Climate Change

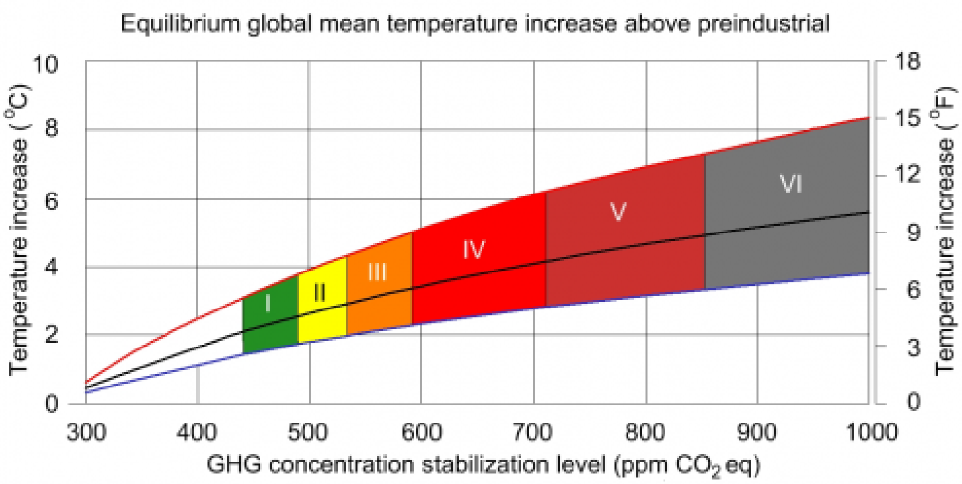
1. The Challenge

The threat of climate change is a serious global concern. There is near consensus among scientists that climate change is unequivocal. Increase in anthropogenic activities, since the advent of industrialization in the mid-18th century, has led to accumulation of Greenhouse Gases (such as Carbon Dioxide, Methane, Nitrous Oxides, etc.) in the Earth's atmosphere. Greenhouse Gases (GHGs) trap infra-red radiations reflected by Earth, leading to global warming; which, in turn, could lead to changes in rainfall patterns, disruption in hydrological cycles, melting of ice caps and glaciers, rise in sea levels, and increase in frequency and intensity of extreme events such as heavy precipitation or cyclones. These developments can have a serious impact on sustainability of water resources, agriculture, forests and ecosystems, affecting the well-being of billions of people on Earth. Climate Change can slow down the pace of development either through its adverse impact on natural eco-systems, or through erosion of adaptive capacity of the people, particularly those who are socially and economically vulnerable. Probabilities of temperature change as estimated by the Intergovernmental Panel on Climate Change (IPCC) are given below:

Table 1: Different Levels of Global Mean Temperature Increase above Pre-industrial Levels

Category	CO2 Concentration (ppm)	CO2 eq. Concentration (ppm)	Global Mean Temperature Increase Above Pre-industrial Levels (Deg C)	Peaking Year for CO2 Emissions	Change in Global Emissions in 2050 (% of 2000 Emissions)
I	350 – 400	445 – 490	2.0 – 2.4	2000 - 2015	-85 to -50
II	400 – 440	490 – 535	2.4 – 2.8	2000 – 2020	-60 to -30
III	440 – 485	535 – 590	2.8 – 3.2	2010 – 2030	-30 to +5
IV	485 – 570	590 – 710	3.2 – 4.0	2020 – 2060	+10 to +60
V	570 – 660	710 – 855	4.0 – 4.9	2050 – 2080	+25 to +85
VI	660 – 790	855 – 1130	4.9 – 6.1	2060 – 2090	+90 to +140

Figure 1: Global Temperature Rise –Effect of Increase in GHG Concentration



(Source: IPCC AR4 (Working Group III: Mitigation of Climate Change))

India is highly vulnerable to climate change. As per recorded observations, India has seen an increase of 0.4 degrees Centigrade, in the mean surface air temperature over the past century (1901-2000). Change in mean temperature and precipitation will require change in cropping patterns. It has been estimated that a 2.0 to 3.5 degree Centigrade increase in temperature, and the associated increase in precipitation, can lower agricultural GDP by 9 to 28 percent. Yields of most crops will fall in the long run. The impact in the short run may be small, but the heat stress will affect the productivity of animals, and milk production may even decrease over the present levels. Agriculture technology can adapt to these changes to partially offset the adverse impact by adoption of water conservation practices, by changing cropping patterns and practices, and by developing new varieties that can withstand short term variability in the weather patterns.

Climate Change will also affect the water balance, particularly the amount of runoff and recharge, which determines the overall water resources available in the ecosystem. This will change vegetative cover, affect availability of fodder, fuel-wood and minor forest produce. Climate change is also expected to raise sea levels, which could submerge coastal lands in some areas, thereby threatening coastal cities and habitations. Apart from the loss of land and property, millions may be displaced. Increase in sea and river water temperatures is likely to affect fish breeding, migration and harvest. We need to understand these threats and take action well in advance.

Since global warming depends upon the total concentration of GHGs, minimization of the threat of climate change requires concerted action by all the countries. The Earth Summit in Rio in 1992 recognized this imperative, and the UNFCC (UN Framework Convention on Climate

Change) has called for a global response based on the principle of *'common but differentiated responsibility'*.

India is, and has been, one of the lowest GHG emitters in the world, on a per-capita basis. Its emission of 1.18 tonne of CO2 equivalent per person in 2008, was nearly one-fourth of the global average of 4.38 tonnes (one-tenth that of Europe and one-eighteenth that of US). Further, since it is cumulative emissions that affect climate variability, and the historical emissions of developed countries have been the major contributor to climate change, India's contribution to climate change is marginal. However, India remains vulnerable to adverse effects of both climate variability and change. Global action is urgently required to minimize the threat and damage that climate change can inflict on us.

As a responsible nation, India has already shown its commitment to help address the global climate challenge. Our Prime Minister expressed on June 8, 2007, at the Heiligendamm meeting of G8+5, India's determination to see that her per capita emissions levels will never exceed the average per capita emissions levels of the developed countries in the world (*Singh Convergence Principle*). Furthermore, in December 2009, India announced that it would aim to reduce the emissions intensity of its GDP by 20-25 per cent over the 2005 levels by 2020. India's voluntary actions will hopefully lead other nations to reduce their emissions, and to arrive at an effective and just global agreement.

India has also formulated a National Action Plan on Climate Change (NAPCC). The plan formulated under the aegis of the Prime Minister's Council on Climate Change has outlined eight missions, which have been subsequently elaborated and initiated. Four of these missions address adaptation to climate change; three address mitigation and one relates to knowledge. As adaptation and mitigation actions take time, precautionary principle requires we act now to ensure a more sustainable and inclusive growth. The 12^{th} Five Year Plan, therefore, takes some decisive steps in this regard.

2. National Action Plan on Climate Change:

Eight national missions were launched in the Eleventh Plan covering the areas of solar energy, energy efficiency, habitat, agriculture, water, Himalayan ecosystems, forestry and strategic knowledge. The Mission documents have been finalized by the Prime Minister's Council on Climate Change and are at various stages of implementation. Although the nodal Ministries entrusted with implementation of the Missions are yet to fully assess the likely costs, the preliminary estimates indicate a sum of Rs. 2,30,000 crore may be needed to fulfil the Mission objectives. Funds of this magnitude cannot be mobilized through budgetary resources alone.

The **Solar Mission** aims at making solar electricity cost competitive to coal power and increasing the share of solar energy in the total energy mix through development of new solar technologies, both photovoltaic and solar thermal. The Mission recommends implementation in 3 stages leading up to an installed capacity of 20,000 MW by the end of the 13th Five Year Plan in 2022. The total financial outlay during Phase 1 is estimated as Rs.4,337 crore. Requirement for 2nd phase will be assessed after review of phase 1.

The **Energy Efficiency Mission** seeks to upscale efforts to create a market for energy efficiency. It comprises of 4 initiatives, namely, Perform, Achieve and Trade (PAT), market transformation for energy efficiency (MTEE), energy efficiency financing platform (EEFP) and framework for energy efficient economic development (FEEED). As a result of implementation of this Mission over the next five years, it is estimated that by about 2015, about 23 million tonnes of oil-equivalent of fuel savings – in coal, gas, and petroleum products, will be achieved every year along with an avoided capacity addition of over 19,000 MW. While the initial cost of starting the Mission during the 11th Plan was about Rs. 425 crore (excluding the investment made by private investors) the costs for implementing the Mission during the Twelfth Plan period is estimated to be Rs. 3,400 crore (excluding the investment made by private sector). The cost for subsequent periods is yet to be estimated.

The **Sustainable Habitat Mission** attempts to promote energy efficiency in buildings, management of solid waste, and modal shift to public transport including transport options based on bio-diesel and hydrogen. Main components of the Mission are (i) development of National Sustainable Habitat Standards (legal/regulatory) measures (ii) incorporation of principles of sustainable habitat in city development and planning and (iii) complementary action such as support for building green demonstration projects and outreach programme for creating consumer awareness. The total cost estimate projected in the Mission Document is Rs.1,000 crore. During 11th Plan, expenditure of Rs. 50 crore is to be incurred and remaining Rs.950 crore is to be incurred during the 12th Five Year Plan.

The **Sustainable Agriculture Mission** aims at making Indian agriculture more resilient to climate change through development of new varieties of climate-stress resistant crops, new credit and insurance mechanisms, and improving productivity of rain-fed agriculture. The main focus of the Mission is ensuring food security and protecting land, water, biodiversity and genetic resources for sustainable production of food. An outlay of Rs. 12 to 15 thousand crore is likely to be available for this Mission during the 12thFive Year Plan.

The **Water Mission** aims at conservation of water, minimizing wastage and ensuring more equitable distribution both across and within states. The Mission focuses on (i) intensive rain water harvesting and ground water charging to meet the demand of 1120 critical blocks during the 11th Plan and remaining blocks in the 12th Plan (March, 2017), and (ii) increasing water use efficiency at least by 20% by 2012. Water has been identified as a major challenge of sustainable development for the Twelfth Five Year Plan. A new national program will be launched for sustainable management of water resources in the country. Since this issue is larger than climate change, it is better to subsume this into the larger Mission to be launched for the 12th Five Year Plan.

The **Mission on Sustainable Himalayan Eco-systems** aims at evolving management measures for sustaining and safeguarding the Himalayan glacier and mountain eco-system. The four key issues to be addressed by the Mission are (i) Himalayan glaciers and the associated hydrological consequences, (ii) biodiversity conservation and protection, (iii) wildlife conservation and protection, and (iv) traditional knowledge societies and their livelihood. For implementing its activities, a total provision of Rs 900 crore needs to be made during the 12thFive Year Plan.

The **Green India Mission** focuses on enhancing eco-system services and carbon sinks through afforestation on degraded forest land, in line with the national policy of expanding the forest and tree cover in the country and improving the quality of forests. A total expenditure of Rs. 46,000 crore is projected under this Mission for coverage of 10 million hectares over the next *ten years*. An outlay of Rs 12,500 crore is likely to be available for this Mission during the Twelfth Five Year Plan.

The **Strategic Knowledge Mission** intends to identify the challenges of, and the responses to, climate change through research and technology development and ensure funding of high quality and focused research into various aspects of climate change.

For a Mission to succeed it must have separable objectives, dedicated implementation machinery and adequate funding. For objectives which lie within the domain of other flagship programs, or are completely cross-sectoral, it is better to identify a few policy thrust areas, which would still be part of the National Action Plan on Climate Change and be regularly monitored by the Prime Minister's Council.

To achieve effective results, the Missions stated above need to be reorganized in accordance with the updated priorities. We should aim at a short list of reorganized Missions and a few policy thrust are as under the National Action Plan for Climate Change, that will be achieve more focused and tangible results over the Twelfth Plan period. Some initial suggestions for reorganizing the NAPCC are as follows (for more details see the concluding section):

1. The Water Mission here needs to be merged with the new *National Water Mission* that is being formulated for the Twelfth Five Year Plan. This will ensure water related issues are dealt with in a more holistic manner, as climate change is also an important subject

under the new National Water Policy being put up for approval. However, critical actions like treatment of all sewage being released into water bodies, which have a bearing on our adaptive capacity to climate change, should be monitored as a separate policy thrust area under the Prime Minister's Council on Climate Change.

2. Strategic Knowledge Mission is also likely to remain peripheral and is not likely to attract adequate funding through this window. It is better to mainstream development of green technology and research into other aspects of climate change into the main programs of the Scientific Departments, like earth sciences, space, S&T, agriculture, health, biotechnology etc., which are likely to attract substantial funding during the Twelfth Five Year Plan. It can be monitored as a policy thrust area under the Prime Minister's Council on Climate Change.

3. Sustainable Habitat Mission presently has over-arching objectives, some of which are out of proportion to the limited funding that is available. Solid Waste Management is an area that is funded through a separate central mission, namely the Jawaharlal Nehru Urban Renewable Mission. This subject, being of immense importance, should be monitored as a policy thrust area through the PM's Council; while the Habitat Mission under NAPCC should focus on critical areas like evolution, adoption and implementation of green building codes, city planning and development etc.

Other suggestions for reorganizing the National Action Plan on Climate Change will flow out of the discussion below and will be summarized towards the end.

State Action Plans on Climate Change

Success of climate change action plan at the national level depends in large measure on involvement of States in the national efforts. NAPCC also envisages involvement of States in implementing adaptation and mitigation actions against the challenge of climate change. Ministry of Environment & Forests has already initiated the process of preparing State Action Plans on Climate Change. The SAPCCs are to be finalised with assistance of experts and through a process of consultations. It will identify vulnerable areas and communities that need to be insulated against the adverse effects of climate change. Some of the effective adaptation strategies are listed below:

a) Agriculture: Change in land use management, development of resource conserving technologies, development of crop varieties that can withstand climate-stress, effective risk management through early warning, credit-insurance support to farmers and better nutritional management of dairy animals.

b) Water: Framework for mapping hydrological units, assessment of water utilization to address inter-sectoral competition, research to support policy improvements in water use management and to improve understanding of linkages within the ecosystem.

c) Forests: Forest planning and development of programmes that will minimize the adverse impact of climate vulnerability and change, implement Reduced Emissions from Deforestation and Forest Degradation (REDD+) activities programme.

d) Coastal Zone: Scientific evaluation of potential changes in the coastal zone, estimation of inundation of vulnerable zones, planning for infrastructure and large scale displacement of people in coastal areas.

e) Health: R&D and clinical management of vector borne respiratory, heart and corneal diseases.

The State Action Plans will include a strategy and a list of possible sectoral actions that would help the States achieve their adaptation and mitigation objectives. Most of the States have already started working on a template provided by the Central Government. A two-stage consultation process has been initiated by the Central Ministry of Environment and Forests (MoEF). An expert committee in the MoEF has been set up to examine the draft action plans from a technical point of view, as well as their feasibility. A National Steering Committee has also been formed to endorse the SAPCCs, as well as strategies and outlays presented by the State Governments.

Most of the resources required for sectoral actions under the State Action Plans will need to be provided by the State Governments through their respective plan outlays. However, some resources may be mobilized as Central Assistance to State Plans through the Gross Budgetary Support. This will incentivize State Governments to undertake adaptation and mitigation actions within their domain. Support to State Governments could be based on a set of transparent and objective criteria to be monitored by a Steering Committee in the MoEF. In addition, State Government may earmark provisions for implementing activities under the SAPCC. 13th Finance Commission has recommended grants to the State Governments for environment action, which also cover some of the activities under the NAPCC. Even then, resources are likely to fall far short of what is required, and international assistance will need to be mobilized through bilateral and multi-lateral channels.

Climate Change Science and Assessment

Existing institutions in different Ministries have studied the patterns and behaviour of climate from a scientific angle. However, the science of study and assessment of climate change has acquired added importance in the recent years. There has been a significant leap in the understanding of the “science” of climate change and its impacts on socio-economic systems, which is evident from the work done by the Inter-governmental Panel on Climate Change in its Third Assessment Report.

The Ministry of Environment and Forests has been engaged in the last two decades in assessing climate change and presenting its findings. It prepared the first National Communication in 2004. The Second National Communication based on the data of 2007 has been prepared and presented to the international community in 2012. To provide a systematic basis to the research in the area of climate change, the Ministry has set up an Indian Network for Climate Change Assessment (INCCA) as a network based scientific programme. The INCCA is visualized as a mechanism to create new institutions as well as engage existing knowledge institutions working with the Government.

Considering the importance of scientific assistance to policy making, we need to create a more systematic and credible institutional arrangement that would enable us to continuously enhance the understanding of the “science” of climate change. It should make a regular assessment of the impacts due to changes in the climate system, and also assess the extent and nature of key vulnerabilities. It should include systematic preparation and publication of GHG inventory, preparation of NATCOMs as per international obligations, and facilitate mainstreaming of climate change related studies. Towards this end, it is proposed that new research programmes may be launched to strengthen scientific research, assessment, planning and management capability particularly in the following areas of climate change:

a) A specific programme aimed at **Climate Change Assessment Studies (CCAS)** and institutionalizing the obligatory and scientific work of the Ministry is urgently called for. The programme is required to build capacity in modelling of climate change effects, which can be done with the help of technological, economic and scientific data collected in a systematic manner. This programme may initially be conceptualized within the MoEF with a Director and at least 10 scientists and experts from different fields and associated support staff. In the long run, a dedicated Centre for Studies & Research in Climate Change should be set up as an autonomous institution attached for budgetary purposes to the MoEF. The Centre should plan, collate and coordinate the assessment work for National Communication, which is a regular and mandatory international obligation performed by the Ministry. The Twelfth Plan should support provision of at least Rs 25 crore over a period of 5 years to this Centre with an appropriate institutional arrangement.

b) **GHG Inventory Management System (GHG-IMS)** needs to be institutionalized as India is required to publish its Greenhouse Gases (GHG) inventory every two years. The programme can initially be planned in the same manner as the Climate Change

Assessment Centre, to be housed under INCCA and operationalized at the MoEF. The programme should coordinate with network agencies for estimation and regular publication of GHG inventory. The nodal centre at MoEF would also act as a data repository for GHG inventory and conduct analysis to support policy making. The budgetary support required for this activity would be Rs. 20 crore per year for the initial 5 years, followed thereafter by regular budgetary support to ensure its continuity.

3. Expert Group on Low Carbon Strategies for Inclusive Growth

The Expert Group on Low Carbon Strategies appointed by the Planning Commission has submitted its interim report, which outlines the low carbon strategy for major potential carbon mitigation sectors namely, Power, Transport, Industry, Buildings and Forestry. It has also computed the emission reduction numbers bottoms-up using the inventory building approach in a way similar to the official greenhouse gas inventory building system. It projects emission intensity reduction over the 2005 levels (measured in grams CO_2 equivalents per rupee of GDP) by 23 to 25 percent by 2020 in the 'determined effort' scenario, which could increase to 33 to 35 percent by 2020 in the 'aggressive effort' scenario. The 'determined effort' scenario assumes effective implementation of mitigation policies that require continuous up-gradation of technology as well as finance from both public and private sources. The 'aggressive effort' scenario requires, in addition to determined effort, design and implementation of new policies that need to be supported through technology and finance from international sources.

The Expert Group has identified Twelve Focus Areas for the Twelfth Plan (see Box-1 below):

1. **Advanced Coal Technologies**
2. **National Wind Energy Mission**
3. **National Solar Mission**
4. **Technology Improvement in Iron and Steel Industry**
5. **Technology Improvement in Cement Industry**
6. **Energy Efficiency Programs in the Industry**
7. **Vehicle Fuel Efficiency Program**
8. **Improving the Efficiency of Freight Transport**
9. **Better Urban Public and Non-motorized Transport**
10. **Lighting, Labelling and Super-efficient Equipment Program**
11. **Faster Adoption of Green Building Codes**
12. **Improving the Stock of Forest and Tree Cover**

Each of these is discussed in greater detail under the relevant sector below.

3.1 Power

In the business-as-usual scenario India would rely heavily on coal to meet its surging power demand. However, this poses an environmental, social and natural resource challenge, as the Power sector is currently the highest contributor (38 percent) to India's greenhouse gas emissions. There are several initiatives which would reduce GHG emissions from this sector. These are discussed in greater detail in the chapter on energy, and therefore, only the main points are summarized here:

3.1.1 Advanced Coal Technologies:

It has already been announced that 50 percent of 12thplan target and the coal based capacity addition in 13thplan would be through super-critical units, which reduce the use of coal per unit of electricity produced. However, determined efforts are needed to achieve these results, and prioritization of coal linkages will be necessary to incentivize adoption of super-critical technology. The alternative would be to stop investment clearances for sub-critical units, except under very special circumstances.

Efficient coal combustion technologies are crucial not just for reducing CO_2 emissions, but also for addressing the acute coal shortage being faced by power plants. India's reliance on coal imports is expected to increase in the coming years. Super-critical (SC) power plants, which operate at steam conditions 560^{o} C/250 bars, can achieve a heat rate of 2,235 kCal/kWh as against a heat rate of 2,450 kCal/kWh for sub-critical power plants. The specific CO_2 emission for super-critical plants is 0.83 kg/kWh as against 0.93 kg/kWh for sub-critical plants. Super-critical technology is now mature and is only marginally more expensive than sub-critical power plants. Therefore, accelerated installation and commissioning of these high efficiency units should be high on priority, while ensuring that competition is not compromised by limiting technology choices.

It is also necessary to invest in research and development of ultra-supercritical (USC) units. These operate at USC steam conditions (620° C/300 bars) and can achieve a much lower heat rate of 1,986 kCal/kWh, while the specific CO_2 emissions are only 0.74 kg/kWh. This technology also requires the development of special materials that can withstand high temperatures and pressures. The government should support research and development to promote indigenous manufacturing of USC units. The first USC plant, which is a joint effort of BHEL, NTPC and IGCAR, is expected to be operational in 2017. Deployment of USC plants may be suitably incentivized and targeted during the 13th Plan period.

Coal gasification provides opportunities for higher efficiency. However, Indian coal has very high ash content and initial results suggest that efficiency gain over sub-critical units is only marginal. Underground coal gasification is an important technology since it enables utilization of deep coal deposits, which cannot be mined using conventional means or because they are located in environmentally fragile regions. It also allows the possibility of in-situ carbon capture. Given India's coal shortage, there should be greater research in this technology, including execution of a few pilot projects. Another potentially promising technology is coal bed methane, and it may also be desirable to undertake some pilot action in this regard.

3.1.2 Wind Power

The power generated by a turbine (and hence the economics) is highly sensitive to the wind speeds, which increases with the hub height. Therefore, global practice now is to build towers in the range of 80-120 m, which significantly increases the power generation potential. At the same time, the size of wind turbines has increased - while the earlier turbines were typically less than 1 MW, the recent designs go up to over 5 MW. Taking these into consideration, the wind potential in India is now estimated at about 103,000 MW for 80m hub height. This is based on meso-scale weather models and a land utilization rate at 2 percent thought to be reasonable for Indian conditions. The land requirement for wind power is a potential limiting factor, even though consumptive land use for towers, roads and facilities is a fraction of the wind farm area. Some recent studies have estimated India's wind potential to be over 500,000 MW based on still higher hub heights and more land availability. However, this assessment is yet to be validated by Experts working under Indian conditions.

Recent technological innovations could make wind a major renewable source of power generation for India and we could safely target a wind capacity addition of 30,000 MW by 2020. However, it is also pertinent to mention that wind potential is unevenly distributed across the country; only Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and Gujarat have significant potential. Therefore, realization of wind potential requires careful regional level planning and coordination. First, the revised wind potential is based on the results of meso-scale weather models, which have to be validated with actual wind measurements in selected locations. Second, regional level studies are required to provide more accurate estimates of land availability and to identify sites suitable for setting up wind farms (site selection depends on several factors including gradient, road connectivity and proximity to transmission network). Finally, the two biggest challenges in accelerating capacity are planning for evacuation infrastructure and managing the intermittency associated with this source. A national grid with adequate capacity of balancing power is needed.

Setting targets for wind power capacity addition, without making a careful assessment of the capacity of the regional grid to balance its intermittency with alternative sources, may lead to a situation, where either the wind generation cannot be utilized, or when the wind suddenly dies down, the loss of generation could impact grid stability and operation. Therefore, wind capacity addition needs to be complemented by other energy sources, which have a quick ramp-up time. There are several possible options to handle this intermittency - pumped storage hydro, open-cycle gas turbines, compressed air and high power density batteries. Till recently, these were not considered necessary since total wind capacity was only about 13,000 MW. However, in future, this will be a critical challenge, if wind power has to reach 100,000 MW and more. Setting targets for wind power also needs to take into account the wide variation across states in actual performance related to capacity addition and generation. These variations are a result of technical factors associated with the wind resource, as well as non-technical factors including land policy etc. It will become increasingly necessary to address these factors, if the resource potential of wind energy is to be realized.

To summarize, achieving ambitious wind generation targets requires careful coordination between multiple Central and State agencies, particularly transmission and distribution utilities, financial institutions etc. We need to set up a National Wind Energy Mission, similar to the National Solar Mission for effective formulation and implementation of policies both at the National and State levels. The objectives of the Mission should also include, but not be limited to the following:

- Incentivizing the industry to invest in indigenous design and manufacture of turbines suited for India's low wind speed regimes. Presently, Indian wind farms use turbines that are designed for global markets
- Land tenure policies that will encourage mixed-land use for wind generation and agriculture (without having to pay commercial rents that will increase the cost of wind power). These powers must be delegated to the local sub-divisional officer
- The bidding models currently being pursued need to be revisited, so that farmers wherever willing are able to benefit from mixed land use and a cost-plus approach can be used to determine feed-in tariffs provided it is done through an independent regulator
- Prioritise the development of pumped hydro storage, which may be suitable for complimenting wind power
- Invest in R&D in energy storage options that can provide backup for longer durations, like compressed air and high power density batteries

India also has considerable off shore wind potential, particularly in Tamil Nadu and Andhra Pradesh. It is also important to undertake studies to examine the economic viability and risks associated with off-shore wind in the Indian conditions.

3.1.3 Solar Power

The Jawaharlal Nehru National Solar Mission (JNNSM) envisages grid parity for solar power by 2022 and sets an ambitious target of setting up 20,000 MW for solar power with phased scale-up of capacity, coupled with technological innovation. Solar photovoltaic and solar thermal are each expected to contribute 50 percent of the above target, in addition to a 2000 MW target for off-grid solar power. The Government has facilitated generous financial incentives for grid-connected solar plants in the form of feed-in tariffs valid for 25 years. The Government has also incentivized state-level utilities to accelerate solar capacity addition by mandating a three percent solar power target by 2022 (under the National Tariff Policy) and by providing opportunity for additional revenue streams through instruments such as Renewable Energy Certificates (RECs).

The feed-in-tariff is determined through a competitive (bidding) process. In the two rounds of bidding so far, developers have bid at prices substantially lower than the nominal tariffs specified by Central Electricity Regulatory Commission (CERC). There are indications that the cost of solar cells could reduce further. Solar photovoltaic technologies have several advantages: it can provide distributed power, enable quick capacity addition and work with diffused solar radiation. Solar thermal technologies are conducive for utility-scale power generation, and have the advantage of energy storage and hybridization with biomass/gas to achieve greater capacity-utilization. This can be used to provide base load power. However, solar thermal technologies only work on direct beam radiation and utility-scale plants require large amount of land and water, which could be potential impediments in scaling it up.

Amongst all the power generation sources, solar presents a unique opportunity for inclusive growth by providing clean off-grid electricity to the rural communities. The NSM has targeted 2,000 MW of off-grid solar power by 2022. Current guidelines limit a solar micro- grid to 100 kW per site and provide a capital subsidy of 30 percent. The concept of micro-grid, even though attractive, has so far not been effective in augmenting rural power generation. This is mainly because the developers have found it difficult to get reasonable returns on their investments and they are unable to collect adequate revenues to cover operating expenses despite the initial capital subsidy.

Since, the capital subsidy mechanism is not sufficient to incentivize developers to take the risk of setting up micro-grids, there is a need to examine other options given that rural electricity supply causes loss to the power utilities and it could take several years before reliable grid power reaches all the villages. First, there is a need for relaxing the cap on total and site-based project capacity. This could help rural industrial consumers who have high load requirements, but are constrained by guideline restrictions. Second, there is merit in providing a generation-based incentive, similar to that provided for grid-connected systems. This would make the off-grid solar projects bankable and assure the developers of steady revenue stream.

The rapidly growing telecom sector provides an excellent synergy for augmenting solar power in rural areas. At present there are close to 0.2 million telecom towers and about 40 percent of these are in the rural areas. This number is expected to double in the next few years. The electricity supply being erratic in the rural areas, most of them rely on diesel for back-up power. Rural micro-grids can not only be used to meet the requirements of the telecom towers, but also to provide power to the rural communities for lighting and irrigation water pumping.

Institutional Structure

Currently, several national and state level agencies are involved with implementation of solar power projects, and it is difficult to coordinate and align their efforts. A central nodal agency could be vested with sufficient regulatory powers to remove bottlenecks in implementation. Such an agency should also set standards to ensure that projects being sanctioned meet the required quality specifications. The solar industry is likely to attract large investments in the coming decade, and it is important that a single nodal agency is made responsible for the overall monitoring and implementation of the JNNSM.

The off-grid and even grid connected solar power projects under National Solar Mission have taken a long time for financial closure. This is because of the reluctance of local banks to provide financing, due to lack of stability of policies and possibility of default by the utilities. The government should immediately classify solar power projects as 'priority lending' so that banks start giving it due importance in their credit plans.

Further discussion is needed in designing the institutional structures for ownership and operation of decentralized off-grid solar power systems. For example, enabling local panchayats with a stake in ownership could ensure local maintenance and operation, and also improve the payment collection system because of community-ownership. An alternative model would be to have entrepreneurs bid for setting up of a cluster of such plants in a contiguous area, and then maintain and operate them on cluster basis.

Indigenous Manufacturing

In order to encourage indigenous manufacturing of components used in solar power generation, GOI has mandated for all the projects allotted in 2010-11 that 100 percent PV modules should be manufactured in India. It has been further mandated that from 2011-12 onwards, 100 percent of cells used in indigenous modules should be manufactured in India.

There is a need to review these policies. Crystalline silicon and thin films are the two proven technologies for solar photovoltaic systems. Of these, crystalline silicon dominates the global market; however, there is considerable interest in thin-film systems given the potential for lower costs. The global manufacturing capacity is several times that of India, and several institutions around the world are pursuing cutting edge research leading to a rapid decrease in solar cell costs. India needs easy access to the best available global technology to ensure rapid adoption of solar power. At the same time, developing domestic industry for manufacturing solar cells is important. The manufacturing policy should strike a balance between these two objectives, and mandate a more gradual indigenization of cell and module manufacture. The following steps need to be taken:

1. Our customs duty structure should not be inverted along solar industry's value chain (basic and intermediate inputs should not attract higher tariffs than finished products)

2. The electricity tariff policy of the Government should be neutral to the type of solar technology being deployed in the approved projects

3. Export subsidies (explicit and implicit) available to foreign manufacturers must be matched by tariff/domestic policy to the extent it provides a level playing field to the domestic solar manufacturers

4. R&D efforts for indigenous manufacturers should be incentivized by permitting them to compete with government laboratories for research funding through the budgetary sources

Nuclear and Hydro Power are also important for emissions reduction, but they face some critical challenges, which are briefly summarized below:

Nuclear power is considered an important source for low carbon and base-load power generation. India has ambitious plans in nuclear power through a combination of Light Water Reactors, Heavy Water Reactors and Fast Breeder Reactors. However, global concerns regarding safety of nuclear power following the Fukushima nuclear accident in 2011 have slowed down nuclear power capacity addition. Future growth will require addressing public concerns about safety of nuclear power, and consensus building at the national and local levels. It is unlikely that large nuclear capacity could be added over the Twelfth Plan period.

Accelerated development of **hydro-power** potential is critical for our economy. Apart from the need to harness the country's water resources for irrigation and flood control, the motivation for accelerated development of hydro power is two-fold: first, it is required for meeting India's peak power demand; and second, it is vital for large scale integration of solar and wind capacity into the grid. Storage hydro-power has a multiplier effect in facilitating renewable energy as it provides the flexibility necessary to respond to fluctuations caused by intermittent sources of renewable power, particularly wind and solar. Prioritized development of this resource, along with close monitoring of a few carefully selected hydro-projects is important during the 12th and 13th Five Year Plans.

3.2 Industry Sector

The Indian industrial sector is a key economic sector enabling strong GDP growth of the country. Indian industry is among the largest in the world and has some of the most advanced plants and technologies available globally. This sector is also one of the largest consumers of energy, and improving the efficiency of energy use is critical for energy security, improving industry profitability and competitiveness, and reducing the sector's overall impact on climate change. Since this sector is growing rapidly, the opportunities to introduce more efficient technologies is quite large as the capital stock will more than double in the next ten years.

The expert group in its interim report has identified iron and steel, and cement as the two sectors which can contribute significantly towards a low carbon growth strategy for the country. The expert group has also recommended that energy efficiency linked emissions intensity reduction is an important lever in this regard and requires development of strong policy mechanisms to ensure India achieves its voluntary emissions intensity reduction goals.

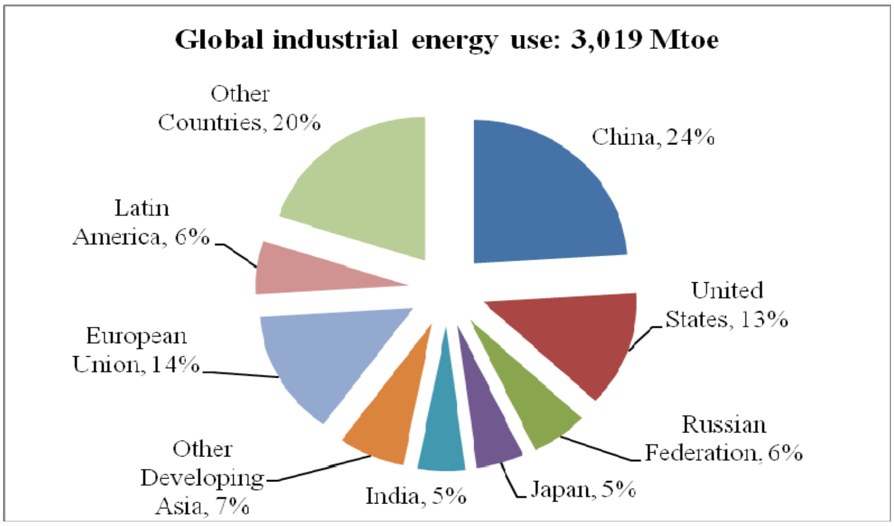
Industrial Energy Consumption Overview

In 2007, the industrial energy use of India stood at 150 million tonnes of oil equivalent (Mtoe) accounting for 38 percent of the country's final energy. Though India is the fourth-largest industrial energy consumer of global industrial energy use, surpassed only by China, the United States and Russia its share is only 5 percent. In 2007, total final energy use in industry across the globe amounted to 3,019 Mtoe. Globally, direct emissions[1] of CO2 in industry amounted to 7.6 gigatons of CO2 (Gt CO2) and indirect emissions[2] to 3.9 gigatonnes of CO2. Analysis by IEA suggests that the industry needs to reduce its current direct emissions by about 24 percent of 2007 levels to halve global emissions from 2005 levels by 2050.

[1] Direct emissions include fuel combustion and process-related CO_2 emissions from within the industry.

[2] Indirect emissions are emissions from the power generation sector due to electricity use in industry.

Figure 2: Industrial Energy Use by Region



(Source: IEA, 2011)

Industrial Energy and Emissions Intensity: Iron and Steel, Cement, Chemicals and Petrochemicals, Pulp and Paper and Aluminium are the five most energy-intensive industrial sectors in India. These accounted for 56 percent of India's industrial energy consumption in 2007.

The Compound Annual Growth Rate (CAGR) of the energy consumption of manufacturing industries in India from 1990 to 2008 was 9.8%. As of 2008, Chemicals, Metals and Metal Products, Machinery and Transport equipment contributed 80% of the total industrial output. The energy intensity of Indian industries has shown a decreasing trend; however, this trend needs to be accelerated and policy interventions may be required to overcome challenges the industry faces as a result of global energy and emission linked constraints. Some of these measures could include use of advanced materials such as composites, mineral admixture, use of slag in cement etc. Iron & Steel and Cement sectors accounted for nearly 60 percent of the total industrial GHG emissions in India in 2007. We deal with these in greater detail below:

3.2.1 Iron and Steel sector

Current Status

India's iron and steel sector is the largest user of industrial energy in India, consuming 38 million tonnes of oil equivalent (Mtoe) in 2007. India produced 53 million tonnes (Mt) of steel in 2007, an increase of over 10% per year since 2000, accounting for about 4% of the global steel production (India is now the fifth largest producer of steel in the world). Considering a steel consumption of 300 kg per capita per year (up from 48 kg per capita in 2008) to achieve a level of economic development comparable to global standards, India will need approximately 300Mt of steel per year (CCI, 2011; CSE, 2010) most of which will be produced domestically, as India has a comparative advantage in steel production.

Energy and Emissions

The Iron and Steel industry is estimated to have a Specific Energy Consumption (SEC) of about 26.4 GJ/ton of crude steel (tcs) and emission intensity of 2.21 tCO_2/tcs in 2007. The energy consumption by the steel industry and the corresponding emissions were 1402 PJ and 117 Mt CO_2 eq. respectively in the same year.

The production of steel has increased from 24.7 Mt in 1995 to 53 Mt in 2007. Specific Energy consumption for steel industry in 1995 was estimated at 35.2 GJ/tcs, which in 2007 was 29.2 GJ/tcs – a decrease of 38%; that is, steel industry has been reducing its energy intensity by about 1.4% every year. The total emissions from the steel industry have also gone down during this period. The energy related emissions were 79 Mt CO_2 eq. in 1995, becoming 147 Mt CO_2 eq. in 2007. The emission intensity has therefore reduced from 3.2 tCO_2/tcs to about 2.78 tCO_2/tcs - a reduction of 13 percent. We find that although steel industry is expanding rapidly with increase in production, the energy intensity and specific emission ratios have reduced considerably. Figure 3 and Figure 4 depict these trends.

Figure 3: Historical energy consumption (in PJ) and specific energy consumption (in GJ/tcs). *(Source: Ray and Reddy, 2008; Singhal, 2009)*

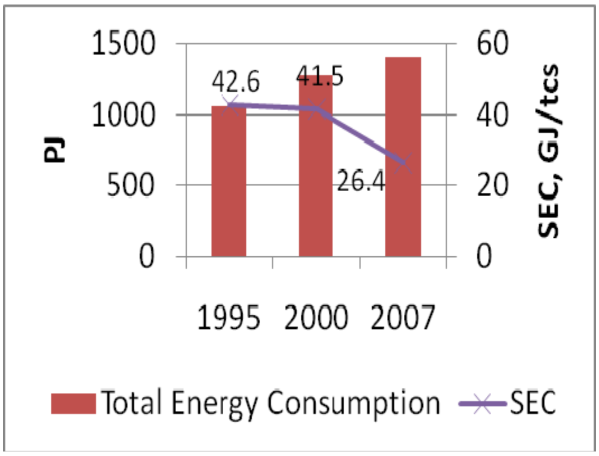
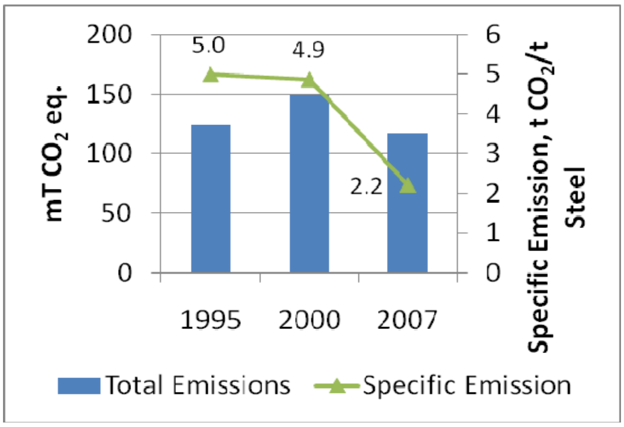


Figure 4. Historical emissions (in Million tonnes) and specific emission (in t CO2/tcs)
(Source: Ray and Reddy, 2008; MoEF, 2010)



Steel production processes

Energy intensity reduction comes from change in technology as well as from increase in efficiency of a particular process. In India there are four main process routes for manufacturing of steel.

1. **BF-BOF**: The Blast furnace and basic oxygen furnace route.
2. **DRI – EAF:** Coal or Gas based Direct Reduced Iron (Sponge Iron) and Electric Arc Furnace route.
3. **COREX-BOF** : The Corex process followed by basic oxygen furnace for conversion of iron into steel,
4. **Induction Furnace** – The Induction furnace route for melting and production of steel.

In 2007, 47% of the steel was manufactured using BF-BOF process, 27% using IF, 20% from COREX/FINEX – BOF and the remaining 6% from DRI-EAF. DRI-EAF is the most energy efficient process, but it depends on the availability of scrap (India is the largest producer of DRI steel in the world). The study expects BF-BOF to continue to dominate Indian steel production till 2020, while the share of COREX-BOF is expected to increase.

Projections of Power, Energy and Emissions

In 2020, the total production could reach 200 mT for the 8% and 240 mT for the 9% GDP growth scenario and emission intensity could reduce by about 14% and 17% respectively over the 2007 values in the determined and aggressive effort scenarios.

Policy and Measures

From a policy planning perspective, there are a number of measures that could provide the pathway for reduction of emissions intensity in the Iron and Steel Sector:

1. A shift in the process mix of the iron and steel sector towards more efficient processes
2. Diffusion of energy efficient technologies into the sub-processes of various process routes mentioned above
3. Waste heat recovery systems for moisture reduction and power generation
4. Utilization of renewable energy in specific process/plant/colony applications
5. Increased use of waste as alternate fuels
6. Increased scrap utilization
7. Improving quality of coke and coal before its use in the industry
8. Low carbon captive power generation

Ministry of Steel and Department of Industrial Policy and Promotion need to work together and evolve a suitable policy framework so that progress along the above dimensions is incentivized to improve the efficiency of iron and steel industry in our country.

3.2.2 Cement sector

Current Status

The cement industry in India has been growing at a strong pace with an average annual growth rate exceeding 8 percent for the past three decades. The total production in 2007 was 165 million tonnes up from 67 million tonnes in 1995. India is the second largest cement producer in the world; second only to China (Assocham and E&Y, 2011). Its per capita consumption in 2008 was approximately 150 kg, which is almost a third of the world average, half that of the US, and one-seventh that of rapidly-industrializing countries such as China and South Korea.

As of March 2009, Indian cement industry comprised of 148 large cement plants and 365 mini-cement plants, with installed capacities of 219 MT and 11 MT respectively. Indian cement industry, the largest consumer of power among the industry, has managed to attain efficiencies comparable to the best in the world.

Energy and Emissions

In 2007-08, the specific energy consumption (electricity) and fuel usage for cement manufacturing was 75kWh/ton and 3.3 GJ/MT respectively. The corresponding emission intensity stood at 0.8 tCO_2/t cement resulting in total mission of 132 mTC_2 in the same year. The production of cement has increased by 146% from 67 mT in 1995 to 165 mT in 2007, while over the same period, total energy consumption has increased by 108 % from 262 PJ to 545 PJ. Specific Energy Consumption has reduced from 3.89 GJ/T in 1995 to 3.3 GJ/T in 2007, which implies the cement industry is reducing its energy intensity by about 1.5 % every year. Figure 5 and Figure 6 depict the total energy consumption, total emissions, and specific energy consumption and emission reduction trends for the cement sector in our country.

Figure 5: Historical trend of total energy consumption (in PJ) and SEC (GJ/ton) in the cement industry. (*Source: PCRA, 2009; CMA, 2006)*

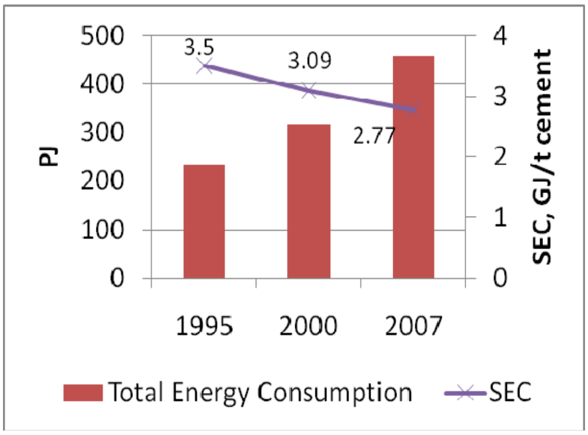
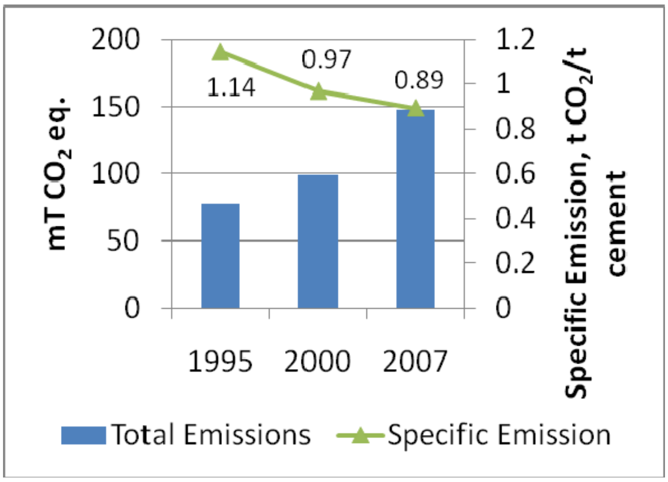


Figure 6: Historical trend of total emissions (mT CO2. eq.) and specific emission (T CO2/T cement) in the cement industry



(Source: CMA, 2010)

Major Process Routes and Products

The cement industry comprises mostly of dry suspension pre-heater and dry-pre-calciner plants, and a few old wet process and semi-dry process plants. The average installed capacity per plant in India is about 1.2 million tons per annum (MTPA) as against more than 2.1 MTPA in advanced countries like Japan. Production from large plants (with capacity above 1 MTPA) accounts for 88% of the total production.

Three types of cements are produced in India: the Portland Pozzolana Cement (PPC), which has the maximum share of the total production (67%), followed by Ordinary Portland Cement (25%) and Portland Slag Cement (8%). Blended cement[3] is another form of cement which is very popular in India.

The production mix in the Indian cement industry is characterized by a large proportion of blended cement (which consumes less energy and is less emissions intensive than ordinary Portland cement). Although the market share of blended cement in India at 75 percent is much higher than US (4 percent), China (40 percent), Japan (25 percent) (2005 data); the percentage of blending material could improve further. Most PPC cement plants use fly ash to the extent of 20%-30% even though the Bureau of Indian Standards permit usage of up to 35% (Assocham and E&Y, 2011).

Projections of Power, Energy and Emissions

By 2020, the total cement production could reach 500 mT assuming an average GDP growth rate of 8 percent.

In this sector, reduction in energy consumption is primarily attributed to reduction in energy intensity, and the Expert Group has estimated that emission intensity could further reduce by 13 to 16 percent by 2020 over the 2007 levels in the determined to aggressive effort scenarios

Policy and Measures

From a policy planning perspective, there are a number of measures that could provide the pathways for the reduction of emissions intensity in the Cement Sector in the near future. They include:

1. Diffusion of energy efficient technologies in various sub processes of cement manufacture.
2. Waste heat recovery systems for moisture reduction in coal and raw materials and for power generation.
3. Utilization of renewable energy in specific process/plant/colony applications.
4. Increased use of waste as alternate fuels, rationalizing the various policies that regulate this activity.
5. Increased blending using fly ash from thermal power plants and granulated blast furnace slag from steel plants, and the increased use of composite cements.

[3] Clinker mixed with fly ash or slag is termed as blended cement.

6. Improving quality of coke and coal before its use in the industry
7. Low carbon captive power generation
8. Increase of blended cements in the public procurement process.

Department of Industrial Policy and Promotion needs to evolve a suitable policy framework to incentivize full realization of the potential offered by above measures in the cement industry.

3.2.3 Energy Efficiency Interventions in the Industry

PAT Mechanism Overview

Perform-Achieve-Trade (PAT) is a market based mechanism under the National Mission for Enhanced Energy Efficiency (NMEEE) within the Prime Minister's National Action Plan for Climate Change (NAPCC). The aim of PAT, as mandated by NMEEE, is to improve cost effectiveness and enhance energy efficiency in energy-intensive large industries through certification of energy savings that could be traded. The Ministry of Power (MoP) has in March, 2007 notified industrial units and other establishments consuming energy more than the prescribed threshold in 9 industrial sectors namely Thermal Power Plants, Iron & Steel, Cement, Pulp and Paper, Textiles, Fertilizer, Chlor-Alkali, Aluminium and Railways. The industries notified are referred to as Designated Consumers (DCs). Table 4 below provides the details.

Table 4: Sector specific minimum annual energy consumption per DC and estimated number of DCs. (*Source: BEE, 2011)*

Sector	Minimum annual energy consumption for the DC (tonnes of oil equivalent)	Number of probable DCs.
Aluminium	7,500	11
Cement	30,000	83
Chlor-alkali	12,000	20
Fertilizer	30,000	23
Iron and Steel	30,000	101
Pulp and Paper	30,000	51
Railways[4] (diesel loco workshops)		8
Textiles	3,000	128
Thermal power plants	30,000	146

PAT Framework

The PAT framework has been developed considering the legal requirement under Energy Conservation Act, 2001 and situation analysis of designated consumers. The PAT framework includes the following elements:

[4]Railways have 8 DCs as per the notification of MoP. As the sectoral energy scenario and energy usage pattern is under study by BEE, these DCs have been excluded from the first cycle of the PAT scheme.

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

The first PAT cycle will be covered in three years (2012-15). In the first phase, the energy intensive DCs (as depicted in Table 1) are assigned individual SEC targets and are allotted a three year time period to accomplish it. The Monitoring and Verification (M&V) is carried out from the second year onwards. After the completion of M&V, energy saving certificates will be issued and trading will be permitted (BEE, 2011).

In the next cycle(s) of PAT scheme (post 2015-16), the number of DCs may get revised as more plants and sectors could be added. Petroleum refineries, petrochemicals, gas crackers/naphtha crackers, sugar, chemicals, port trusts, transport (industries and services), hydro power stations, electricity transmission and distribution companies, and commercial buildings and establishments are some of the probable list of DCs that could be added in the second PAT cycle (BEE, 2011).

Rationale and Target Setting

The DCs of the eight sectors account for about 231 mMTOE (million metric tonnes of oil equivalent) of energy consumption annually as per the 2007-08 data, which is about 54 percent of the total commercial energy consumed in the country. The target under the scheme will be defined in terms of the percentage reduction of SEC from the baseline value.

The methodology of establishing SEC reduction for each Designated Consumer is on a gate-to-gate[6]basis and will be such as to achieve the targeted savings in the first commitment period of 3 years (2012-2015), which is estimated at 10 million metric tonnes of oil equivalent (mMtoe), which will amount to 4.2 percent energy intensity reduction in three years. Further, the overall target reduction of 10 mMtoe would be apportioned amongst identified sectors in proportion to their relative energy use. The breakup of energy consumption and the apportioned energy reduction of each sector are depicted in Table 5 (BEE, 2011). Ministry of Power notified the energy savings in the Gazette of India on March 30, 2012. As per the notification, the numbers

[5]Specific Energy Consumption is defined as the ratio of energy consumed to the total quantity of output produced.

[6] Gate-to-gate SEC is computed by considering all forms of energy entering the plant boundary and the sum of all the products leaving the plant boundary. The measure of energy intensity or SEC, based on this gate-to-gate concept, is the ratio of the total energy entering the plant to the total amount of products leaving the plant.

have been revised downwards and the overall energy savings in the first cycle of PAT would be 6.6 Mtoe.

Table 5: Initial estimate of energy consumption and energy reduction targets

Sector	Energy Consumption in 2007 (mMtoe)	Share of Consumption in 2007 (%)	Apportioned energy reduction by 2015 (mMtoe)over 2007 levels	Number of probable DCs
Aluminium	2.42	1.05%	0.11	11
Cement	14.47	6.25%	0.6	83
Chlor-alkali	0.43	0.19%	0.02	20
Fertilizer	11.95	5.16%	0.51	23
Iron and Steel	36.08	15.58%	1.56	101
Pulp and Paper	1.38	0.60%	0.06	51
Textiles	4.5	1.94%	0.2	128
Thermal power plants	160.3	69.24%	6.92	146
Total	**231.53**	**100%**	**10.00**	**563**

The PAT scheme is an energy intensity type Cap and Trade scheme as it does not place an absolute cap on the total energy consumption in the industry. Some people argue that a simpler alternative, for achieving energy efficiency, and for mobilizing finances with greater certainty, would be to implement a Carbon Tax scheme. Both approaches have their own advantages and disadvantages. These are compared in the section below.

Cap and Trade vs Carbon Tax

Cap-and-trade programs often are designed to achieve greater reductions over time, so the cap may be lowered in subsequent years to enable market participants achieve emission reductions gradually. To achieve compliance with the capped emission level, market participants are allocated allowances to emit (1 ton per allowance) with the total number of allowances summing to the level of the cap. Market participants can purchase allowances from other participants to cover excess emissions, or sell allowances if they reduce emissions below their allocation. Such trading increases economic efficiency.

A carbon tax is an alternative to a cap-and-trade. It could be called by other names like cess, surcharge, levy etc. Although both policies generate a carbon price signal, there is a fundamental difference in the way in which the level of this carbon price signal is determined under these two regimes. A carbon tax fixes the price of c and allows the quantity of emissions to adjust in response to the level of the tax. In contrast, a cap-and-trade system fixes the quantity of aggregate emissions and allows the price of CO2 emissions to adjust to ensure the emissions cap is met (Stavins, 2008). UK's Climate Change Levy (CCL) and Australia's Clean Energy Package are examples of carbon tax.

Table-6 below summarizes the advantages and disadvantages of each mechanism (Yale Environment 360, 2009):

Cap and Trade	Carbon Tax
It sets a steadily declining ceiling on carbon emissions, and, by creating a market that rewards companies for slashing CO_2 (corporations that reduce emissions below their allotment can sell them on the open market), it uses the free enterprise system to achieve emissions reduction.	Uncertainty about how much it will reduce carbon emissions. However, tax linked to benchmarks of energy or emissions intensity can help improve certainty with respect to mitigation.
It does not provide cost certainty as price of permits fluctuates and could be highly volatile in the spot market.	Carbon Tax provides cost certainty by setting a clear price on carbon emissions for many years ahead.
It needs a market monitoring agency to examine issues such as rent seeking, cornering the market etc.	It's simple to understand and implement
The design leaves out many small and medium organizations (who together may release significant portion of the emissions)	Carbon Tax covers the entire economy, including automobiles, household use, and other units impossible to reach in cap-and-trade.
The revenues are likely to be bargained away well before the first trade ever takes place	Carbon Tax raises a clear amount of revenue, which can be used for targeted purposes or rebated to the public.
It can be more easily manipulated to allow additional emissions; if the permits become too pricey, regulators would likely sell or distribute more permits to keep the price "reasonable".	The chances of manipulation are remote. The structure of the tax doesn't allow periodic regulator intervention.
The long-term signals from cap-and-trade are less powerful, and the behavioural changes (e.g. choice of the type of power plant) could turn out to be far fewer.	Clear signals and impetus for behavioural changes
Political pressures could lead to different allocations of allowances, which affect distribution, but not environmental effectiveness and cost effectiveness	Political pressures could lead to exemptions of sectors and firms, which reduces environmental effectiveness and drives up costs.
It will be a difficult process to adopt different international allowances and make it at par with the domestic allowance.	Carbon-taxing nations can easily offset import price differences with a "border tax adjustment."
The setting of the price (in an open market) could be very opaque.	The process is more transparent and trustworthy.
One of the immediate consequences are the design of financial and legal instruments	This directly rewards innovation in engineering.

Foundations of a New Policy Initiative for the Indian Industry:

Global trends in energy and environment are likely to have a major impact on the profitability of Indian industry; and also on the larger goal of energy and strategic security for the country. It is essential to design and set up policy mechanisms to minimize this impact. The existing National Mission on Enhanced Energy Efficiency (NMEEE) has been designed to deal with energy efficiency and emission reduction issues of a relatively small number of very large industries, which contribute significantly to the emissions. Many of the provisions of NMEEE such as the strong baseline, monitoring & verification, penalty and trading mechanisms are not easily extendable to the large number of small and medium units. Some recent studies (Krishnan, 2012) have, however, emphasized the need for developing a strong framework for increasing awareness and facilitating funding for technology up-gradation of the small and medium enterprises.

India is experimenting with both cap and trade in the form of the PAT Scheme and a Carbon Tax in the form of a cess on coal (Rs. 50 per tonne). Both are in early stages of implementation. While the cap and trade mechanism has greater certainty in emissions reduction, as a tool for financing they face greater uncertainty. Carbon tax mechanisms, on the other hand, can provide greater certainty as a source of financing; while the uncertainty on emissions reduction can be brought down by using energy or emission intensity benchmarks.

Studies on the demand side management of energy consumption have shown pay back periods to be in the range of 2 to 8 years. Yet firms do not take up such measures on their own. The major barriers are perceived risk, uncertainty about technology, costs of disruption and initial financing. What is needed is a mechanism to insure risk and assure finance at reasonable terms. The need is being felt for setting up a special fund with seed capital that will be managed at an arm’s length from the Government with the participation of the private industry.

While the PAT should continue to evolve, it would be useful to envisage a combined Energy Efficiency Package - consisting of the PAT Scheme and an Energy Efficiency Levy, to be implemented by a unified central agency, like the Bureau of Energy Efficiency. The energy levy should be small (unless the cross-subsidy on power is brought down significantly) and collected from the consumer of energy. It could be used to establish a ‘Carbon Trust’ or an ‘Energy Efficiency’ Fund managed by the Bureau of Energy Efficiency. It is pertinent to mention that Levy, unlike Cess, need not be deposited in the government account. The collections from the Levy could be supplemented by international funding, as well as block grants from the Central Government through the National Clean Energy Fund. The Fund could be used to leverage and/or finance energy efficient technology up-gradation of the domestic industry on terms softer than commercial borrowing. Since Energy Levy is simpler to implement than the PAT scheme, smaller industrial units would find it particularly useful. An integrated Energy Efficiency

Package of this kind, along with its legal framework, needs to be carefully evolved over the Twelfth Plan period. The final report of the Expert Group will delve into greater detail on this.

3.3 Transport

3.3.1 Vehicle Fuel Efficiency Program

The number of vehicles in India grew at about 10 percent per annum between 2004 and 2009, with passenger cars growing slightly faster than two wheelers. Passenger and freight activity by road have also increased correspondingly, growing at about 15 and 6 percent p.a. respectively between 2001-02 and 2005-06, the last year for which data is available[7]. In turn, fuel consumption has increased, as indicated by the 10 and 8 percent p.a. increase in petrol and diesel consumption respectively over the 11th Plan. The fact that India's net petroleum imports were about 85 percent of its consumption in 2010-11, is a matter of concern[8]. GHG emissions from the transport sector have also grown at 4.5 percent p.a. between 1994 and 2007[9]. Therefore, in addition to ensuring that automobiles pay for their full externalities such as congestion, pollution and reduced safety; India needs to urgently introduce fuel efficiency norms for the automobile industry to address both energy and climate challenges. Countries such as the US, Canada, Japan and the EU have already enacted such fuel economy legislations.

Framework of fuel efficiency norms

Fuel efficiency norms can be defined within a 'standards and labelling' framework. Vehicle labelling is a demand side measure to enable consumers to take an informed decision while purchasing a vehicle, whereas fuel efficiency standards are supply side measures for manufacturers to adhere to.

Vehicle labelling

Vehicles should carry prominent labels similar to those made popular by the appliance labelling scheme introduced by the Bureau of Energy Efficiency (BEE). These labels should give the consumer sufficient information about the relative efficiency of the vehicle to enable him to make an informed choice. It must contain the following:

- The fuel efficiency of the vehicle (in litres/100 km) as determined by an approved test mechanism,
- Its star rating, on a 1 to 5 scale, as compared to other vehicles of the same type and in the same (weight) category and
- A pointer on a band indicating the fuel efficiency position of this vehicle among all vehicles of the same category

[7] Source: Road Transport Year Book 2006-07 and 2007-09, Ministry of Road Transport and Highways
[8] Source: Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas
[9] Source: India Greenhouse Gas Emissions 2007, Ministry of Environment and Forests

Fuel Efficiency Standards

Given the relatively smaller size of the average Indian vehicle, the Indian vehicle fleet is among the most fuel efficient in the world. The fuel efficiency standards should ensure that this characteristic of Indian vehicles is encouraged and preserved. Some measures are suggested below:

- The standards should be applicable to all vehicles sold in India – whether manufactured domestically or imported.

- Ambitious efficiency improvement programs, such as Japan's "top runner" program define efficiency standards based on the best performers in the industry[10]. However, given the efficiency levels of the Indian fleet; Indian standards may be derived considering the average efficiency of the global vehicle fleet of a given type, the best performer and the average efficiency of Indian fleet.

- The standards must ensure that Indian vehicles retain their global fuel efficiency advantage and remain among the most fuel efficient in their class. It should be noted that the average efficiency of passenger cars in India improved by 3 percent p.a. between 2006-07 and 2009-10, in spite of an increase of 2 percent p.a. in average kerb weight of cars sold in that period[11]. This is comparable to the rate of efficiency improvement proposed in the EU and South Korea[12].

- There has been a tendency for vehicles to get heavier without a corresponding increase in capacity, as seen in the 2 percent p.a. increase in average kerb weight of cars sold in India. This is not a desirable trend as it leads to increased fuel consumption without additional benefits. Therefore, standards must contain an explicit disincentive against up-weighting of vehicles. This can be achieved by making the standards not linear, but a sub-linear function of the vehicle weight, as indicated in the figure below. As can be seen from the dotted lines, in the sub-linear case, the permitted fuel efficiency loss for a given increase in vehicle weight is lower at a higher weight as compared to the permitted loss at lower weight levels. Additional disincentives for up-weighting of vehicles, such as fiscal measures, should also be discussed.

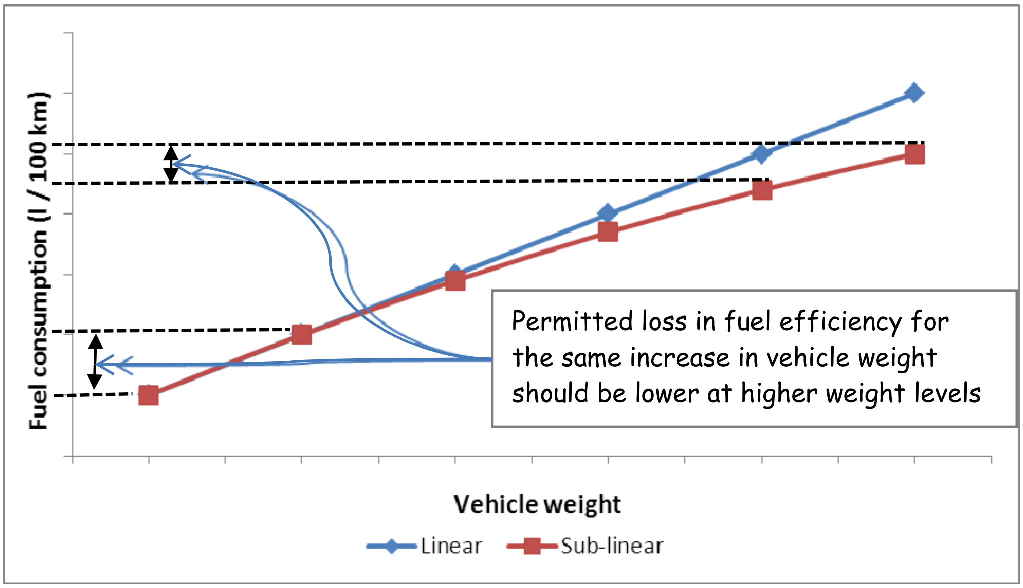
- There should be stringent fiscal penalties for non-compliance to these standards.

[10] Source: Top runner program: Developing the world's best energy efficient appliances, Ministry of Economy, Trade and Industry, Government of Japan

[11] Source: Consultation paper on proposed fuel efficiency norms published by Bureau of Energy Efficiency, Ministry of Power

[12] Source: The International Council for Clean Transportation

Figure 7



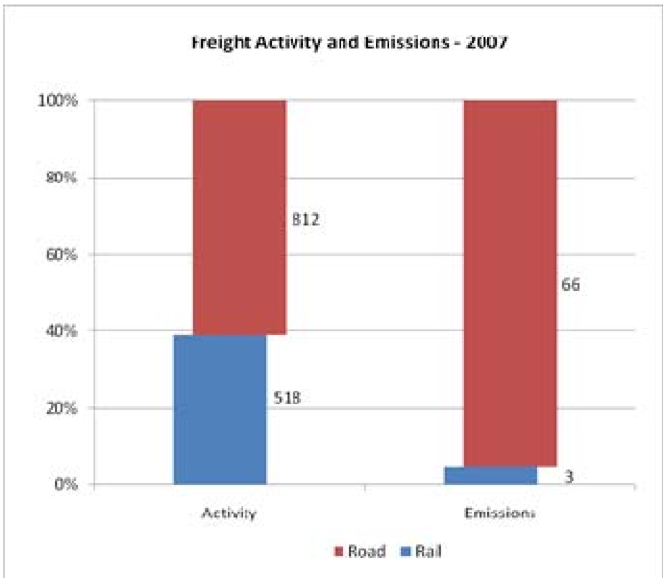
- The Bureau of Energy Efficiency (BEE) has already proposed a fuel efficiency scheme for passenger cars, and sought feedback on the scheme at a public consultation held on 1 November 2011. Given the rapid rate of growth of vehicles in the country, this process needs to be expedited. Some suggestions on further course of action are as follows:
    - BEE is in the process of publishing an alternative proposal based on the inputs received. This should be followed by another round of public consultations to ensure that significant concerns are addressed. It should then notify the norms, say, by September 2012.
    - Consumption of diesel by heavy commercial vehicles (buses and trucks) is considerably more than the fuel consumption of cars and two wheelers. Therefore, norms must be defined for these vehicles also at the earliest – say, by end 2012.
    - Two wheelers account for about 70 percent of the vehicle sales as well as vehicle fleet in the country. Therefore, norms must soon be defined for them also.
    - The definition of fuel efficiency norms must not only be expedited, but also be based on public consultations with all stakeholders including the citizens groups and the automobile industry.
    - A clear cut policy should be put into place for encouraging electric vehicles, including facilities for recharging.

3.3.2 Improving the Efficiency of Freight Transport

India's growing economy has resulted in increased demand for movement of freight in the country, with freight movement increasing roughly in proportion to the GDP. This has resulted in a corresponding increase in energy consumption and GHG emissions from freight transport. In order to improve the efficiency of freight movement, it is necessary to devise policy instruments to incentivize modal shift to the more efficient modes of freight transport.

Freight is predominantly carried by rail and road in India. Of these, rail freight is significantly more energy efficient, with the energy intensity of rail freight in India being 0.18 MJ / ton-km and the intensity for road freight being 1.6 MJ / ton-km – a *nine-fold* difference. This is also reflected in the GHG emissions from the two modes. As can be seen in Figure 8, though rail carried 40% of the freight, it contributed only 5% of the emissions from freight, while road freight resulted in 95% of the emissions while carrying only 60% of the freight.

Figure 8: Freight activity (billion ton-km) and GHG emissions (million tonnes) in 2007[13]

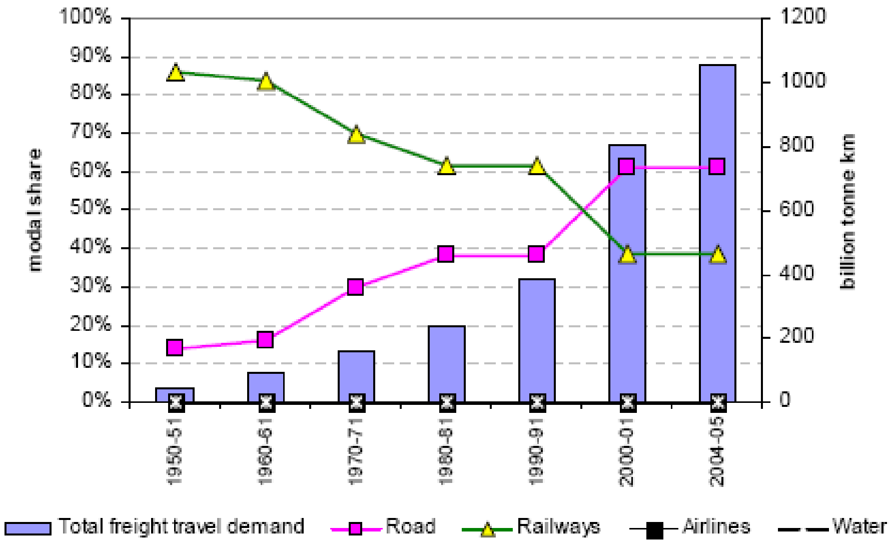


However, as shown from Figure 9, the share of rail in total freight carried has steadily deteriorated from about 88% at independence to about 40% currently, while the share of road freight has increased correspondingly. Such a change in freight modal share not only increases the country's GHG emissions, but also has other impacts:

[13] Source: *Interim report of the expert group on low carbon strategies for inclusive growth,* Planning Commission, 2011

1. It hurts the country's energy security as road freight is powered by diesel, and India imports over 80% of its petroleum requirements
2. It worsens the balance of payments situation due to increased imports
3. It worsens the fiscal deficit given that diesel is a subsidized fuel in India
4. It worsens local air pollution in the form of tail-pipe emissions from the trucks

Figure 9: Modal share of freight transport in India[14]



Therefore, there is a clear need for policy instruments to incentivize movement of freight by rail. As a principle, railways (which are more capital intensive) should be the major freight mode along the major corridors, while road (with its greater reach and flexibility) should be the preferred mode from the 'spine' to the interior parts of the country. There is also a feeling that road freight in India is not as efficient as it could be and this also needs to be addressed. Movement of freight by waterways (inland or coastal) is more efficient than even railways and this should be further explored. These points are elaborated below.

Increasing the share of rail freight in India

India's Integrated Energy Policy of 2006 recognizes that there should be an increased role for railways in carrying freight in the country. Enabling such a transition requires the following actions:

1. **Dedicated freight corridors (DFC):** The Government of India initiated the DFC project by setting up a special purpose vehicle called DFCCIL in 2006. The DFC project is expected to result in over 10,000 km of dedicated rail routes over six key corridors connecting India's four largest cities. The first phase of two corridors is expected to be completed

[14] Source: *Transport and Energy: The challenge of climate change*, S. Sundar and C. Dhingra, International Transport Forum workshop on transport CO2 in emerging economies, Leipzig, May 2008

by 2016-17. These corridors would be built with modern technology supporting higher axle loads, greater train lengths and speeds etc., thus further improving efficiency and reducing GHG emissions. However, work on these corridors is behind schedule. The Government needs to use all its energies to ensure this is completed as soon as possible.

Funding for the first two phases of the DFC program, expected to cost around Rs. 80,000 crore, has been tied through financing from the World Bank and JICA. As the remaining four corridors are expected to cost an additional Rs. 1,70,000 crore – about 2% of India's GDP in 2011-12 – Government of India may wish to consider seeking international climate finance assistance for this project as it would significantly help reduce GHG emissions from the country's transport sector.

2. **Improving efficiency of Indian Railways:** Freight transport by railways is also hampered by other inefficiencies, and these should be addressed. Many committees, including the recent committee led by Mr. Sam Pitroda, have provided recommendations on how overall efficiency of Indian Railways can be improved. From the perspective of freight in particular, the railways must provide time-tabled freight services, develop multi-modal logistics parks, support container traffic and improve operational efficiency.

3. **Fiscal support:** Railway freight also suffers from a few fiscal disadvantages. Freight transport on railways also cross-subsidizes passenger transport, further hampering it. Such cross-subsidy should be eliminated and passenger transport subsidy should be provided directly from the general budget to make them transparent like the power tariffs. A tariff regulator must be set up for the Railways without any delay.

Improving the Efficiency of Road Freight

Road is expected to play an important part in freight movement even after a modal shift to railways. Therefore, there is a need to ensure that road freight performs as efficiently as possible. There is a perception that current road freight is inefficient because of reasons such as sub-optimal utilization of trucks, inefficient border crossing, toll regimes, insufficient use of multi-axle and tractor-trailer trucks, and lack of hub-and-spoke like arrangements for efficient dispersal of heavy loads onto smaller trucks for last mile connectivity. The Transport Policy Committee needs to further investigate these bottlenecks and suggest solutions to overcome them.

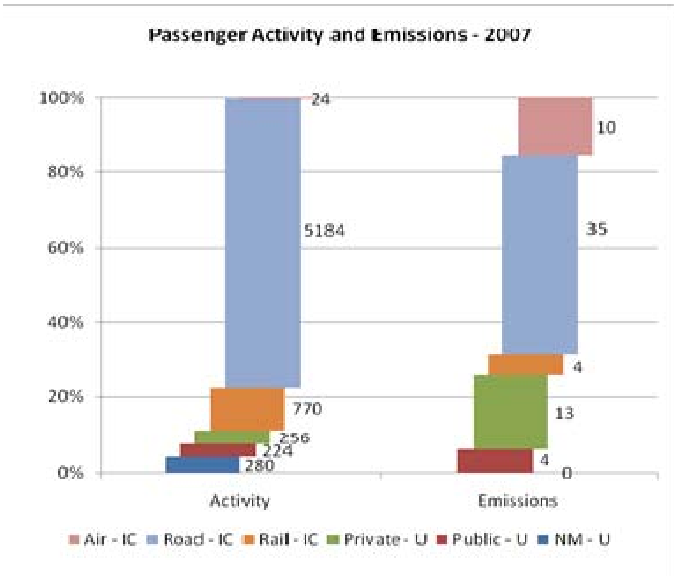
Water-borne freight

Freight carriage by waterways – both inland and coastal – is the most efficient form of freight transport. Though India has a long coastline and about 15,000 km of inland waterways, the share of water in freight transport is negligible at about 0.3 percent. In contrast, water transport occupies about 6 percent of the freight modal share in Europe. There is considerable room for improvement in this regard, and Government of India must initiate a serious study of how this potential can be maximized without affecting other uses of the water or waterways.

3.3.3 Improving Urban Public and Non-motorized Transport

Our need for mobility has been growing rapidly. Official data indicates that passenger-km travelled by Indians is increasing at a rate of about 15 percent per annum[15]. Consistent with this, automobile sales in the country are increasing around 10 percent per annum. From an emissions perspective, this indicates rapid growth of emissions from the passenger transport sector, since most of the transport is powered by petroleum products. Further, such an increase of transport activity has also results in increased imports, since India's net import dependence for petroleum products is about 80 percent. Given India's energy insecurity and balance of payment problems, there is a need to move transport in a more efficient direction so that mobility needs of our citizens are met with a lower consumption of fossil fuels.

Figure 10: Passenger transport activity and emissions, 2007[16,17]



[15] Source: Ministry of Road Transport and Highways, Year book 2006-07

[16] Sources: Ministry of Road Transport and Highways, Year book 2006-07, Directorate General of Civil Aviation, Indian Railways, Ministry of Petroleum and Natural Gas and *Study on traffic and transportation policies and strategies in urban areas in India,* Ministry of Urban Development, May 2008

[17] NM-U: Non-motorized transport (Urban), Public-U: Public transport (urban), Private – U: Private transport (Urban), Road – IC: Road transport (inter-city), Rail – IC: Rail transport (inter-city, assumed), Air - IC: Air transport (inter-city). Discrepancies in data from different sources results in inter-city road transport's activity share being shown higher than its emission share, though its emission share is likely to be more than its activity share (with public transport's emission share being correspondingly lower).

The figure above depicts passenger transport activity and emissions in 2007. The important points to note are:

1. Only 4 percent of the total passenger transport activity is by private automobiles in cities, but they contribute about 20 percent of passenger transport emissions.
2. Air transport supports only 0.4 percent of total passenger transport, but contributes 15 percent to emissions from it.
3. Non-motorized transport supports 4 percent of passenger transport activity in the country without causing any emissions at all, while rail supports 11 percent of activity with just 5 percent of emissions.

This indicates that way forward should include promoting non-motorized and public transport in cities, and rail for inter-city passenger travel, while discouraging the use of private vehicles in cities, as well as inter-city air transport. This will have important co-benefits, such as:

a) Making mobility more inclusive since the promoted modes are typically cheaper than those they displace
b) Improving the country's energy security
c) Reduce air pollution in the country's cities, towns and villages
d) Reducing congestion on our city roads and
e) Improving road safety since studies show that public transport modes have lower per passenger-km fatality rates than private transport modes

We should focus on policy instruments to encourage greater use of public and non-motorized transport in India's cities and towns, while discouraging the use of private motor vehicles. Official projections show that the current trend is exactly the opposite, as public and non-motorized transport is losing their share to private motorized vehicles. Hence, there is an urgent need to introduce and implement such policies. However, as urban transport is a state subject, the levers available with the Union Government are limited; and it is the state governments and urban local bodies which have an important role to play in realizing the transformation objective described above. The Government of India can, however, adopt the following policy instruments to further these objectives:

Improving JNNURM

Recognizing the importance of urban governance and planning, the Government of India introduced the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) on a pilot basis in 2007, where it linked funding to reforms in urban governance. Though the mission document stated that urban transport projects under JNNURM would be funded only if they conformed to the National Urban Transport Policy (NUTP), which prioritized public and non-motorized transport; in reality, JNNURM funded more projects that benefit private vehicles rather than public or non-motorized transport. Another weakness of the current JNNURM set-up is a weak monitoring and verification framework. Therefore, there is a need to ensure that funding for urban transport under the proposed New Improved JNNURM, includes the following:

1. JNNURM already requires that cities prepare Comprehensive Mobility Plans (CMPs) to address their mobility needs. The new JNNURM should provide for a centrally appointed expert committee which can evaluate CMPs to make sure that they conform to National Urban Transport Policy. If not, it should evaluate various alternatives and propose a reformed plan.
2. JNNURM should only fund projects that are selected from approved CMPs.
3. JNNURM should engage with local civil society stakeholders in cities to continuously and actively monitor the implementation of projects funded by it.
4. JNNURM funding should also be contingent on cities defining quantifiable urban transport goals (perhaps based on the service level benchmarks being defined by the Ministry of Urban Development), which should be measured by experts and published on a yearly basis.

Supporting Public Transport

Most urban bus utilities in the country are financially unviable, and a significant part of their financial burden is due to capital expenditure (to buy buses) and taxes. Some studies[18] suggest that these expenses – including various taxes on fuel – form about 20 percent of the total expenditure of a bus utility, and that these are comparable to or higher than taxes on private vehicles. Such taxation policy is clearly contrary to the objective of promoting public transport and discouraging private transport. Government needs to revisit its taxation policy of vehicles and ensure that tax burden on bus utilities is considerably lowered. It could also consider refunding fuel taxes collected from the bus utilities.

Urban Planning and Governance

Urban Local Bodies (ULBs) in India currently do not have the capacity to deal with the challenges posed by rapid urbanization. As a result, presently, the urban planning in the country does not go beyond land use, and simply does not take an integrated view of multiple services including transport. This needs to be addressed urgently and capacities of ULBs (and related bodies such as metropolitan planning committees and regional development authorities) need to be strengthened to enable preparation of an integrated transport plans for each city in the country[19].

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[18] See *"Urban public transport systems: Are the taxation policies congenial for their survival and growth"* by P. S. Kharola and Geetam Tiwari, Economic and Political Weekly, October 11, 2008

[19] For example, the *"Report on Urban infrastructure and services"* by the High Powered Expert Committee set up by the Government of India

3.4 Lighting, Labelling and Super-Efficient Equipment Programme

Lighting and appliances (such as refrigerators, air conditioners, water heaters, fans etc.) account for about 10 percent of the total electricity consumption in India, which was estimated to be 68 billion kWh in 2010-11. With rising incomes and increasing penetration of appliances in households, the demand for electricity for lighting and appliances is expected to rise to 155 billion units by 2016-17. Over the 11th Plan period, the standards and labeling programme of the Bureau of Energy Efficiency (BEE) has enabled consumers to identify and purchase more energy-efficient appliances. Labels have already been introduced for 13 appliances[20]. They have been made mandatory for 4 appliances, namely, frost-free refrigerators, room air conditioners, tube lights and distribution transformers. As a result of this programme, the average energy efficiency ratio (EER) of air conditioners sold in India increased from 2.2 in 2006-07 to 2.8 in 2011-12; and the average consumption of a 300 litre frost free refrigerator declined from 547 kWh per day in 2006-07 to 368 kWh per day in 2011-12. Overall, savings due to the standards and labelling programme avoided an installed capacity of over 7,500 MW during the 11th Plan period.

The BEE has tightened the labelling norms for refrigerators and air conditioners w.e.f. 1st January, 2012, and has notified a second tightening of norms to come into effect from 1st January, 2014. As a result of these interventions, a further 30 percent reduction in the average energy consumption of refrigerators and air conditioners is expected by 2016-17, as compared to those sold in 2011-12.

Table-1 below provides an estimation of the electricity savings from various appliances in the market. While the actual savings may be different due to changes in assumptions underlying sales projections, the list of the top five appliances that contribute about 85 percent of the total savings does not change from that shown in Table-1. Of the five appliances, while refrigerators and air conditioners have already effectively adopted the BEE's standards and labelling programme; a greater emphasis is needed for enhancing the efficiency of lighting appliances, motors and fans.

[20] Labels have been introduced for TFLs, Room Air Conditioner, Frost Free Refrigerators, Distribution Transformers, Direct Cool Refrigerators, CTV, Storage Water Heaters, Agriculture Pumps, Induction Motors, Washing Machines, LPG Stoves, Laptops and Ceiling Fans

Table 1: Estimated Energy Savings due to Electrical Appliances in the 12th Plan

	Current Market Size (2007)	Expected Annual Growth Rate (2007-2020)	Units Sold Cumulatively (between 2014-2020, both included)	Post 2014 Stock Surviving in 2020	Avg power consumption (W)	Total Annual Electricity Consumption (in MWh)	Energy Saving Potential (in % terms)	Total Energy Savings Potential (in GWh)
Refrigerators	5,150,000	10.0%	95,212,234	92,444,456	300	124,208,520	30%	37,263
Motors	2,000,000	10.0%	36,975,625	35,900,760	7500	673,139,244	5%	33,657
Air Conditioners	2,253,000	15.0%	66,323,602	64,579,520	1641	152,603,989	15%	22,891
Colour Televisions (CTVs)	13,500,000	15.0%	397,411,730	328,431,475	120	86,311,792	25%	21,578
Lighting - (TFLs+CFLs)	130,400,000	12.0%	2,908,388,221	713,996,050	29	36,235,300	40%	14,494
Chillers	7,182	15.0%	211,423	205,863	98000	40,349,215	30%	12,105
Lighting - (TFLs+CFLs)	195,600,000	12.0%	4,362,582,331	1,070,994,074	29	54,352,949	15%	8,153
Ceiling Fans	4,000,000	11.0%	81,246,576	80,387,618	65	15,675,586	50%	7,838
Central AC and Heat Pump (5-15 Ton)	86,953	10.0%	1,607,571	1,560,839	8400	26,222,102	20%	5,244
Ceiling Fans	6,000,000	11.0%	121,869,863	120,581,427	65	23,513,378	20%	4,703
UPS	1,937,817	13.0%	47,433,986	43,865,644	140	42,988,331	10%	4,299
Computer Servers	293,233	20.0%	13,570,829	11,450,034	350	33,663,100	10%	3,366

In the area of lighting, a major shift has taken place during the last 10 years due to large scale replacement of incandescent bulbs by Compact Fluorescent Lamps (CFLs), which consume only 20 percent as much electricity as incandescent bulbs to produce the same amount of light. During 2011-12, the sales of CFLs in India exceeded 300 million; a 15 times increase as compared to the sales in 2002. However, incandescent bulbs continue to be used primarily in households where the higher first-cost of CFLs continues to be a barrier. The Bachat Lamp Yojana (BLY) provided an innovative business model to sell CFLs to households at the same price as incandescent bulbs, the balance being recovered as carbon credits. However, a sharp decline in the price of carbon credits has effectively made this business model non-viable.

At the same time, the emergence of solid state lighting, based on Light Emitting Diode (LED), presents an opportunity for another quantum jump in lighting energy efficiency. LED-based lighting appliances (bulbs and tube-lights) are “super-efficient lights” in as much as they use only half as much electricity as fluorescent devices (CFLs and tube lights) to produce the same amount of light. However, their price is still much higher than those of CFLs; even though the price of a 5 W LED bulb (equivalent to a 10W CFL or a 50W incandescent bulb) declined from about Rs.1200 in June 2010 to Rs.550 in December 2011. Further price decreases are possible with increased sales volume. During the 12th Plan period, enhanced procurement of LED bulbs and LED tube lights could create the sales volumes necessary to bring down prices to levels where large scale penetration of LED lights in India would become a reality.

In a similar manner, “super-efficient fans”, which use half as much electricity as conventional fans, could be of great help in reducing electricity demand from this widely-used appliance in the country. The current sales of ceiling fans in India is about 30 million per year and most of them are rated at 70W. The penetration of five-star fans (which are rated at 50W) has been only 2 percent, reflecting the price sensitive nature of this market. During the 12th Plan period, development, introduction and market penetration of super-efficient fans, which are rated at 35 or less, will be promoted in a manner that boosts their sales volumes, while also making them affordable.

Motors are the fifth application where market transformation towards more energy-efficient motors could lead to large scale savings. Most of the motors are, however, sold to businesses (rather to end-consumers), who incorporate them into other products, such as pumps, fans, air conditioners, etc. Consequently, direct sales incentives for efficient motors may not be the most appropriate or efficient way of promoting their uptake. A more aggressive labelling programme that will help in selection of energy-efficient motors may be more effective. Branding of products containing efficient motors (for example “energy efficient motor inside”) could help inform the end-consumers about the energy efficiency of products they are buying.

During the 12th Plan period, the Super-Efficient Equipment Programme (SEEP) for super-efficient fans, LED bulbs and tube lights, seeks to incentivize the sale of these products to increase their volumes and bring down their prices for large-scale adoption. This “virtuous cycle” could be jump started though provision of a financial incentive for each super-efficient fan or light that is sold, that would help lower the price for end consumers and enhance sale volumes. This will provide confidence to manufacturers to invest in the development, manufacture and marketing of these products, which would otherwise find limited markets because of their higher price. The incentive should decrease with increasing volumes and reducing prices, till it is no longer needed. In terms of the transaction costs, it would be cost-effective to provide the incentive directly to the manufacturers, once third-party verification of sales volume has been carried out. However, performance standards for each of the super-efficient devices need to be put into place before the start of the programme, and periodic check-testing of the super-efficient products that are being sold needs to be carried out to the check conformance to these standards. The super-efficient equipment programme (SEEP) for lights and fans could result in savings of 6.06 billion units per year by 2016-17, and help avoid an installed capacity of 1,500 MW during the 12th Plan period.

3.5 Faster Adoption of Green Building Codes

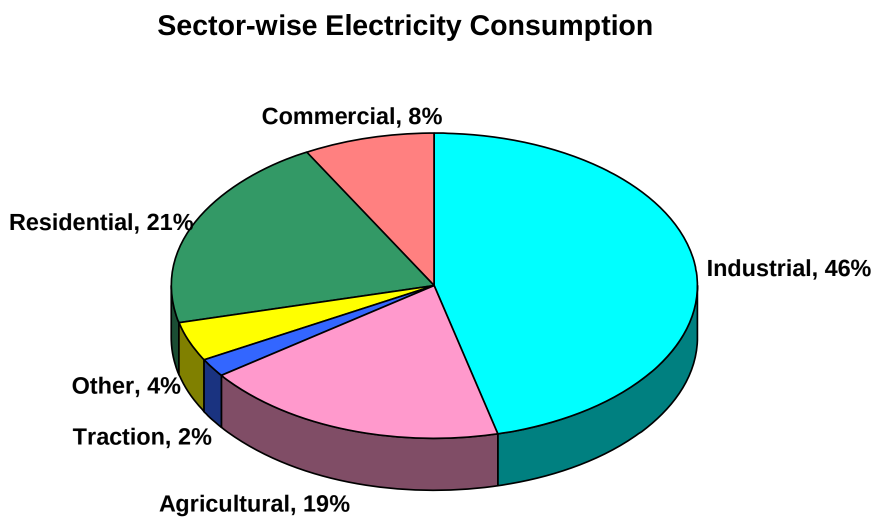
Introduction

We define the building sector to include residential and non-industrial buildings. The latter are called commercial buildings, which include offices, hospitals, hotels, retail outlets, educational buildings, government offices etc. Here we only deal with energy consumed in using these buildings. The energy embodied in construction of these buildings and structures is not considered.

Energy consumption in buildings offers a large scope for improving efficiency. The potential to reduce energy consumption through improvement in efficiency of appliances and equipment is already accounted for above. However, apart from this, buildings can be made more energy efficient by designs that reduce the need for lighting, heating, ventilation and air conditioning. We concentrate on savings in energy intensity that can be realized over and above what is possible through improvement in appliances and equipment.

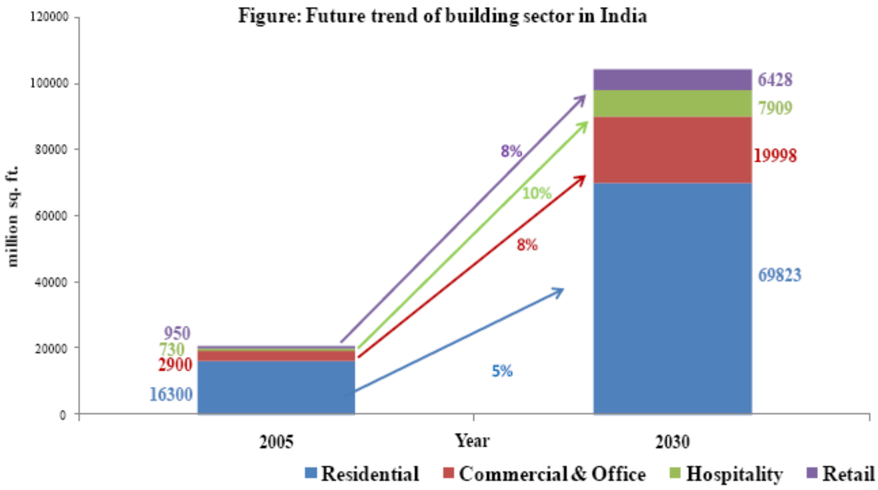
The sector-wise electricity consumption in India is shown in Figure 3.13.The residential and commercial buildings account for 29 percent of the total electricity consumption and this is rising at a rate of 8 percent per annum (CWF, 2010). Significant part of this goes into heating, cooling and lighting. In order to work out the likely opportunities to reduce emission intensity, we need to first project the likely growth in buildings of different categories. The energy demand by buildings will continue to grow with the growth of ITES and the hospitality sectors.

Figure 11: Primary electricity consumption in India



(Source: IEA, 2008)

Figure 12: Growth of Indian Building Sector



(Source: CWF, 2010)

The major growth in constructed area will be seen by residential and commercial sectors, as much as 4 to 5 times the constructed area in 2005 (CWF, 2010). The growth rates in hospitality and retail sectors are even higher, through their total areas are relatively small. Figure 12 above highlights the projected growth in the residential, commercial, hospitality and retail sectors.

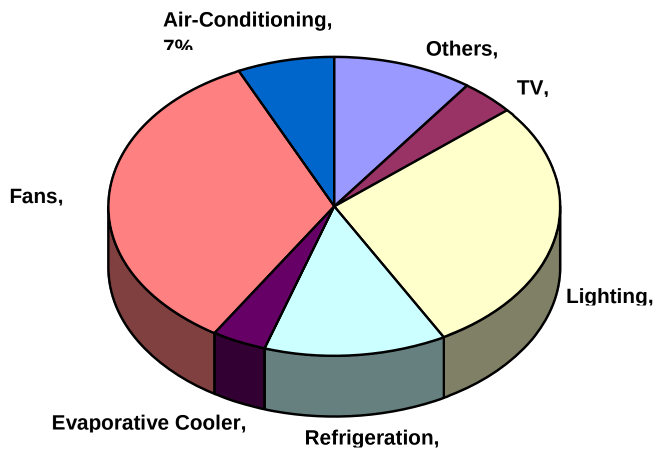
Residential Sector

Indian residential sector has witnessed phenomenal growth over the last fifteen years, primarily due to population increase, rise in income levels, growing urbanization, change in lifestyles and favourable public policies.

In 1961, the urban population of India was 78.9 million i.e. 18 percent of the total population. By 2011 it has reached 377.1 million, which is 31.2 percent of the total population. The urban populations are predicted to rise to over 600 million by 2031 (High Powered Expert Committee on Urban Infrastructure (2011)). This urban growth, combined with rapid growth in the economy, has put enormous pressure on housing requirements, urban infrastructure and other services.

The residential sector accounts for 21 percent of the total energy consumption[21] in India. The share of various energy consuming equipments in the residential sector is indicated in Figure 13 below:

Figure 13: Energy consumption distribution in Residential buildings



(Source: Bureau of Energy Efficiency, Government of India)

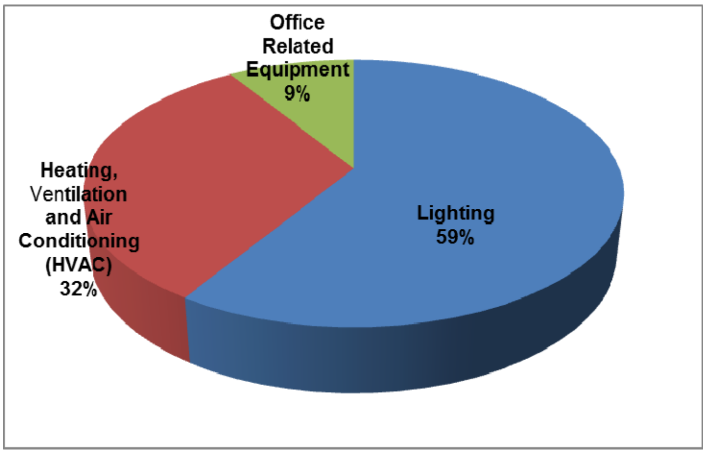
Ceiling fans and lighting constitute major energy use (62 percent) in residential buildings. The efficiency gains from the launch of the BEE energy labelling program for domestic appliances to enhance energy efficiency of these appliances has already been accounted for above. The gains from redesigning buildings, to reduce the load for heating and air conditioning, have not been accounted for. However, these would be small for residential buildings, and we do not estimate them here at this stage.

[21] Cooking is not included. This includes only electricity consumption in households.

Commercial Sector

The major energy consuming equipment in commercial sector are lighting (59 percent); heating, ventilation and air conditioning (HVAC) (32 percent), and other office related equipment (9 percent), as illustrated in Figure 14 below.

Figure 14: Energy consumption distribution in commercial building



(Source: Bureau of Energy Efficiency, Government of India)

Commercial buildings also use window air conditioners and the gains in efficiency of these have already been accounted above. However, many of the commercial buildings have central air conditioning and chillers, whose efficiencies can be greatly improved. In other words, designs that increase daylight and reduce need for daytime lighting have not been accounted for above; nor have been the gains from better insulation, plugging of leaks and use of natural ventilation for geo-thermal energy. The gains from Energy Conservation Building Codes (ECBC) are mainly of these types and we estimate the potential for efficiency gains on the basis.

Present Codes and Standards

Codes and Standards as determined by policy can significantly enable the reduction of CO_2 emissions in the building sector. The country has done well in developing various standards like National Building Code (NBC), Energy Conservation Building Codes (ECBC), Bureau of Energy Efficiency rating programs for appliances, and the more recent energy rating program for the existing buildings. The market-driven voluntary Green Building Rating Programs have significantly transformed the way buildings are designed. Green buildings have the potential to save 40 to 50% energy vis-à-vis the conventional practices.

Some of the widely used building codes in India are discussed below:

Energy Conservation Building Code

Energy Conservation Building Codes, formally launched in May 2007, specifies the energy performance requirements of commercial buildings in India. ECBC has been developed by the Bureau of Energy Efficiency (BEE) under the provisions of the Energy Conservation Act, 2001. The code is applicable to all commercial buildings having a connected electrical load of 100 kW or more (or a contract demand of 120kVA or more).

The purpose of this code is to provide minimum requirements for the energy-efficient design and construction of buildings. The code is presently in the voluntary phase of implementation and is expected to become mandatory during the 12th Plan. However, some States have already moved ahead and notified it within their jurisdiction. The Bureau of Energy Efficiency is the primary body responsible for implementing the ECBC; and it works towards policy formulation as well as technical support for the development of these codes and standards, as well as in supporting compliance tools and procedures.

Green Building Rating Systems

One of the major green building rating systems currently operating in India is the Indian Green Building Council (IGBC) programme. The ratings depend on a number of factors including energy consumption. The number of green buildings indicating their aggregate area by rating categories is given in Table 7 below :

Green Building Rating Level	Energy Saving vis-à-vis ECBC/ASHRAE	Number of Buildings rated	Built-up area (in sq.m)
Platinum	40-50 %	61	1,198,005
Gold	30-40 %	121	4,342,259
Silver	20-30 %	39	730,944
Certified	15-20 %	6	66,781

The average savings in green buildings over those designed as per ECBC / ASHRAE are observed to be in the range of 30-35 percent. Further, the buildings, which comply with ECBC / ASHRAE standards would save at least 30 percent energy when compared to the conventional buildings. In some cases, buildings that achieved certified ratings were designed for much higher energy efficiency than shown above.

Presently, 95 percent of buildings coming up in the country do not conform to the ECBC/ ASHRAE codes. The large percentage of buildings that do not comply with ECBC/ASHRAE codes and the large savings that some of the rated buildings have achieved, indicate a large potential for energy savings in the building sector.

GRIHA

The Energy and Resources Institute (TERI) has evolved a rating system called GRIHA. Some 200 projects have been registered with a total built up area of 8,196,303 sq. meters. The scope for energy saving can be seen from the 20 odd projects for which calculations have been performed. These suggest that typically 47 percent energy savings may be achieved per square meter of GRIHA complaint built-up area.

CO_2 Mitigation Opportunities in the Building Sector

Building sector provides tremendous opportunities for maximizing energy efficiency, and thereby reducing the GHG emissions. These opportunities are available in both existing (see Box: Retrofitting Bombay House) and new stock, covering both commercial and residential buildings. The estimated abatement potential is 142 Million Tonnes of CO_2 per year by 2020 and 296 Million Tonnes of CO_2 per year by 2030 respectively (IGBC - Indian Green Building Council estimates).

The projected area of commercial buildings is likely to increase from 4,580 million sq. ft. in 2005 to 15,200 Million Sq ft by 2020.The existing consumption pattern in conventional buildings (data from BEE) and the consumption trends in some of the recently constructed energy efficient buildings, which would be ECBC compliant, have been analysed. The ECBC compliant buildings are estimated to be 20 to 30 percent more efficient than conventional buildings. These buildings have many energy conservation measures such as the use of flash blocks, wall and roof insulation, high performance glass, high SRI paints, vegetated roofs, LPD's (<1w/sq.ft), high performance chillers, economizers, variable frequency drives and cooling towers. The current baseline for CO_2 emissions for conventional buildings is estimated at 40,000 tonnes of CO_2 per million Sq. ft or 430,570 tonnes of $C0_2$ per million Sq m of building area. At this rate, the expected emissions from the commercial building sector will be 610 Mt of CO_2 in 2020 and 1370 Mt of CO_2 in 2030.

Policy Measures

Since approval plans for buildings lie within the domain of Urban Local Bodies and/or Urban Development Authorities created by the State Government, the scope for Central intervention is limited, the only real legal backing being the Energy Conservation Act, 2001. However, JnNURM and Finance Commissions are a major source of finance for the urban local bodies. To hasten the adoption of Green Building Codes across the country, implementation of these codes should be made one of the conditionalties under the revamped JnNURM in the 12^{th}Five Year Plan. Moreover, the next Finance Commission should be given the task of linking financial devolution to urban local bodies to the implementation of Green Building Codes within their jurisdiction.

3.6 Increasing the Stock of Forest and Tree Cover

Enhancing Forest and Tree Cover mitigates climate change by absorbing CO_2 from the atmosphere and turning it into biomass. This section attempts to bring out the present and the future potential that forestry sector of India can offer in mitigating the climate change, by directly increasing the forest and tree carbon sink on one hand, and by promoting efficiency of fuel-wood use, replacement of energy intensive building and household products with wood substitutes on the other. Needless to say, actions aimed at sustainable supply of domestic wood products would also aid mitigation and adaptation efforts, as sustained supplies would not be possible unless forests and tree vegetation themselves are first secured at reasonable levels.

With regard to the contribution to mitigation and adaptation actions, the forestry sector helps in mitigation by sequestering carbon, and helps in adaptation by increasing resilience of the system through ecological services of water retention, reduction in soil erosion, enhanced provision of renewable resources, etc. The forestry sector can make a positive contribution both in the numerator and the denominator- one, by increasing the forest carbon sink, and two, by increasing the GDP.Local livelihoods depending on forests are most likely to be impacted adversely not only because of climate change, but also due to continued pressure of land use change for development and other purposes. The national strategy aims at enhancing and improving the quality of forest and tree cover, which in turn will enhance the quantum of forest ecosystem services that flow to the local communities.

Strategy proposed to realize enhanced potential of forestry sector in mitigation and adaptation should therefore be two pronged- first, focus on actions that promote carbon sequestration; and second, focus on actions that improve and enhance ecosystem goods and services. Some options in the forestry sector for saving, maintaining and increasing forest carbon stocks are enumerated below:

Conservation and Sustainable Management of Forests:

- Conservation of natural forests and protected areas
- Sustainable management of native forests
- Dissemination of improved and efficient wood-burning cook-stoves

Afforestation:

- National Mission for a Green India
- Agro-forestry practices including pulpwood plantations
- Energy plantations i.e.use of forestry products as bioenergy to replace fossil fuel

Wood Products Use Management:

- Initiate part replacement of energy intensive building materials like cement, iron and steel with lumber
- Initiate part replacement of office and domestic furniture made with metals by wood based furniture

The business-as-usual scenario comprises the present initiatives like National Afforestation Programme (NAP), together with programmes in sectors like agriculture and rural development, which on an average are adding or improving 1mha of forest and tree cover annually in our country. This annually adds about 1 million tonne of carbon incrementally, which if combined with the accretion of biomass in our managed forests, protected areas and in tree cover outside the government forests, the total carbon service at present has been estimated at 138 mt CO_2eq every year (Kishwan et al. 2011)[22].The cost of business-as-usual reforestation and afforestation activities is estimated at Rs. 5,000 crore annually.

National Mission for a Green India: The business-as-usual scenario will however, not suffice. In the Twelfth Plan, the national afforestation program needs to be re-organized into a more comprehensive 'National Mission for a Green India'. The Mission is still being finalized, but the realistic aim was to double the present afforestation efforts by adding or improving 2 mha of forest and tree cover annually. Over a ten year period, this could increase and/or improve the quality of forest and tree cover over 20mha; which includes regeneration of 4.0 mha of degraded forests, improving the canopy cover over 2.0 mha of moderately dense forests, restoration of 2.0 mha of degraded scrub/ grasslands and agro-forestry over another 2.0 mha of degraded/fallow agriculture lands, in addition to eco-restoration of mangroves and wetlands. The Green India Mission also proposes to improve the fuel-wood use efficiency (through the improved cook-stoves initiative) in 10 million rural households. It must also lay emphasis on liberalization of felling and transit rules for identified commercial species so that farmers get the right incentives to undertake agro-forestry in a big way; and harvested wood products can replace building materials in house construction, while metal and plastic based furniture can be replaced with wood and wood based substitutes.

According to preliminary estimates, the cost of this mitigation service would be double of the amount currently being spent on afforestation activities - about Rs 10,000 crore annually in the Twelfth Plan. It was estimated by the Expert Group that if implemented properly, the Green India Mission would help neutralize an additional 1.5 percent of India's GHG emissions annually, bringing the total Greenhouse Gas removal by India's forests to 6 percent by 2020.

It will, however, not be possible to mobilize resources of this magnitude from gross budgetary support alone. CAMPA (Compensatory Afforestation Fund Management and Planning Authority)

[22]*Jagdish Kishwan; Rajiv Pandey and VK Dadhwal. 2011. Removal Capability of India's Forests. Review of Forestry. Small Scale Forestry. DOI: 10.1007/s11842-011-9168-9*

funds, already accumulated, could be used to supplement this resource. Further resources could be mobilized using the "Emitter Pays Principle". Possible mechanism for implementing this could be a system of compulsory carbon credits purchased by emitting entities equal to their emissions over and above the permissible limit, or a carbon tax regime with proceeds going to the carbon service providers, including the State Forest Departments, in proportion to the quantum of carbon service provided. The REDD-plus funds (United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries), as and when received, could also be channelized to supplement the available financial resources.

4. Co-Benefits Framework

The final report of the Expert Group will include an economy wide modelling and analysis of co-benefits in a cross-cutting framework. It will spell out the policy actions required to take the mitigation and adaptation effort forward up to 2030, and also suggest some finance strategies for the same. To evaluate the alternative policy instruments, a four pronged strategy of 'growth, inclusion, carbon mitigation and local environment benefits' has been formulated. Taken together, the economy wide modelling and co-benefits analysis of the policy framework will provide analytic tools for implementing low carbon strategies for sustainable and inclusive growth.

Table 2 below provides an indicative and qualitative analysis of co-benefits that may be associated with each of the Twelve Policy Thrust Areas identified by the Expert Group above. This initial analysis only examines direct effects. In the final report, a more detailed analysis will assess the direct as well as indirect effects of each policy action, the pathways for these effects and the interactions among them, leading to a more informed analysis of synergies and trade-offs.

S. No	Thrust Area	Co-Benefit sought	Brief Qualitative Assessment of Co-Benefit Potential
Power			
1.	Advanced Coal Technologies	Growth	Positive – Although costs are marginally higher, coal is used more efficiently. Energy security and reduced import dependence.
		Inclusion	Neutral or mildly negative if power costs increase and are passed on to low income consumers
		Local Environment	Positive - reduced emission of SOx, NOx and particulate matter
		Carbon Mitigation	Positive - 10 GW of Ultra Supercritical coal plants can reduce emissions by ~ 15% compared to current plants
2.	National Wind Energy Mission	Growth	Positive – can substitute for fossil fuel imports and provide energy security. Indigenous manufacturing for large capacities can lead to job creation and growth.
		Inclusion	Neutral – Can be mildly negative if average electricity costs increase. Could also be mildly positive through creation of a

			decentralized energy industry.
		Local Environment	Positive– although land is required for wind installations, policy can enable mixed land use. Noise pollution could be a concern.
		Carbon Mitigation	Positive - zero emissions power.
3.	National Solar Mission	Growth	Mildly positive – can substitute for fossil fuel imports, decrease import bill and providing energy security
		Inclusion	Neutral – Can be negative at present costs, which are higher than other sources. Could also be mildly positive through creation of a decentralized energy industry.
		Local Environment	Positive – decentralized rural applications substitute diesel, kerosene and firewood. For large projects, dedicated land and water requirement may be a concern due to competing uses. However, solar power does not emit local air pollutants.
		Carbon Mitigation	Positive - zero emissions power
Industry			
4.	Technology improvement in Iron and Steel Industry	Growth	Positive - Less fossil fuel consumption, reduction in import of fossil fuels; Improved domestic and global competitiveness.
		Inclusion	Neutral – Mildly positive, if MSME also benefits esp. the sponge iron industry; mildly negative, if cost of output increases.
		Local Environment	Positive - Usually, improved technologies provide increased environmental performance such as reduction in noise, particulate matter, SO_x, NO_x ; reduction in slag and other waste.
		Carbon Mitigation	Positive – Reduced emissions per unit of iron and steel produced.
5.	Technology improvement in Cement Industry	Growth	Positive - Less fossil fuel consumption; Reduction in consumption of raw material per unit of cement produced;
		Inclusion	Neutral – Mildly positive if price of cement reduces with higher clinker substitution; mildly negative, if cost of output increases due to technology costs.
		Local Environment	Positive - Usually, improved technologies provide increased environmental performance such as reduction in noise, particulate matter, SO_x, NO_x etc.; reduction in fly ash, slag and other waste and reduction in landfill;
		Carbon Mitigation	Positive – Reduced emissions per unit of cement produced.
6.	Energy Efficiency Programs in the Industry	Growth	Positive – Less fossil fuel consumption, reduction in import of fossil fuels; Improved domestic and global competitiveness.
		Inclusion	Positive – Potential price reduction over a longer term due to increased efficiency; Lower consumption could reduce peak power or energy deficit
		Local Environment	Positive – improved technologies provide increased environmental performance such as reduction in noise, particulate matter, SO_x, NO_x etc.; reduced waste as by-products of energy feedstock are utilized;
		Carbon Mitigation	Positive – reduced production intensity of fossil fuels.
Transport			
7.	Vehicle Fuel Efficiency Program	Growth	Mildly positive – reduced fuel imports, enhanced energy security. Savings on fuel expenditure could be invested domestically.
		Inclusion	Neutral, unless it results in significant improvement in bus

			efficiencies which could lower fares.
		Local Environment	Reduced Air Pollution - as tail-pipe emissions decrease.
		Carbon mitigation	Moderately positive - fuel consumption would reduce, unless undermined by increased driving patterns.
8.	Improving the Efficiency of Freight Transport	Growth	Positive – savings on fuel expenditure, reduced fuel imports. May facilitate enhanced trade.
		Inclusion	Mildly positive - transport cost of goods would reduce, thus impacting overall prices.
		Local Environment	Positive – decreased emissions either through modal shift or improvements in efficiency of road transport.
		Carbon Mitigation	Improving freight transport efficiency will have a positive impact on carbon mitigation.
9.	Better Urban Public and non-motorized Transport	Growth	Mildly positive – reduced fuel imports and savings on fuel expenditure could get invested domestically
		Inclusion	Positive - mobility for the poor would improve significantly.
		Local Environment	Positive - reduced local emissions
		Carbon Mitigation	Positive - reduced consumption of fossil fuels.
Others			
10.	Lighting, Labelling and Super-Efficient Equipment Program	Growth	Mildly positive – energy efficiency is typically cheaper than new power generation, bringing down average cost of electricity
		Inclusion	Neutral – positive, if appliances supported are used by relatively poor populations; negative, if predominantly used by the rich.
		Local Environment	Positive – energy efficiency substitutes for thermal power generation and brings down local air pollution.
		Carbon Mitigation	Positive – carbon mitigation as energy efficient appliances substitute for thermal power generation
11.	Faster Adoption of Green Building Codes	Growth	Neutral or mildly positive – decreased energy costs lead to lower investments in higher cost power infrastructure
		Inclusion	Neutral ; negative if green building codes raise costs
		Local Environment	Positive – energy efficiency substitutes for thermal power generation and brings down local air pollution.
		Carbon Mitigation	Positive - carbon mitigation occurs as energy efficient appliances substitute for thermal power generation
12.	Improving the Stock of Forest and Tree Cover	Growth	Neutral or mildly positive – forest enhancement can increase ecosystem services
		Inclusion	Neutral or negative – depends on the existing use of land; and whether afforestation causes displacement and loss of livelihood
		Local Environment	Positive or negative–depending on the type of forest cover
		Carbon Mitigation	Positive – forests sequester carbon

5. Strategies for Financing

The assessment and quantification of the costs of adaptation and mitigation is a difficult task, although it is clear that these costs are significant, and will likely be greater in the future, as initiatives are taken in line with the mitigation and adaptation goals outlined in our national policies, such as the National Action Plan on Climate Change.

Though no ready estimates are available, several studies[23] suggest that incremental economic or investment costs incurred for adaptation and mitigation of emissions will be sizeable and may divert resources from other critical sectors of our economy. During the 12th Plan, low carbon strategies will particularly require capital finance for improvements in technology, and enhanced deployment of renewable and clean energy technologies. Some of these objectives may be met through regulatory interventions and use of market mechanisms, in which case the required budgetary support may be small, but indirect and un-quantified costs for economy may be larger. In other cases, adequate financial outlays will be needed to implement policies and measures that can achieve specific mitigation outcomes in the individual sectors.

A framework for understanding finance strategies is outlined in Box-2 below:

A. Changing the Cost Curves (Producer Side Strategies)
   - Capital Costs : capital subsidy, interest subsidy, depreciation rules
   - Variable Costs: output based incentive (Feed-in-tariffs, rebate/drawback of commodity taxes)

B. Changing the Demand Curves (Consumer Side Strategies)
   - Purchase Based Incentives (purchaser rebates)
   - Purchase Quotas (Renewable Purchase Obligations)
   - Guaranteed Procurement (public procurement policy)

Before deciding on the optimal strategy it is important to answer questions like whether the incentive will actually be passed on to the consumer, whether the income transfer to the consumer actually result in increased demand, what the impact will be on risk-sharing, information asymmetry, moral hazard etc. Where markets exist, signals could be delivered through either price or quantities. Where they don't exist, and externalities are paramount;

[23] "Energy and Environmental Sustainability: An Approach for India", Mckinsey& Co., New Delhi, 2009; "National Energy Map for India, Technology Vision 2030", The Energy Resources Institute, New Delhi, 2006

markets may need to be created as well as deepened. In this context, the relevance of regulatory measures as appropriate instruments to reflect externalities and trading as a possible way of minimizing the economic costs will need to be examined.

Policies also need to reflect the state of technology, given that energy supply and end-use technologies are evolving rapidly. Whether a technology will be viable and hence adopted depends on private discount rate, social discount rate and monetization of net co-benefits. An example of what policy intervention will be optimal for what technology is explained with examples in Table 8 below:

Technology Examples	Viability using private discount rates	Viability using social discount rates	Social discount rates + monetized mitigation benefits	Policy Approach
ECBC, CFL, Supercritical Coal Tech.	Viable	Viable	Viable	Mandatory Standards + Information labeling
Super-efficient Appliances	Unviable	Viable	Viable	Incentive to Manufacturer and/or incentive to Consumer
LED's & Ultra-supercritical Coal Tech.	Unviable	Unviable	Viable	Domestic or International Carbon Finance (grant/loan)
Carbon Capture & Storage	Unviable	Unviable	Unviable	Pilot Project on 100 percent grant basis

Domestic Resources

The most obvious source of financing for climate change action is the government budgetary support. Most of it would come as sectoral finance since some of the resources for adaptation and mitigation are built into the on-going schemes and programmes of the respective Ministries. Although carbon mitigation is sometimes an important co-benefit, the deployment of resources for such purposes is largely guided by the overall availability of resources with the respective Ministries. Some prominent examples are budgetary support for super-critical thermal power plants, for dedicated freight corridor, for urban public transport etc. This is supplemented by internal and extra-budgetary resources of public enterprises like NTPC, Ministry of Railways, Metro-Rail Corporations etc. Additional allocations are available as grants from the Central Government on the recommendation of the 13th Finance Commission. Three grants of Rs. 5,000 crore each, namely for forest cover, renewable energy and water sector, have been recommended for the State Governments.

While the budgetary resources indicated above flow through the Consolidated Fund, Government of India has created another window for climate action through the Public Account. With a view to generate additional resources, a cess at the rate of Rs 50 per tonne of coal was levied in the budget of 2009. The cess has become operational and its revenue (of the order of about Rs 3,000 crore every year) will go to a newly created National Clean Energy Fund (NECF), which will be used to finance innovative projects in clean energy technologies and to harness renewable energy sources to reduce dependence on fossil fuels. From the Fund, allocation of Rs 200 crore has already been proposed for environment remediation programmes and another Rs 200 crore for the Green India Mission. Given the importance of supporting the development of clean energy technologies, resources from the NCEF could also be used to create venture funds for supporting early stage technologies in the mode of public-private partnerships.

Funds can also be established outside the Government. This is particularly important for private sector industry, even more so small and medium enterprises, who will find it difficult to access the National Clean Energy Fund in the Government Public Account. It would be simpler and more useful to set up a 'Carbon Trust' or a 'Low Carbon Fund' managed by an autonomous body like the Bureau of Energy Efficiency, into which collections from an 'Energy Efficiency Surcharge or Levy', as suggested in the industry section, could be deposited. The collections, even though small, could be supplemented by block grants from the National Clean Energy Fund under the Government, and indeed some international sources of finance. This could go a long way in meeting the demands of the private industry. We could also create a 'priority' credit facility through the scheduled commercial banks to help finance their low carbon efforts, while interest subvention could be dovetailed with the Trust fund suggested above.

International Sources

Considering scarcity of resources and competing demands, the provision of specific budgetary outlays reflect India's strong will to address the challenge of climate change. However, domestic resources will not be sufficient when compared to the scale of actual requirements. Expert Group on Low Carbon Strategies has also stated in its Interim Report that aggressive mitigation cannot be achieved without substantial international help, both in terms of financial resources and technology transfer. The intensity of domestic mitigation response also depends on the overall multi-lateral response to climate change.

A major channel for mobilizing funds to the developing countries is likely to be the Green Climate Fund that is still under construction. At the same time, the World Bank (Climate Investment Fund) and other multilateral agencies are offering their funds to be used for climate action on the basis of agreed terms and conditions. The expected funds flow from the developed world to the developing countries through the Green Climate Fund, and other bilateral and multilateral channels will enhance India's capacity to address the climate challenge. These may be utilized appropriately if the funds flows through these sources are indeed 'new and additional resources', and terms of finance are in accordance with the multilateral rules of climate change. Unfortunately, the promises made through the Conference of Parties and recommendations of the High Level Panel on Climate Change Finance are yet to be implemented.

One way of differentiating between domestic and international sources of finance is the co-benefits framework as mentioned above. Policy measures that generate adequate development co-benefits should be funded domestically, while those which primarily provide climate benefits should be funded by international sources. Even measures with adequate co-benefits may require international financing, if the initial investment is very large. *Only the actions which generate climate benefits along with substantial development co-benefits could be categorized as the Nationally Appropriate Mitigation Actions (NAMA).*

Carbon Markets and Clean Development Mechanism

Mechanisms like carbon emission trading allow developed countries to meet their emission reduction targets besides benefiting developing countries to find some financial resources for complementing their sustainable development efforts. The market can be compliance based such as the one created under Kyoto protocol, or it could be voluntary in nature. India has been an active player in the Clean Development Mechanism, and the National CDM Authority (NCDMA) in the Ministry of Environment &Forest has so far accorded Host Country Approval to over 2000 projects, which has the potential of facilitating an overall inflow of approximately US $ 7.07 billion by the year 2012, if all the projects get registered. However, the scale of likely financing available either during the 2nd commitment period under the Kyoto protocol, or through new market mechanisms that are still under negotiation, is still uncertain. Most of the projects in India are unilateral in nature wherein the project entity itself undertakes the registration of the project, and aim to sell the Carbon Emission Reduction (CER) units in the spot market rather than selling them in the forward markets. Efforts are being made to increase participation of financial institutions/banks in financing voluntary projects, including the bundling of small projects which may reduce transaction costs and increase the average project size. However, the contribution of CDM to real technology transfer is very limited, the market prices remain volatile and considerable uncertainty prevails over its future.

Innovative domestic markets mechanisms are being evolved under the Perform, Achieve & Trade (PAT) Scheme that is being implemented for the designated industries under the National Energy Efficiency Mission. This is clearly an area where new markets need to be created. However, it may not be a suitable scheme for the more widespread small and medium industry. Renewable Energy Certificates is another attempt at creating domestic markets, although the logic behind them is less clear. It may be easier to deepen the existing quasi-markets in the power sector so that renewable power achieves grid parity faster.

The potential for these domestic measures to link with global carbon markets remains unclear, largely due to lack of clarity in the international negotiation process. Until such clarity emerges, the most that can be expected are loosely linked regional markets. We must be prepared to link with them, though we cannot expect substantial resource flow from this source in the short term. On balance, the main source of finance is likely to be domestic sources, supported in some measure by international carbon finance that will hopefully start flowing through the multilateral sources in accordance with the commitments made.

6. Way Forward:

India faces the twin challenges of adaptation and mitigation. As a country with many critical sectors and regions that are highly climate-sensitive, there are significant costs associated with addressing the impact of climate variability, and in future, climate change. At the same time, as a signatory to the UNFCCC, India is expected to undertake actions to mitigate climate change in a manner consistent with the multilateral framework.

India has already taken decisive steps in this regard. Over the Eleventh Plan Period, it initiated the National Action Plan on Climate Change to be monitored by the Prime Minister's Council for Climate Change. It has also set up an Expert Group to evolve Low Carbon Strategies for Inclusive Growth. Some of the recommendations of the Expert Group are summarized in the write-ups on power, industry, transport, energy efficiency, buildings and forestry sectors above.

As we embark on the Twelfth Plan, the National Action Plan for Climate Change needs to be re-organized in accordance with the updated priorities. As already mentioned, for any Mission to succeed, it must have separable objectives, dedicated implementation machinery and adequate funding. For objectives which fail to meet this test, it is better to identify a short list of 'policy thrust areas', which could be separately listed under the National Action Plan on Climate Change and be regularly monitored by the Prime Minister's Council.

As already mentioned in the section on NAPCC above, we need to shorten the list of Missions and separate out three policy thrust areas from the existing Mission that need to be monitored on a stand-alone basis. These are - treatment of all sewage before release into water bodies, solid waste management system for all towns and cities, and climate related research through the scientific departments like earth sciences, space, agriculture, health, biotechnology, S&T etc.

Some of the policy thrust areas identified by the Expert Group are Missions in their own rights, for example the Solar Mission and the National Mission for a Green India. The Energy Efficiency

Mission needs to be reorganized to include a more comprehensive PAT plus Energy Efficiency Levy Scheme for the industry, a Super-Efficient Appliance and Equipment Program for demand side management in the power sector and a Vehicle Fuel Efficiency Program for the transport sector. Further, as mentioned above, a dedicated National Wind Power Mission needs to be launched in its own right. The remaining four policy thrust areas identified by the Expert Group, which do not meet the core requirements for constituting a National Mission, should remain as policy thrust areas under the NAPCC. These are - faster adoption of advanced coal technologies, technology improvements in steel and cement industry, dedicated freight corridor along major routes, and improved urban public and non-motorized transport.

Accordingly, a re-organized framework for the National Action Plan for Climate Change is suggested in Box-3 below. *These suggestions need to be placed before the Prime Minister's Council on Climate Change and discussed before a formal decision is taken.*

Suggested Re-organization of the National Action Plan for Climate Change

A) National Missions

1. **National Solar Mission**
2. **National Wind Energy Mission**
3. **The Energy Efficiency Mission**
4. **Sustainable Habitat Mission**
5. **Sustainable Agriculture Mission**
6. **Mission on Sustainable Himalayan Eco-systems**
7. **National Mission for a Green India**

B) Policy Thrust Areas

1. **Advanced Coal Technologies**
2. **Technology Improvements in Steel and Cement Industry**
3. **Solid Waste Management Systems in Towns and Cities**
4. **Treatment of all Sewage before Release into the Water Bodies**
5. **Dedicated Freight Corridors along Major Routes**
6. **Improved Urban Public and Non-motorized Transport**
7. **Climate Related Research through Scientific Departments**