fuel-switching and energy efficiency (WSP, 2010). With CDM and new domestic opportunities opened up by the NAPCC, many banks have provided loans to low carbon industries against carbon credits, while some have initiated weather based insurance coverage against crop failure. Though insurance companies are least represented in this market, unfortunately, they are best positioned to catalyze carbon trading by providing risk and financial analysis skills (NAPCC).

The wider basket of opportunities for low carbon industry in India, inclusive of all core environmental services, supply chain components and the reclassified conventional sectors, is pegged at around USD 294.2 billion (Sharp, 2009). Another study by the HSBC (Figure 7) indicates the industry segments where low carbon business opportunities are available, including future markets beyond 2012.

Figure 7: Anticipated investments in low carbon industry sectors in India



Source: Robins N et al, (2008) 'Wide Spectrum of Choices', HSBC

The Government of India has initiated major regulatory changes, coupled with incentives to promote businesses that reduce GHG emissions. The Jawaharlal Nehru National Solar Mission (JNNSM) aims at twenty Giga Watts power generation from solar energy by 2022. Energy efficiency potential in industrial sector is immense for India. Currently, almost every industrial sector is characterized by a wide band of energy efficiencies in different units. In fact, the National Mission for Enhanced Energy Efficiency in Industry (NMEEE) aims to improve energy efficiency in priority industries such as power, cement, fertilizer, aluminium, iron and steel, railways, pulp and paper, and textiles. One of the key initiatives under the NMEEE mission is creation of energy efficiency financing platforms for enabling public-private-partnerships to capture energy savings through demand side management programmes in the municipal, buildings, and agricultural sectors. Such measures, expected to be maintained or strengthened in coming years, will defiantly represent a growth potential for many sectors in India; particularly energy, transport, industry, agriculture and forestry.

India has made significant progress in terms of establishing the necessary institutional systems to promote CDM projects and also tried to align the CDM projects with the national interests and sustainable development goals. Several studies have established that India has considerable potential to attract CDM projects and in terms of future opportunities, India would continue to attract CDM projects in the power sector and for enhancing energy efficiency in industries. Transport is another sector that could attract large CDM projects (Gupta, 2003).

Presently, CDM is the only mechanism (under Kyoto Protocol) that allows non-Annex I Parties to participate in the global carbon market and operate only on a project-by-project basis. With the 2012 approaching, it has become an urgent need for the global community to identify the future of CDM mechanism for the international climate negotiation.

Post Kyoto: As the year 2012 approaching the window of opportunities created by the first commitment period under the Kyoto Protocol is narrowing down and eventually will be closed. It has been speculated that developing countries (with significant potential for hosting CDM projects) will have to bear the maximum risk owing to uncertainty prevailing around the post kyoto regime.

The Carbon Market Report 2009 by Capoor et al. suggests that the financial crisis and uncertainty regarding the fate of Kyoto protocol post 2012 climate regime have actually affected the market for project-based emission reductions. Moreover, given current uncertainties over market prices beyond 2012, it cannot be ruled out that investors will be forced to sell emission reduction credits from CDM projects at very low prices or even prove unable to sell them altogether. Such risks are borne both by host country Governments and the project investor (Nguyen et. al. 2010).

It is unlikely that CDM will disappear; however, the rules for using CERs beyond 2012 may take time to develop. Until new rules are in place, it is likely that prices will remain low for post-2012 CERs (USAID, 2009). However, as voluntary markets offer greater flexibility and lower transaction costs than the Kyoto market it has been speculated that carbon credit selling under this will prevail considering uncertainties around post Kyoto regime.

4. Case Studies

The present section provides case studies enumerating potential and emerging areas where CDM benefits can be availed.

4.1 MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) Potential of Generating Co-benefits

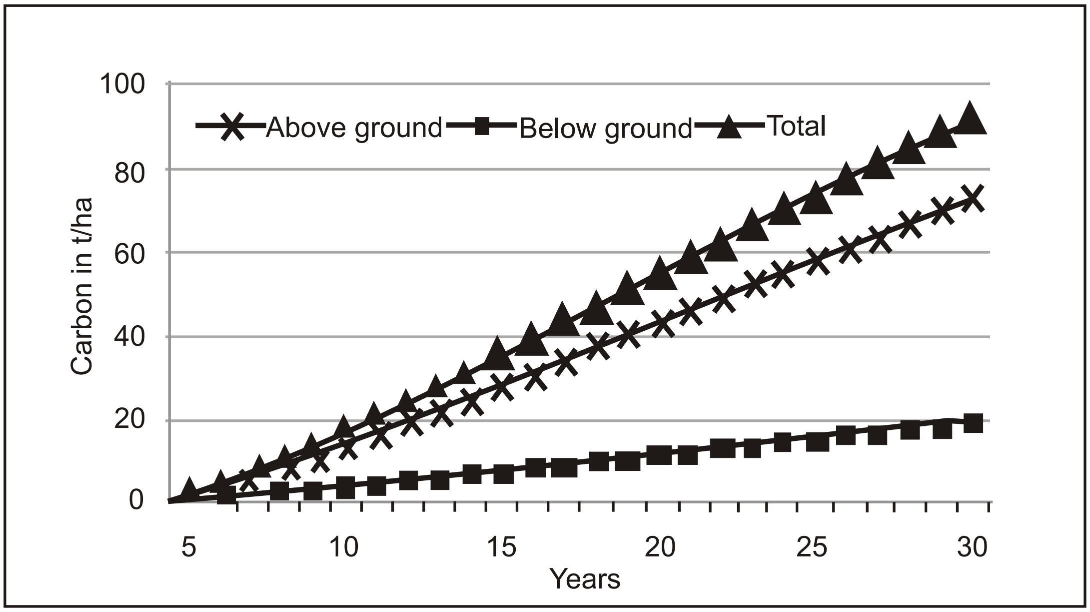
Enacted in 2005, the Mahatma Gandhi National Rural Employment Guarantee Act (earlier known as National Rural Employment Guarantee Act) aims to enhance the livelihood security of people in rural areas by guaranteeing hundred days of wage-employment in a financial year to a rural household *(whose adult members volunteer to do unskilled manual work)*.

Though the main aim of the Act is to provide guaranteed employment to rural poor, environmental concerns of sustainability and adaptation to the changing climate have been built into the grammar of MGNREGA guidelines. The kind of activities permitted under the Act reflects that while there are some activities that contribute to reduction in emissions and off-set the impact through plantation, afforestation, horticulture, land-development and de-siltation of traditional tanks, there are others which possibly contribute to emissions through their use of cement (roads, wells, leach-pits, renovation of ponds etc).

A study conducted by the Indian Institute of Science and Centre for Sustainable Technologies, assessed the environmental services provided by the MGNREGA activities and the vulnerability reduction potential for Chitradurga district of Karnataka. Preliminary results of the assessment unfolds that MGNREGA activities, apart from providing employment and income, provided multiple environmental services such as increased ground water recharge, increased water percolation, enhanced water storage in tanks, increased soil fertility, enabled reclamation of degraded lands and carbon sequestration.

Biomass or wood production and carbon sequestration potential was projected for activities such as tree planting on crop and tank bunds and wastelands, using a potential conservative growth rate of 3t/ha/year. Cumulative carbon sequestration after 30 years (Figure 8) is projected to be 93 tC/ha (74 tC/ha above the ground and 19 tC/ha below the ground). MGNREGA activities also reduced the vulnerability of crop production, water availability and livelihoods to uncertain and low rainfall, low water availability and poor soil fertility.

Figure 8: Projected cumulative total carbon stocks in Pongamia pinnata (block plantation raised under MGNREGA at density of 300 trees/hain Parashurampura)



Source: MNREGA, Department of Rural Development, Ministry of Rural Development, Govt. of India.

4.2 Vertical Shaft Brick Kiln (VSBK) or Eco-kiln

The Indian brick industry is primarily an informal or unorganized sector, composed of more than 100000 brick kilns operating in clusters in rural and peri-urban areas in the country producing fired clay bricks. The choice of technology for firing of bricks depends generally on factors such as the scale of production, availability of soil and fuel, market conditions and availability of skills. Due to the simplicity in operation and low capital investment requirements, the conventional technologies, such as the clamps, continue to be the brick manufacturers' preferred option. However, the energy demand of this technology is high, representing 35-50 per cent of the total production cost.

VSBK Technology: VSBK operates on the principles of effective utilization of the heat produced by the fuel. To achieve maximum utilization of the heat, a continuous chain of green bricks, which are loaded from top, passes through a centrally located firing zone in a rectangular vertical shaft. These green bricks emerge as fired clay bricks from the bottom. Stacking of bricks in a batch is a special feature of the VSBK technology. A weighed quantity of coal is spread on each layer uniformly to fill the gaps. Fresh green bricks are shifted to the top loading platform using the ramp (Figure 10). These green bricks are loaded in batches after every two hours and are moved down slowly through the firing zone located at the centre of the shaft. Each batch remains in the firing zone for nearly two hours and then slowly moves down along the shaft in a stepwise unloading process after every two hours. As the procession of batches gradually passes through the shaft, the green bricks encounter pre-heating, firing and cooling zones before they reach the shaft exit.

The unloading of bricks is done from the bottom, using a trolley which runs on long rails provided up to the unloading tunnel. Lifting and loading of the trolley is done using a single screw mechanism. For unloading, the trolley is lifted so that the whole stack of bricks in the shaft rests on it. The stack is then lowered till the layer with openings appears, through which the support bars are reinserted. On further lowering, the load of the stack is taken by the support bars except for the batch being unloaded which comes down along the trolley which finally rests on a pair of rails. Later, the trolley is pulled out along the rails and the bricks subsequently unloaded and sorted out for dispatch. The skill in operation is to keep the firing zone in the middle of the shaft. The draught air moving up from the bottom cools the fired bricks in the cooling zone and it gets heated and ultimately provides oxygen for coal which is burning in the firing zone. Maximum temperature in the firing zone goes up to 10000 degree celsius in the central firing zone. The hot gas moving upwards dry and pre-heat the green bricks in the pre-heating zone. Thus, recovery of sensible heat accounts for the high energy efficiency of the VSBK technology.

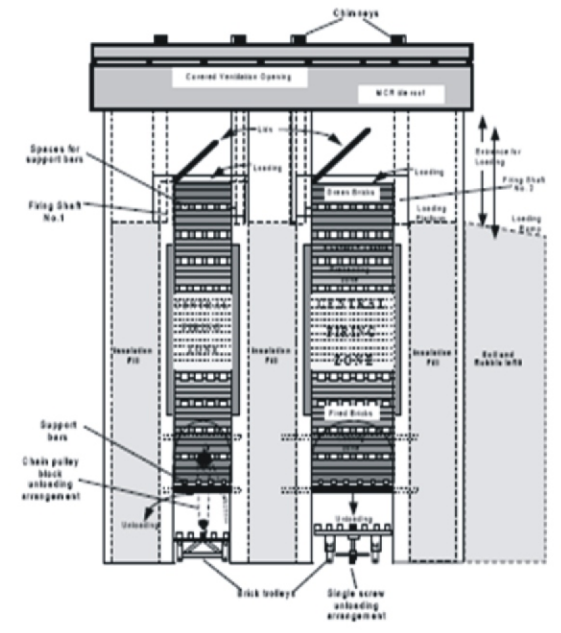
The VSBK technology was originally invented in China. It has been adapted to the Indian conditions by Technology and Action for Rural Advancement (TARA) and has been proven to be technically feasible. However, the capital investment requirements and operational sophistication have created a perception among brick manufactures that the technology is risky. These issues have raised significant barriers, preventing the technology from penetrating into the market. In order to make the technology feasible for the small and medium enterprises and increase its attractiveness, TARA is providing the technical know-how as well as operational and logistical support to the brick entrepreneurs.

Each VSBK plant qualifies as a small scale CDM project as per the definition of small scale CDM projects contained in Appendix B to the simplified modalities and procedures for small scale CDM projects. In order to reduce the transaction cost and maximize the returns to the entrepreneurs, a bundling approach is being followed in compliance with the rules prescribed by the Executive Board.

TARA is promoting VSBK technology since it is superior in terms of resource conservation and reduced environmental pollution as compared to the prevalent technologies. The environmental and social benefits of the initiative are further enhanced by a specific community benefit programme that is implemented in order to meet the requirements of the Community Development Carbon Fund (CDCF) of the World Bank. The project thus contributes to sustainable development through resource and energy efficiency, and local employment generation in large scale.

Figure 9: Map Showing Locations of the Eco Kilns

Figure 10: Schemetic Diagram of VSBK



In the geographical clusters where the project activities are being implemented, burnt clay bricks are manufactured using a technology with lower thermal performance leading to higher amount of coal combustion and hence significant CO_2 emissions. The energy efficient VSBK technology reduces the quantity of coal required for combustion to produce equivalent amount of bricks and reduce CO_2 emissions.

Roll Out Hurdles: VSBK is a new technology in India and demands higher capital investments as compared to the commonly used clamp technology. The capital investment requirements and operational sophistications have both posed hurdles in terms of preventing the brick technology from penetrating the market and making it a common practice. In the absence of any mandatory requirement regarding thermal performance, and in the absence of availability of any option with commercial advantages, use of the clamp technology is expected to continue for manufacturing burnt clay bricks, culminating in higher CO_2 emissions.

Impact: Emission reduction to be achieved by the project over a period of ten years, through implementation of VSBK technology at 14 different locations, is estimated to be about 71,196 tCO_2 eq.

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Some Useful links

1. www.nrega.net/...resources/.../Executive_summary_FINAL_NHR.doc
2. http://www.indg.in/agriculture/schemes/schemes
3. http://www.planningcommission.gov.in/sectors/energy.html
4. http://envfor.nic.in/mef/per5.pdf
5. http://pib.nic.in/release/release.asp?relid=48318

Annex – I

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List of Acronyms

Bt	Billion tonnes
CAGR	Compounded Annual Growth Rate
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CO2	Carbon dioxide
CO2eq	CO2 equivalent
EURO – III	European Emission Standards define the acceptable limits for exhaust emissions of new vehicles sold in EU member states
GDP	Gross Domestic Product
GHG	Green House Gas
GoI	Government of India
GW	Gigawatt
IGIDR	Indira Gandhi Institute Of Development Research
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation (mechansim)
MGNREGA	Mahatma Gandhi National Rural Employment Gurantee Act
MoEF	Ministry of Environment and Forests
Mt	Million tonnes
MtCO2eq	Million tones of CO2 equivalent
MW	Megawatt
NAPCC	National Action Plan on Climate Change
NATCOM	National Communication (to UNFCCC)
PPP	Purchasing Power Parity
PV	Photovoltaic
R&D	Research and Development

SHS	Solar Home System
SWH	Solar Water Heater
tC/ha	Tones Carbon per Hectare
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VSBK	Vertical Shaft Brick Kiln
WTE	Waste to Energy

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