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A log frame analysis of India's climate change mitigation policies and technology implications

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Introduction

Climate change is a looming threat over the humankind today. Developing countries including India face the challenging task of achieving development goals while following a low carbon growth trajectory, as the luxury of unrestricted growth enjoyed by the developed countries is no longer available. During the Copenhagen conference in December 2009, India announced[1] a reduction of 20-25% cut in emission intensity by 2020 compared to 2005 levels. This paper looks at the implementation options for emission intensity reduction as committed by India, using *logical framework matrix analysis* or *log-frame* model. This matrix can be gainfully employed to depict the options for a mitigation framework. Technology emerges as the prime mover of the mitigation superstructure, as many strategic interventions are critically dependent on energy related technologies on the demand side as well as on the supply side. This indicates the need for adequate technology support to developing countries to achieve the intended outcomes. Thus emission mitigation in a development framework suggests the need, not only for adequate financing but also for technology transfer mechanisms for achieving mitigation targets.

Materials and methods

Climate change and India

Climate challenge has an inherently inequitable dimension in the sense that countries with low rates of growth, rapid increases in population, and ecological degradation are more vulnerable to climate change[1], though these countries are least responsible for it. Therefore, developing countries including India have to bear major negative impacts of climate change[2]. lists some of these major impacts on India:

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[1] A summary of the pledges of developing countries is available at: <http://pdf.wri.org/summary_of_non_annex1_pledges_2009-12.pdf>

- *Water resources*

  Water balance in different parts of India and quality of ground water along the coastal plain will be adversely affected due to warming induced precipitation variations.

- *Agriculture*

  Food security of India may be at risk in future due to increase in frequency and intensity of droughts and floods, thereby affecting production on small and marginal farms.

- *Forest eco-systems*

  About 70 per cent of the vegetation in India may be less than optimally adapted to its existing location with consequent adverse impact on biodiversity.

- *Natural ecosystems*

  Natural ecosystems such as grasslands, mangroves, and coral reefs are likely to be affected by climate change. Though increasing atmospheric CO_2 levels would favour C3 plants over C4 grasses, increase in temperature would favor the C4 plants.

- *Coastal zone*

  Climate-related concerns in the context of the Indian coastal zones are erosion, flooding, submergence and deterioration of coastal ecosystems such as mangroves, and salinization.

- *Human health*

  Malaria is projected to move to higher latitudes and altitudes in India, with 10 percent more area offering climatic opportunities for the malaria vector to breed throughout the year during the 2080s with respect to the year 2000.

- *Infrastructure and energy*

  Climate change in the medium and long term may have serious impacts on Infrastructure and would also increase the energy demand offsetting energy conservation measures.

Results and discussion

Climate change in a development framework

It is imperative that India pursues a development-friendly approach to any strategy of emissions reduction. Sustainable development involves the key components of economic growth, social equity and environmental sustainability[5]. As the[4] observes, developing countries can shift to low-carbon trajectories, if financial and technical assistance from high-income countries is available. India's National Action Plan on Climate Change rightly emphasizes the need to

avoid compromising national economic growth[5]. As part of mitigation efforts, India has announced that its per capita greenhouse gas emissions will at no point exceed that of developed countries, even as it pursues development objectives. While designing the optimal intensity reduction pathways, it is essential to harmonize the priorities of achieving human development, economic growth and sustainability[3]. Identify some of these strategies:

- Adoption of cost-effective energy-efficient technologies.
- Enhancing sustainable energy supply using renewables, some of which are already cost-effective.
- Adoption of forest conservation, reforestation, afforestation and sustainable forest management practices.
- Efficient, fast and reliable public transport systems such as metro-railways.
- Adoption of a participatory approach to forest management, rural energy, irrigation, water management and rural development in general to promote sustained development activities and long-term greenhouse gas emission reduction or carbon sink enhancement.
- Rational energy pricing based on long-run-marginal cost principle to provide level playing field for renewables[6]. Argues for the alignment of development and climate actions in this context. In view of the diverging nature of developmental and climate action pathways, it becomes necessary to find Pareto optimal points in policy action space, represented in climate and development orientation dimensions. This Pareto optimal front is shown as the coloured upper boundary of the feasible region in Figure 1. Any point on this front represents non-dominated feasible solutions denoting priority actions. A multi-objective action space would be needed in case of a hierarchy of objectives including cost and impacts on various economic and non-economic sectors.

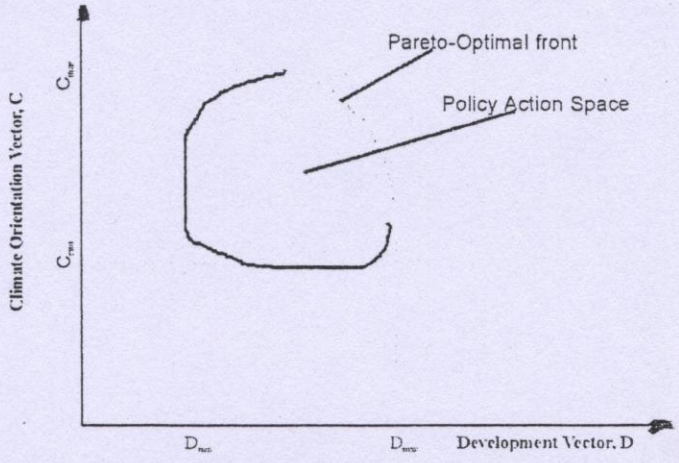

Fig. 1. Representation of Pareto optimal policies in a bi-objective space

A key criterion for selection of optimal points would be the long term marginal mitigation cost. Based on various modeling exercises[7] have reported the mitigation potential and marginal costs for major carbon mitigation actions of India (Table 1).

It is seen that low-cost carbon mitigation options exist in India like in other developing countries. Since mitigation involves technology inputs[8] argues that for successful global mitigation that accommodates developing country growth, energy-efficiency convergence needs to be addressed first, for which carbon abatement technology should be transferred from advanced countries to developing economies.

Table 1. India: Mitigation potential and marginal costs

Mitigation Options	Mitigation Potential (2002-2012) (Million tons)	Long-term Marginal Cost ($/ton of carbon equivalent)
Demand side energy efficiency	45	0-15
Supply-side energy efficiency	32	0-12
Electricity transmission and distribution	12	5-30
Renewable electricity technologies	23	3-15
Fuel switching (gas for coal)	8	5-20
Forestry	18	5-10

(Source: Chandler *et al.*, 2002)

Adaptation and mitigation

Dealing with climate change involves acting globally and locally and the key component is building 'climate-neutral energy infrastructure'[9]. Mitigation consists of reducing emissions of greenhouse gases (GHG) at the beginning of the chain and adaptation responds to economic damages of climate change at the end of the chain. Adaptation comprises of measures taken to minimize the adverse impacts of climate change, e.g. development of higher temperature crops, coastal area protection measures, malaria eradication programmes, food security schemes etc[10]. Indicate that for developing countries, a major adaptation strategy would be accelerated achievement of development goals which increase adaptation capacity. As regards mitigation[11], estimate that when "the emission restriction level is tightened from 10% to 20% and further to 30%, the effects on long run GDP and welfare become increasingly adverse. GDP falls by 0.53%, 1.36% and 4.06% and the number of poor increases by 2.1%, 5.9% and 17.5%, in the 30th year for 10%, 20% and 30% cumulative carbon emission restrictions respectively. The flexibility of the economic system gets reduced, as emission restriction becomes tighter."

Proposed actions: Eight national missions

Under the business-as-usual (BAU) scenario, it is projected that a four fold increase in GDP will increase CO_2 emissions by 2.8 times, methane by 1.3 times,

N_2O by 2.6 times, and fluorocarbons by 15 times in India[10]. Reducing emissions is critical to achieving intensity targets. On a sectoral basis, of the total CO_2-eq emissions in 1994, the largest share of 61% was contributed by the energy sector, followed by the agriculture sector at 28% and industrial process at 8%[2]. In 2007, these figures were 58%, 22%, 17% respectively, the variation being partly due to the accounting of industrial fossil fuel emissions under industry instead of energy[12]. The challenge of achieving low carbon development trajectory requires simultaneous action on several fronts with main focus on energy. Vanek and Albright (2008) recommend a portfolio approach combining renewable, fossil and nuclear resources for a twenty-first century energy system. An outline of the roadmap for an efficient energy sector of India is available in the Integrated Energy Policy[13-14] detail the efforts made by India for reducing emissions:-

(a) Emphasis on energy conservation.

(b) Promotion of renewable energy sources.

(c) Abatement of air pollution.

(d) Afforestation and wasteland development.

(e) Economic reforms, subsidy removal

India's National Action Plan on Climate Change[15] focuses on development and use of new technologies in key sectors. The implementation of the Plan would be through appropriate institutional mechanisms suitable for effective delivery of each individual Mission's objectives and include public private partnerships and civil society action. There are eight National Missions which form the core of the National Action Plan[16], each of which has a technology development and R&D component, while the mission on strategic knowledge seeks to fill the gaps that continue to exist in our understanding of climate change phenomenon and its impact specifically on India and our region.

Mitigation policy framework for India

Achieving the intensity targets proposed will depend on attaining a high growth rate as well as building sufficient number of stabilization wedges. A stabilization wedge[17] is 'an activity that reduces emissions to the atmosphere that starts at zero today and increases linearly until it accounts for 1 GtC/year of reduced carbon emissions in 50 years.' In the Indian context, activities can be categorized in terms of centiwedges (cw), a measure of 0.01GtC/year or about 36 $MtCO_2$/year.

World Development Report (2010)[4] suggests an 'integrated multi-track climate framework' with a 'target track' for developed countries and a 'policy-based track' for developing countries. India's policy appears to conform to such an approach to climate mitigation. This necessitates a framework for detailed analysis and optimization of the policies. It is seen that the policies for reducing emission intensity can be conveniently depicted in a logical framework or log frame, a logical tool for undertaking policy analysis and design. It has 'the potential to present considerable amount of information in a coherent and concise manner. The log frame has the distinct advantage of focusing project planners,

and subsequently, its implementers and evaluators'[18]. An illustrative, but not exhaustive logical framework[19] matrix for emission intensity reduction in India is given in the **Appendix**, illustrating the broad range of design components in the social, economic, institutional and infrastructure sectors[5]. Give a comparative picture of a few developing country strategies.

Though India has a very high potential to reduce emission intensity of its GDP, it requires substantial investments[4]. Estimates that limiting global emissions[20] to 450ppm requires an additional annual investment of $40 billion to $75 billion for India in 2030. Compared to this requirement, developed countries have committed only an annual amount of $100 billion by 2020 for all developing countries, according to the Copenhagen Accord[21]. Estimates an annualized increase in investment of around US$5 billion in India for the period 2012–2017 to support a rapid transition to low-carbon energy generation, *over and above current investment plans*. It is obvious that effective climate change mitigation would require substantial financing arrangements from developed countries to developing countries including India.

Technology as key component of the mitigation framework

Of equal or greater importance than financing is the role of technology as the prime mover of any mitigation policy framework. Most of the strategies of GHG mitigation involve a substantial technology component and therefore, effective diffusion of climate related technologies in a seamless manner could be the single most effective global mitigation strategy. However, there are many barriers to such global cooperation, including competitive trade and Intellectual Property Rights (IPR) regimes negotiated within the WTO framework. The Stern Review[20] on the economics of climate change, while identifying technology support as a key mitigation strategy, suggests that a combination of formal institutional mechanisms, enabling environment for private sector investment, and direct funding initiatives can overcome the barriers to technology transfer.

Das and Ahlgren (2010)[22] identify several barriers for diffusion and transfer of advanced technologies, such as high investment cost, lack of adequate knowledge on technology, lack of policy and institutional support etc. The role of Foreign Direct Investments (FDI) and CDM in technology transfer and the need for continued support from technology suppliers have been stressed in addition to the need for capacity building for technology assessments and adaptation[23]. show that CDM can exert a leverage effect to create a flow of additional investments and technology transfer to the developing countries[24]. observes that while there is a potential for technology transfer in CDM, it was not explicitly designed with that objective. This appears to be one of its major deficiencies[25]. points out that while a moderate carbon policy in a developing economy could promote transition to low-emission energy technology, too stringent policy in a relatively poor economy may rather hinder the process by reducing its financing capacity to build new energy infrastructure.

Though climate-related technology transfer is critical to a global mitigation strategy, there have been very few instances of effective and efficient actual transfer of such technologies so far and there is a significant lack of concrete mechanisms for technology transfer, addressing the role of intellectual property rights(IPR) as a barrier[26]. Bali Action Plan[27] has, therefore underscored the need for effective action in this area.

Market mechanism for technology transfer

Srinivas (2009)[28] discusses some of the innovative approaches to address the issue of technology transfer in an IPR barrier regime as follows:

(i) Transfer of Technology Fund for developing nations, as in the case of Montreal Protocol to phase out Ozone Destroying Substances (ODS).

(ii) Centres for technology development and transfer based on the Green Revolution model.

(iii) Multilateral Climate Technology Fund under UNFCCC.

(iv) Open source models and distributed innovation.

(v) Patent pools of relevant technologies, as in the case of electronics and IT industry, for countries to get licenses without dealing with too many parties.

(vi) A global R&D alliance, as in the health sector for certain diseases.

(vii) Collaborative networks for energy R&D and for establishing a Global Technology Venture Capital Fund.

(viii) Global pact on access to Science and Technology so that WTO Agreements, particularly Trade-Related Aspects of Intellectual Property Rights (TRIPS) do not become a barrier against access to science, technology and knowledge.

Murphy *et al.* (2009)[29] examine the performance of market based instruments (MBI) under the Kyoto Protocol, namely, International Emissions Trading (IET), Joint Implementation (JI) and the Clean Development Mechanism (CDM), and also outline current proposals for the expansion and/or new market mechanisms for post-2012 mitigation regime[24]. suggests that CDM projects should include a component of technology transfer including disembodied knowledge, so that the benefits spill over to the economy as a whole. The Copenhagen accord[26] mentions the importance of technology transfer by deciding to 'establish a Technology Mechanism to accelerate technology development and transfer in support of action on adaptation and mitigation that will be guided by a country-driven approach and be based on national circumstances and priorities'.

In view of the efficacy of MBIs to achieve the intended outcomes in the most optimal manner, it appears that the Copenhagen technology mechanism should be a MBI. Effective technology transfer in an IPR regime needs integration with market mechanisms. It is necessary either to integrate

technology transfer with CDM to earn emission reduction credits for the technology transferring country or organization in proportion to the realized reduction potential of the technology transferred or to evolve a dedicated MBI for the purpose. This would encourage technology development and transfer to be integrated with emission markets for effective mitigation in developing countries and also for addressing IPR issues.

Conclusions

This paper focuses on the situation of India in the global climate change mitigation effort post-Copenhagen. The emission intensity reduction commitment of 20-25% during the next decade has been analyzed in the context of its implementation.

The possible options of achieving harmonization of developmental and environmental objectives have been examined. The logical framework matrix has been employed for this analysis to represent various aspects of policies in a concise and succinct form. This matrix can be utilized as a preliminary planning tool for carbon mitigation in developing countries. An examination of possible options indicates the need for formulating a set of Pareto optimal policies. Many of the feasible design components are potentially win-win points. The precise extent, to which these contribute to the achievement of various developmental and climatic objectives, needs to be analyzed further with suitable models which capture the interaction between climate change policies and corresponding economic impacts.

It is well-recognized that finance, technology and international co-operation are the pillars of globally effective carbon mitigation. These pillars are not strongly in place in the current frameworks assembled by weak or half-hearted international efforts confronted with the problem of protection of the global commons. It is unlikely that a game-theoretic approach of maximizing self-interest would find a convergence pathway for common benefit. It would require a paradigm shift in basic premises. Optimal pathways are possible and available as in the case of India which can be pursued effectively with equitable burden-sharing approach based on a robust international co-operation framework.

Effective technology transfer has not become a reality for climate-related technologies due to various factors including IPR issues. In view of the technology intensive nature of mitigation, a market based mechanism to integrate technology transfer for earning carbon credits for such transferor, fortified by appropriate measurable, reportable and verifiable criteria, needs to be worked out to address the current impasse in this vital area. This can be achieved by suitable expansion of the CDM framework in the post-2012 regime or by devising a separate mechanism tailored for the purpose[4]. rightly states, an equitable and effective global climate deal is required which 'recognizes the varying needs and constraints of developing countries, assist them with the finance and technology to meet increased challenges to development, ensure they are not locked into a

permanently low share of the global commons, and establish mechanisms that decouple where mitigation happens from who pays for it.'

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Appendix

INDIA - LOGICAL FRAMEWORK FOR EMISSIONS MITIGATION POLICY

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
1. Goals			
1. Contribute to Carbon mitigation by reducing Emission intensity of GDP. 2. Diversify Energy Baskets to increase energy security and sustainability, Increase Energy efficiency	Emissions Intensity of GDP to be reduced by 20-25 percent by 2020 from 2005 levels; Adjust emissions to converge to global average per capita emissions at 2050; Developing new and efficient technologies for electricity generation; Developing renewable sources of energy; Reducing transportation sector emissions.	Statistical measurements and analysis Baseline data and monitoring reports Progress reports from implementing agencies.	Availability of capital investment funds; Technology transfer of climate-related technologies from developed countries; Adverse impact on growth or human development.
2. Objectives / Outcomes			
(i) Energy efficiency and conservation as a national goal Making development-friendly climate change mitigation a national priority; Voluntary achievement of carbon-neutral status by institutions, organizations, cities etc; Assessment of carbon footprints; Economy-wide energy intensity reduction on the demand side and increased efficiency of power generation on the supply side; 10,000 MW Energy savings by 2012; Competitive energy markets; Rational energy pricing and resource allocation; Market based mechanism to enhance cost effectiveness of improvements in energy efficiency;	Introduction of efficient technologies for iron and steel, cement, oil and petrochemicals, agricultural machinery industries etc; Improvement in the energy regulatory framework and capacity building; Subsidies to progressively increase on clean fuels and reduce on fossil fuels; Development of Institutional framework for planning and implementation; Number of carbon footprint assessments; Mandatory energy audits in all medium and large industries;	Increased proportion of clean fuels Production and consumption data Industry reports Amendment of rules for mandatory audits Improved energy intensity values to be measured by indicators Periodic reports, reviews;	Availability of technology Awareness among consumers Political will and commitment for the project Appropriate legal and institutional framework

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
Land use planning and management in urban areas to reduce emissions.	Promotion of ESCOs (Energy Service Companies) and retrofits.		
(ii) Power Generation			
Efficient base load coal plants Efficiency in power generation; Setting up of supercritical and ultra-supercritical plants; Increased efficiency of existing plants.	Additional Number of projects coming up with efficient technologies; Efficiency improvement projects in existing plants;	Progress reports of quantum of power generation with efficient technologies; Efficiency measurements of power plants.	Cost effective technology availability; Transfer of technology from developed countries for GHG mitigation
Fuel shift Promotion of Gas base load power and fuel; Producer gas from biomass fuels for thermal applications; Fuel substitution by bio-diesel and ethanol, Fuel shift in transportation.	Milestones regarding setting up of additional projects; Milestones regarding release of better fuels; Fuel allocation policies; Bio-fuel promotion policies; Targets regarding introduction of ethanol and bio-diesel.	Share of natural gas in thermal power; Production and consumption quantities of bio-diesel and ethanol; Fuel mix in transportation; Surveys and projections.	Increased availability of natural gas both domestically and abroad; Availability of land for bio-fuel plantations.
Renewable electricity and fuels By 2012 -23,000MW from non-conventional renewables (1,300MW from solar) Promotion of the major renewable sources in a big way, namely, hydro-power, wind, solar and bio mass.	Project milestones and implementation charts; Policy preference for fuel allocation for efficient cogeneration plants; Milestones regarding financial closure of projects; Policy support roll out plan.	Measured change in fuel mix, policies for renewables; Quantum of renewable power generation; Measurements of carbon intensity of power generation.	Cost effective commercially available technologies; Synergies with international effort for techn-ology transfer; Resolving IPP issues.
hydropower potential Utilization of large, medium, small hydro power potential	Project site selection, milestones; Implementing institutions; Award of sites action plan; Increased hydro power generation by 50,000 MW.	Number of hydro power projects being implemented Policies for site allotment	Availability of environmentally feasible hydro sites; Availability of funds.

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
Solar Energy Accelerated development and utilization of solar power.	Yearly increase in production of solar PV and CSP; Issue of policy incentives; Institutional mechanisms, centres set up; Number of workshops, training programmes.	Demand for solar products and technology; Quantum of solar power generation; Photovoltaic demand and production.	PV production cost Technology transfer
Wind power Scaling up the grid-connected wind power	Yearly targets for wind power; Issue of policy incentives; Number of R&D personnel; Quantum of annual production of wind turbines; Number of training programs.	Demand and production of wind turbines & systems; Quantum of wind power injected into the grid; Wind power enhancing schemes/policies.	Multiple uses of land because windmills are widely spaced
Nuclear power Increased share of nuclear power in the fuel-mix	Number of supply and project agreements; Additional agencies for implementation; Progress of human resource development.	Periodic reports Projects under implementation Policy dialogue	Availability of fuel; Public acceptance of the technology; Nuclear proliferation, terrorism, nuclear waste
(iii) Power Transmission and Distribution Efficient Transmission and Distribution Reducing T& D loss to 6%-8% from 16%-19%.	Number of projects and project related milestones Procurement/development of technologies-milestones Targets for production of systems Surveillance and penal measures for power theft	Measured losses in the transmission and distribution system; Measured aggregate technical and commercial losses; Policy support measures; Assessments of level of competition and private participation in transmission and distribution.	States cooperate to provide open access Technology transfer Availability of funds
(iv) Transportation Improve fuel economy 30% or more by 2020;	Policy Incentives for smaller fuel efficient vehicles;	Air quality monitoring results in urban centers;	Availability of funds for huge mass transit systems

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
Efficient vehicles, hybrid designs Mass Transport; Increased coverage of public transport and improving cycling and walking; Reduced emissions from transportation sector; Transport pricing reform and higher regulatory standards; Better traffic and congestion management.	Town planning policies of urban areas; Incentives for hybrids and electric vehicles: H_2 in fuel-cell car for gasoline in hybrid car; Number of fuel efficient vehicles registered; Number of Vehicle emission checking centers; Passenger miles through mass transit; Awareness programmes.	Mass transit project under implementation and passenger miles achieved; Periodical progress reviews; Policy dialogue.	H_2 safety
(v) **Green buildings** Promotion of green buildings -Water saving up to 30-40% -Energy saving up to 40-50% Increased energy efficiency of commercial and residential buildings Reduce carbon emissions by one-fourth in buildings and appliances	Enforcement policies and mechanisms; Mandatory application of energy service building code for select class of buildings; Campaign for Energy Efficient buildings milestones; Education and training milestones.	Yearly progress targets for implementing agencies; Residential and commercial sector electricity consumption; Sale of building efficiency materials and equipment; Emissions intensity of the services sector.	Large number of old buildings; Availability of cost effective materials; Availability of trained man power for design and implementation.
(vi) CO_2 sinks, Methane to Markets, Increased efficiency in mining, exploration Increased sequestration of CO_2 Reduced deforestation, plus reforestation Improvement and methane capture from sources Efficient coal mining, oil and gas exploration Coal beneficiation	CO_2 injection technologies for improved oil recovery; Research into CCS technologies; Coal beneficiation technologies, coal to liquid technologies; Recuperation of methane from landfills; Measures to stop gas flaring, capture of methane from solid waste processing, Coal bed methane capture, etc.	CH_4 emissions into the atmosphere; Quantum of CO_2 utilization; Quantum of flared gas; Policies for incorporating improved technologies in mining leases; Co-operation with international agencies; Satellite measurements of tree cover; Biodiversity assessments.	Lack of sites and risks associated with geological injection of CO_2 Cost of methane capture; Distributed nature of methane emissions; Inaccessibility of sites

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
(vii) Improved Agriculture, Irrigation and Water Management Improved productivity in agriculture; Optimization of water use and reduced energy consumption; Waste water reuse; Reduced emissions from water and agriculture sector.	Performance targets for policy measures and projects of various implementing agencies Milestones for awareness campaign and knowledge support.	Electricity usage surveys in irrigation; Water consumption for irrigation and domestic use; Quantum of treated water use; Water use efficiency studies; Progress reports and consultations.	Public participation in water management; Availability of cost effective technologies and equipment; Financing mechanisms.
(viii) Communication and Awareness Building Increased public awareness of the national goal of energy efficiency; Lifestyle changes for emissions intensity reduction	Identification/setting up institutional mechanism Milestones for identified activities	Surveys of awareness levels, lifestyles and energy efficiency improvements	
3. Deliverables / Outputs			
(a) For Objective 2(i) : Energy efficiency and conservation as a national goal Implementation of a number of energy efficiency projects in public and private sectors; New financing mechanisms and tax policies to promote energy savings; Transparent and targeted subsidy disbursal; Fiscal instruments to promote energy efficiency; Organization of competitive electricity markets and trading; Automatic open access for electricity across the country; System to target subsidies to beneficiaries directly and reduce fossil fuel subsidies; Differential taxes for efficient and other products;	Energy Efficiency increase of 5% in one year in specified sectors Policy targets Increased trading of power Subsidy and taxation policies Urban design standards.	Periodical reports and monitoring meetings Mandatory energy audits in all medium and large industries Comprehensive efficiency surveys on a quarterly basis Achievement based release of funds Assessment by independent agencies	Availability of technology Awareness among consumers

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
Consumer education campaign; Design of dense, low-emission cities.			
(b) For Objective 2(ii) : Power Generation			
Efficient base load coal plants Increase average efficiency to 42% from current 32% in 10 years; Retire or rehabilitate 10,000 MW old capacity; All new plants above 1500 MW to use supercritical technology; IGCC commercialization.	Project milestones Financing targets	Progress reports from monitoring agencies	Transfer of technology Availability of finances
Renewable electricity and fuels Increase non-conventional renewable share from 3500MW(2002) to 23,000 MW by 2012; Renewable Electricity Standard (RES): dynamic minimum renewables purchase standard starting in 2010-11 3000MW cogeneration projects using bagasse, agro-residues etc by 2012 and additional 5,000MW by 2015; Electrification of 18,000 remote villages by renewable power systems by 2015	Progressive milestones for projects; Notification of standards by 2011; Notification of policy by 2011; Project mile stones; Institutional mechanisms for implementation; Financing mechanisms for renewables.	Progress & review reports Visit by monitoring teams Assessment of periodical share of renewables	Transfer of technology materializes under technology agreements
Hydropower potential Timely completion of current large and medium hydro power projects by 2013 2000 MW power from small hydro projects by 2012 and 4000MW by 2015.	Allocated yearly targets/activities for the projects	Progress & review reports Visit by monitoring teams Hydro power generation data	Adverse environmental impacts of hydropower; Long gestation period of projects; Financing.
Solar Energy Solar energy for at least 80% coverage for all low temperature (<150°C), and at least 60% coverage for medium temperature	Allocated yearly targets/ activities for the projects; By 2022 - 20,000 MW of grid power including roof top	Progress & review reports Visit by monitoring teams	Cost effecti-veness Availability of land Trained

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
(150° to 250°C) applications; Photovoltaic (PV) production from integrated facilities at a level of 1000 MW/annum and at least 1000 MW of Concentrating Solar Power (CSP); 'Free Solar Pumps' as against 'Free Electricity' for farmers.	systems - 2,000 MW for off grid applications - 20 million sq. m. solar collectors for heating applications - 20 million solar systems for lighting applications.	Periodical assessment of the share of solar energy Number of workshops, product expos etc.	manpower availability
Wind power Add 5,000 1-MW-peak windmills on land or offshore; R&D into low velocity wind turbines and Vertical axis wind turbines by 2012 and additional 10,000 MW by 2015; R&D projects for low speed turbines and vertical axis turbines; Assessment of wind power potential; Development of 10MW wind-diesel or Wind-solar hybrid systems and 10MW offshore wind farms.	Project implementation milestones Targets for wind power potential assessments Technology transfer projects Progress milestones of R&D projects.	Progress & review reports Visit by monitoring teams Wind Power into the grid	Availability of potential sites Grid connectivity problems
Nuclear power Add 5,000 MW of nuclear power by 2015; Full capacity utilization of existing nuclear plants.	Quarterly progress Milestones specified; Fuel supply agreements; R&D progress milestones.	Progress & review reports	Technology and Fuel availability
(c) For Objective 2(iii) : Power Transmission and Distribution			
Reducing transmission & distribution loss by 1% per year till 2020 to bring it down to 7%. Increasing HVAC (high voltage AC) and HVDC (high voltage DC) transmission; Increased monitoring and Penal measures for avoiding power theft; Improved electronic meters and metering at various levels in transmission and distribution system;	Yearly progress milestones HV line capacity for implementing agencies Surveillance and penal measures for power theft Number of electronic meters Yearly of commercial losses Number of private sector projects	Measured losses in the transmission and distribution system Measured aggregate technical and commercial losses Power factor levels Policy support for faster	States cooperation to provide open access; Political will for anti-theft activities; Availability of funding; Institutional and regulatory

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
		implementation	framework for the sector.
Implementation of smart power system with distributed energy systems with mini or micro-grids and mini or micro-utilities; Transparency and making available electricity bills on the internet		Level of competition and private participation in transmission and distribution.	
(d) For Objective 2(iv) : Transportation Incentives for smaller fuel efficient vehicles; Retiring old inefficient vehicles; Reduced use of passenger cars; Incentives for hybrids and electric vehicles: H_2 in fuel-cell car for gasoline in hybrid car; Vehicle emission checks; Reduce air travel; Telecommuting; Improve mass transit: Metro rails & metro bus projects; Increase share of rail and water transport; Urban design, Bicycling tracks in urban areas; Consultation with stakeholders.	Policy incentives notifications; Milestones for various projects.	Progress reports Guideline documents Specific research into regulations is undertaken Real time data for traffic management Draft Regulations in place Reports received from local authorities Regulations approved and in place in all provinces	Funding availability Government support for implementation
(e) For Objective 2(v) : Green buildings Promotion of LED/CFL lighting; Energy efficient building design; Mandatory code for higher minimum temperatures for air conditioners; Geo exchange and solar cooling systems; Energy efficient apparel designs; Training of personnel; Promotion of energy efficient materials and systems; Extension of Energy Conservation Building Code (ECBC);	Extension of compliance to the ECBC to residential sector Yearly targets for each activity and energy consumption surveys in buildings Energy intensity of the service sector	Independent surveys and assessments Electricity consumption data Monitoring reports, progress reports, and review missions Regulations and standards	Public awareness and support Availability of retrofits Affordability of inputs

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
Eco-retrofitting of urban buildings to save energy & water; Enforcement policies and mechanisms; Labeling programme for Appliances; Awareness building measures.			
(f) For Objective 2(vi): CO2 sinks, Methane to Markets, Increased efficiency in mining, exploration Expand forest cover to 1/3 of country's area; Treating 5 million degraded forest land; Afforestation of 18 million Ha wasteland by 2016-17; CO_2 injection technologies for improved oil recovery; CO_2 as refrigerant in air conditioning; Research into Carbon Capture & Storage technologies; Coal beneficiation technologies, coal to liquid technologies; Waste collection services at all urban households; Recuperation of methane from landfills; R&D on food additives to reduce the methane emissions and to block enzymes in the cow's rumen that are required to produce methane; Measures to stop gas flaring; Capture of methane from solid waste processing; Coal bed methane capture, etc; City forests and increase in green cover; Tree preservation legislation mandating planting when cut Utilisation of REDD plus mechanism	Milestones regarding prevention of deforestation Number of research centers and projects in such centers Number of research personnel engaged in research Milestones for reduction of gas flaring, methane capture etc Number of REDD plus(Reducing Emissions from Deforestation and Degradation) projects submitted for assistance Number of trees planted Enactment of legislation Awareness campaigns.	Reports regarding the use of CO2 use, methane capture, etc Surveys of extent of illegal dumping / waste accumulation and littering Number of patents for new technologies Reduced negative health, safety and environmental impact resulting from waste Satellite imaging of forests and green cover	Funding constraints Poverty and food availability Agricultural unemployment Tribal and forest dwellers' rights issues Availability of timber substitutes

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
(g) For Objective 2(vii) : Improved Agriculture, Irrigation and Water Management Conservation tillage methods, crop rotation, buffer strips, nutrient management, water conservation, growth of energy crops on spare lands etc; Development of drought resistant and less water intensive crops; Introduction of bio-technologies for improved productivity & promotion of organic farming; More fuel plantations; Increase water use efficiency by 20%; Increased use of drip, sprinklers and micro sprinklers; Effluent water for irrigation; Optimize the efficiency of existing irrigation systems; Water harvesting structures; Mandatory water harvesting policies.	Milestones for projects of various implementing agencies	Progress reports of achievement Field level checks Independent verification by surveys and studies Productivity surveys	Public participation in water management Availability of cost effective technologies and equipment Financing mechanisms
(h) For Objective 2(viii) : Communication and Awareness Building Established functioning communication channels between tiers of government; Stakeholder consultations; Seminars and workshops; Campaigns through the educational institutions; Media campaigns, Local capacity building; Training, Research & Scenario building; e-learning & use of internet and digital media.	Milestones and targets for various activities Milestones regarding education programmes on environmental ethics	Periodical reports and reviews	Political support Civil society involvement

Design Summary	Performance Targets / Milestones	Monitoring Mechanisms/ Source of Verification	Assumptions / Preconditions / Risks for Implementation
4. Inputs			
Financing; Knowledge support; Institutional mechanisms; Economic Policy Instruments-carbon markets and clean development mechanism; Regulatory Policy Instruments; Technologies development and transfer mechanisms; Human Resource development.	Milestones relating to progress of achievement of input linkages	Project implementation progress reports Project accounts Policy dialogue, review missions.	Financing Mechanisms Climate related technology transfer agreements Performance of the economy