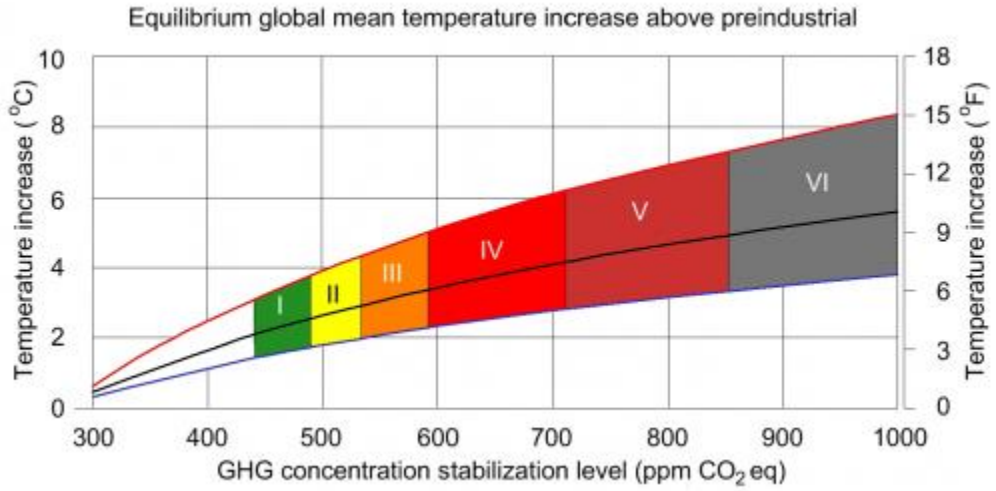
1. Climate Change: Need to Act Now

The threat of climate change is a serious global concern. There is near consensus among scientists that the threat is due to man-made emissions of Greenhouse Gases (such as Carbon Dioxide, Methane, Nitrous Oxides, etc.). These gases in the atmosphere trap the infra-red radiation reflected by the earth and lead to global warming, which in turn can change the climate in many ways. Probabilities of different degrees of temperature change have already been estimated by the Inter-governmental Panel for Climate Change (IPCC)-See Table-1 and Figure-1 below. Increase in anthropogenic activities since the advent of industrialization in the mid-18th century, has led to cumulative accumulation of Greenhouse Gases (GHGs) in earth's atmosphere. Increased concentration of GHGs and overall warming of the atmosphere can 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 and cyclonic activities. These, in turn, can have serious impact on sustainability of water resources, agriculture, forests and ecosystems, affecting the well-being of billions of people on earth. They would pose a serious threat to our objective of sustainable inclusive development.

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 Emission	Change in Global Emission 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 extremely vulnerable to these effects. Change in mean temperature and precipitation will require change in cropping patterns. It has been estimated that a 2 to 3.5 degree Centigrade increase in temperature and associated increase in precipitation can lower agricultural GDP by 9% to 28%. Yield of most crops will fall in the long run, even though impact in the short run may be small. Heat stress will affect the productivity of animals and milk production may even decrease by 2020. Agriculture technology can adapt to these changes to partially offset the adverse impact, by changing cropping patterns and practices, by developing new varieties that can withstand short term climate variability and by adoption of water conservation practices. However, developing a new variety takes 10 to 15 years, and so we need to start acting now. Climate change is also expected to raise sea levels. That will submerge coastal land and threaten coastal cities. Apart from the loss of land and property, millions of people may be displaced. We need to understand the threat and take action well in advance.

Many of the GHGs remain in the atmosphere for decades and the warming potential depends on their total concentration, which in turn depends on the past and present emissions of all countries on earth. To minimize the threat of climate change requires concerted action by all countries. The Earth Summit in Rio in 1992 recognized these facts and the UNFCC (UN Framework Convention on Climate Change) calls for 'common but differentiated responsibility'.

On per-capita basis India is one of the lowest GHG emitters in the world. 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. Although India's emissions have in no way contributed to the threat of climate change, which has been created by historical emissions of developed countries, India is vulnerable to

climate change. We need to act now to minimize the threat and damage that climate change can inflict on us.

India has shown its commitment as a responsible nation 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 carbon emissions level of the developed countries. Furthermore, in December 2009, India announced that it would aim to reduce the emissions intensity of its GDP by 20-25 per cent from 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.

The second set of actions India has taken is to formulate a National Action Plan on Climate Change (NAPCC). The plan formulated by the Prime Minister's Council on Climate change has outlined eight missions, which have been subsequently elaborated and initiated. Four of these missions address mainly adaptation to climate change; three mitigation (i.e. containing emissions) and one relates to knowledge. Whatever the world community does, some effects of climate change seem unavoidable at this stage. It is important for us to adapt to minimize our vulnerability, and make our economy, society and environment resilient to possible manifestations of climate change. Some of the adverse impacts are already being felt, though they cannot be unequivocally attributed to climate change. As adaptation and mitigation actions take time, precautionary principle requires that we act now to ensure sustainable and inclusive growth. The 12th plan, therefore, includes actions needed to address the threat of climate change.

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 crores may be needed to fulfil the Mission objectives. Funds of this magnitude cannot be mobilized through internal 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, while attempting to expand the scope of other renewable and non-fossil options such as nuclear energy, wind energy and biomass. 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 crores. 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 which is estimated to be around Rs. 74,000 crores. 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 tons 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 costs for implementing the Mission during the 11th Plan period are estimated at Rs 425 crores (excluding the investment made by private investors) the costs in the subsequent periods are 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.1000 crores. During 11th Plan, expenditure of Rs.50 crores is to be incurred and remaining Rs.950 crores 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. Against a projected requirement of Rs. 91,800 crores; an outlay of Rs. …….. crore is likely to be available for this Mission during the 12th Five 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 12th five year plan.

This **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. 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…….. 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 not-too-long 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.

To achieve effective results, the above Missions need to be reorganized in accordance with the updated priorities. We should aim at a package of seven reorganized Missions and a few 'policy thrust areas' 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 Energy Efficiency Mission needs to be reorganized to evolve a more comprehensive PAT-Energy Efficiency Surcharge package for the industry, a Super Efficient Appliance/ Equipment Program and a Vehicle Fuel Efficiency Program.
2. Strategic Knowledge Mission is 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 which are likely to attract substantial funding, and convert this into a Policy Thrust Area to be monitored by the PM's Council on Climate Change.

3. Water Mission here needs to be merged with the new National Mission for sustainable management of water resources; which is being formulated and where issues can be dealt with in a more holistic manner. Climate change is also a subject under the new National Water Policy that has been formulated recently. Since dedicated funding would be elsewhere, water actions related to climate change should be monitored as a Policy Thrust Area through the PM's Council.
4. A dedicated National Wind Power Mission needs to be launched on the same lines as the National Solar Mission.

State Action Plans on Climate Change

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.

After finalization through coordinated effort of central and state governments, resources will need to be provided for their implementation. Some resources may be mobilized as Central Assistance to State Plans through Gross Budgetary Support. 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 various activities under the SAPCC. 13th Finance Commission has recommended grants to the State Governments for environment action, which covers 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.

3. Expert Group on Low Carbon Strategies for Inclusive Growth

Expert Group on low carbon strategies has submitted its interim report, which outlines the low carbon strategy for the major carbon mitigation potential 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 and by 33 to 35 percent by 2020 in the aggressive effort scenario. The 'determined effort" scenario assumes effective implementation of mitigation policies that have already been put into place or are presently contemplated by the Government. This is by no means automatic, but requires continuous up-gradation of technology as well as finance from both public and private sources. The 'aggressive effort' scenario on the other hand will

require, in addition to determined effort, design and implementation of new policies. It need deployment of new technologies and significant additional finance. India alone may not be able to mobilize resources of this scale and magnitude, and significant international help may be necessary.

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.

The Expert Group has identified twelve policy thrust areas for the Twelfth Plan:

A. Power
   1. **Advanced Coal Technologies**
   2. **National Wind Energy Mission**
   3. **National Solar Mission**

B. Industry
   4. **Technology Improvement in Iron and Steel Industry**
   5. **Technology Improvement in Cement Industry**
   6. **Energy Efficiency Programs in the Industry**

C. Transport
   7. **Vehicle Fuel Efficiency Program**
   8. **Improving the Efficiency of Freight Transport**
   9. **Better Urban Public Transport**

D. Others:
   10. **Lighting, Labelling and Super-efficient Equipment Program**
   11. **Faster Adoption of Green Building Codes**
   12. **Improving the Stock of Forest and Tree Cover**

We deal with each of these in some greater detail below:

3.1 Power

Ensuring access to clean and affordable power for everyone in the country is an important objective in India's plan strategy. Several studies have shown that per capita electricity consumption is highly correlated with human development Index and that electrification

significantly improves the quality of life. Rising income levels requires and leads to a surge in electricity demand from households, industries and small enterprises.

In the business as usual scenario; the country would rely on coal to meet this surging power demand; however this poses an environmental challenge. Power sector is currently the highest contributor (38 percent) towards India's greenhouse gas emissions. The following are the desired objectives for the growth of the power sector in the country:

- Growth: Capacity addition to meet increased demand for power to sustain the projected growth rates
- Inclusiveness: Energy access to all, through distributed generation where grid extension is either impossible or uneconomical
- Low-carbon: Net reduction in emissions per unit of power produced in the country

These objectives have to be realized in the context of available resources and feasible technology options.

Nuclear power is considered an important source for low carbon and base-load power generation. India has ambitious plans in nuclear power with 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. At this point it is unclear how much of the nuclear power capacity targets could be achieved.

Accelerated development of **hydro-power** potential is critical for our economy. Apart from the need to harness country's water resources for irrigation and flood control, the motivation for rapid 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 to respond to fluctuating grid demands that may be caused by high penetration of intermittent sources, like wind and solar. Prioritizing development of this resource, along with close monitoring of a few hydro-projects under the Prime Minister's initiative, is essential during the 12^{th} and the 13^{th} five year plans.

3.1.1. Advanced Coal Technologies:

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 that operate at steam conditions of ??? C / ??? bars, can operate at a heat rate of 2,235 kCal/kWh as

against 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 for sub critical. 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.

It has already been announced that 50 percent of 12thplan target and the entire fleet of coal-based capacity addition in 13thplan would be through Super Critical units. 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.

Further, it is also necessary to invest in research and development of Ultra Supercritical (USC) units. These operate at USC steam conditions (600° C/325 bars) and can achieve a much lower heat rate of 1986 kCal/kWh, while the specific 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.

India has pursued research in coal gasification as it provides opportunities for higher efficiency. However, Indian coal has very high ash content and initial results suggest that efficiency gain over subcritical units is only marginal. Underground coal gasification (UCG) 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. Further, it is environmentally friendly, as it 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.

3.1.2. Wind Power

Till recently, onshore wind potential in India was estimated to be about 49,000 MW. (was it 45,000; check?) This was based on establishing wind-turbine towers with a hub height of 50 meters and with 2 percent land utilization at suitable sites. 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 capacity 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 for the country can be revised to about 100,000 MW. This estimate assumes increase in hub height to 80 m, while keeping the land utilization at 2 percent. The land requirement for wind power is considered a potential limiting factor. Some recent studies have estimated that up to 6 percent land could be utilized, increasing India's wind potential to over 500,000 MW; however, this assessment needs to be reviewed. Moreover, the captive land use for towers, roads and facilities is a fraction of the wind farm area, implying that land requirement of wind is actually comparable to that of coal plant and the coal mines. 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 40,000 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 biggest challenge in accelerating wind and solar generation capacity is planning for the infrastructure required for the grid to evacuate wind and solar power, 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 should be augmenting other energy sources, which have a quick ramp-up time. There are several possible options to handle the intermittency such as 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, going forward, this will be a critical challenge, if wind power has to reach 100,000 MW and more.

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 which will increase cost of wind power)
- 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 achieving grid parity for solar power by 2022 by an ambitious target of setting up 20,000 MW of solar power with phased scale-up of capacity coupled with technological innovation. Solar PV and solar thermal each is expected to contribute 50 percent of the above target. Further, we have targeted 2000 MW for off-grid solar power. The Government has provided generous financial incentives for feed-in tariffs for grid-connected solar plants valid for twenty five years. The Government has also incentivized state-level utilities to accelerate solar capacity addition by providing opportunity for additional revenue streams through trading of Renewable Energy Certificates (RECs). For RECs to be effective, a uniform renewable portfolio obligation should be stipulated by all state electricity regulatory commissions and effective floor and ceiling price guarantees need to be provided.

The desired feed-in-tariff is competitively bid by developers. Initial results of such bidding seem to be encouraging. A large number of solar developers submitted proposals and in the two rounds of bidding so far; they 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 provide base load power. However, solar thermal technologies work on direct beam radiation and utility-scale plants require large amount of

land and water at one place, which are potential impediments in scaling up. The coming years will provide further learning and experience with the emerging technologies.

Off-grid and decentralized solar applications

Amongst all power generation sources, solar presents a unique opportunity for inclusive growth by providing clean electricity off-grid to the rural communities. A solar micro-grid could not only supply power to remote off-grid villages, but also augment power supply in grid- connected villages leading to immense social benefits.

The NSM targets 2,000 MW of off-grid solar power. 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 not been very 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. Also, the level of subsidy given to off-grid plants is much below what is given to grid connected power plants in the form of feed-in-tariff.

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 for reliable grid power to reach the villages. There is a case 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 rural areas. This number is expected to double in the next few years. The electricity supply in rural areas being erratic, most of these towers rely on diesel for back-up power. Therefore, there is an opportunity to use rural micro-grids, not only to meet the requirements of the telecom towers, but also to provide power to the rural communities for lighting and irrigation water pumping.

Further discussion is needed in designing the institutional structures for ownership and operation of decentralized solar power. For instance, enabling local panchayats with a stake in ownership could ensure efficient operation and maintenance, and assured payment collection

system from the perspective of community-ownership. An alternative would be to have entrepreneurs bid for setting of a cluster of such plants, and then maintain and operate them.

Institutional Structure

There is a need for a single nodal agency to be responsible for the overall monitoring and evaluation of the JNNSM Currently, several national and state level agencies are involved 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 to ensure there is no compromise in the quality of equipment being installed.

The off-grid projects have suffered and even 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, as they were worried about the stability of policies and possibility of default by the utilities. The government should immediately classify solar projects as 'priority lending' so that banks start giving it due importance in their credit plans.

Indigenous Manufacturing

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

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

1. Ensure our custom duty structure is not inverted along the 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 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

In brief, solar manufacturing policies, including tax and duty structures, will require a careful balance between promoting indigenous manufacture and easy access to globally available best technologies.

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 tons 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 giga tons of CO2 (Gt CO2) and indirect emissions[2] to 3.9 giga tons 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.

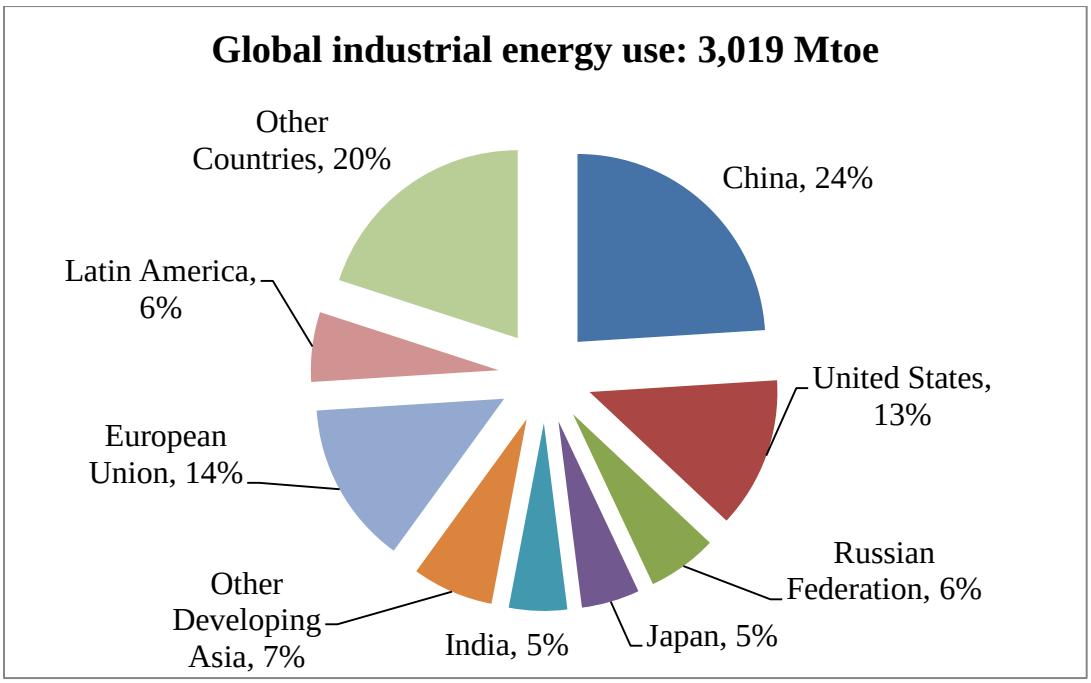


Figure 1. Industrial energy use by region (Source: IEA, 2011)

Industrial Energy and Emissions Intensity: Iron and Steel, Cement, Chemicals and Petrochemicals, Pulp and Paper and Aluminum are the five most energy-intensive industrial sectors in India. These accounted for nearly 60 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 specific policy measures are required to overcome challenges this sector faces as a result of global energy and emissions linked constraints.

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 tons of oil equivalent (Mtoe) in 2007. India produced 53 million tons (Mt) of steel in 2007, an increase of over 10% per year since 2000, accounting for about 4% of the global steel production. Considering a steel consumption of 300kg 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 comparative advantage in steel production.

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 tCO2/tcs in 2007. The energy consumption by the steel industry and the corresponding emissions were 1402 PJ and 117 Mt CO2 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 42.6 GJ/tcs, which in 2007 was 26.4 GJ/tcs – a decrease of 38%; that is steel industry has been reducing its energy intensity by about 3.2% every year. The total emissions from the steel industry have also gone down during this period. The energy related emissions were 123.5Mt CO2 eq. in 1995, becoming 117 Mt CO2 eq. in 2007. The emission intensity has therefore reduced from 5.0 tCO2/tcs to about 2.21 tCO2/tcs - a reduction of 56 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 2 and Figure 3 depict these trends.

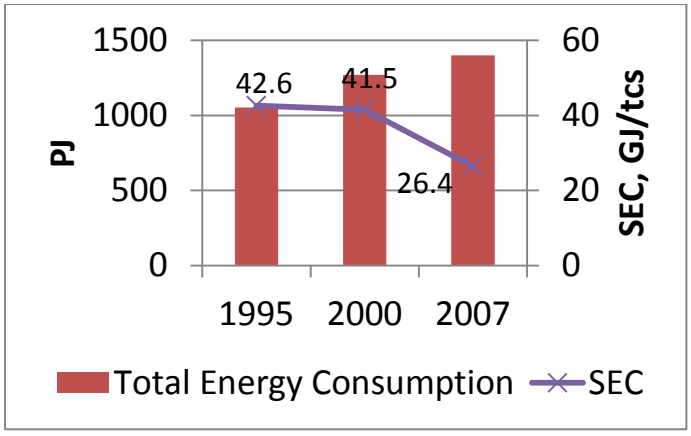


Figure 2. Historical energy consumption (in PJ) and specific energy consumption (in GJ/tcs) (**Source:** Ray and Reddy, 2008; Singhal, 2009)

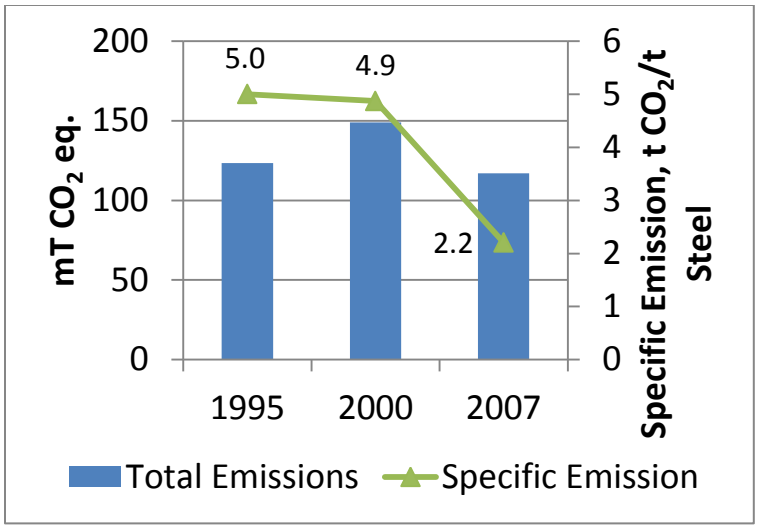


Figure 3. Historical emissions (in Million tons) and specific emission (in t CO_2/tcs) (**Source:** Ray and Reddy, 2008; MoEF, 2010)

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. The study expects BF-BOF to continue dominate the Indian steel production till 2020. The share of COREX-BOF will also 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 pathways for the reduction of emissions intensity in the Iron and Steel Sector in the near future. They include:

1. A shift in the process mix of the iron and steel sector towards more efficient processes
2. Diffusion of energy efficiency 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 above dimensions is incentivised 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 tons up from 63 million tons on 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 best in the world.

Energy and Emissions

In 2007-08, the specific energy consumption (electricity) and fuel usage for cement manufacturing was 75 kWh/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 95% from 235 PJ to 457 PJ. Specific Energy Consumption has reduced from 3.5 GJ/T in 1995 to 2.77 GJ/T in 2007, which implies the cement industry is reducing its energy intensity by about 1.7% every year. Figure 4 and Figure 5 depict the total energy consumption, total emissions, and specific energy consumption and emission reduction trends for the cement sector in our country.

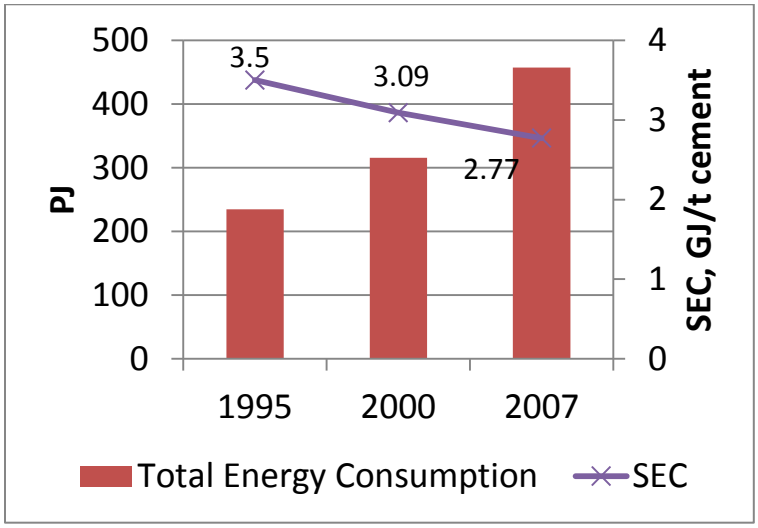


Figure 4. Historical trend of total energy consumption (in PJ) and SEC (GJ/ton of cement) of the cement industry (Source: PCRA, 2009; CMA, 2006)

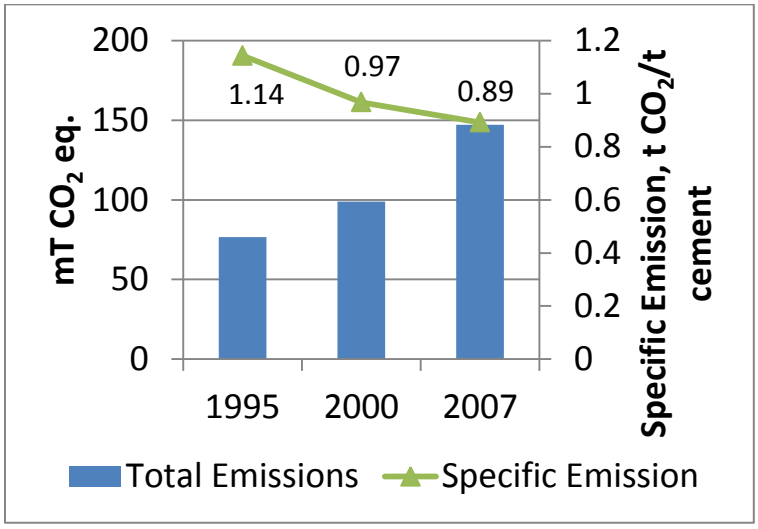


Figure 5. Historical trend of total emissions (mT CO_2. eq.) and specific emission (T CO_2/T cement) of the cement industry (**Source:** CMA, 2010)

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 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.

In this sector, any reduction in energy consumption is primarily attributed to reduction in energy intensity; and the Expert Group estimates that emission intensity could further reduce by about 13 to 16 percent by 2020 over the 2007 levels for this sector.

Policy and Measures

From a policy planning perspective, there is 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 efficiency 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 and ensure full realization of 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 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, Aluminum and Railways. The industries notified are referred to as Designated Consumers (DCs). Table 1 highlights the minimum annual energy consumption and the number of DCs chosen in the selected sector.

Table 1: Sector specific minimum annual energy consumption per DC and estimated number of DCs

Sector	Minimum annual energy consumption for the DC (tons of oil equivalent)	Number of probable DCs.
Aluminum	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

Source: BEE, 2011

[4] Railways are having 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.

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:

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 tons 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 to the target year.

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 tons of oil equivalent (mMtoe),

[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.

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 is depicted in Table 2 (BEE, 2011). However, more recent feedback suggests these numbers may be revised downwards and the overall energy savings in the first cycle of PAT is likely to be in the range of 6.6 mMtoe.

Table 2: 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
Aluminum	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**

Source: BEE, 2011

The PAT scheme is a Cap and Trade scheme. Some people argue that it could be lot simpler and more efficient to achieve the energy efficiency targets through a carbon tax. Both the approaches have their own advantages and disadvantages. These are compared in the section below.

Comparing Cap and Trade with Carbon Tax based Policies

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 to 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 CO2 emissions 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.

Advantages and Disadvantages

The following are the typical 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 improve certainty with respect to emissions reduction.
It does not provide cost certainty as price of permits fluctuates and could be highly volatile in the spot market.	A 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)	A 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	A 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 behavioral changes (e.g. choice of the type of power plant) could turn out to be far fewer.	Clear signals and impetus for behavioral 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 par with the	Carbon-taxing nations can easily offset import price differences with a "border tax adjustment."

domestic allowance.	
The setting of the price (on 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

In the context of global trends related to energy and environment, there is likely to be a major impact on the profitability of the Indian industry; and hence on the larger and more important national goal of energy, economic and strategic security. In order to minimize the impact and to address the potential problems, it is essential to design and set up adequate policy mechanisms early. A recent study provides a background for setting the foundations of additional policy initiatives or missions which can adequately address the potential challenges that could be faced by Indian industry (Krishnan, 2012). The study emphasizes the need for design and development of a strong framework to increase the knowledge, awareness and capacity of energy, low carbon and climate change issues in the SME sector. The knowledge framework needs to be complemented by an investment friendly economic framework based on a public private partnership.

The existing NMEEE has been designed to effectively deal with energy efficiency and emission reduction issues concerning a relatively smaller number of very large industries. However, many of the provisions of NMEEE such as the strong baseline, M&V, penalty and trading mechanisms may not be extendable or scalable in the case of a large number of smaller units.

Studies on demand side management to reduce energy consumption have shown pay back periods of 2 to 4 years. Yet firms on their own do not take up such measures. The major barriers faced by them include perceived risk, uncertainty about technology, costs of disruption and initial financing. What is needed is a mechanism to provide knowledge, insure risk and assure finance. Government could set up a special fund with seed capital. The fund could be used to finance preparation of project report, the cost of which may be recovered from the firm only when it agrees to implement it. It also finances the investment on reasonable terms.

India is also 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 have 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 source of financing; while the uncertainty on emissions reduction can be brought down by using energy or emission intensity benchmarks. *It is probably better to have a combined Energy Efficiency Package for the industry, consisting of a*

PAT Scheme, and an Energy Levy or Surcharge, to be implemented by a unified central agency, namely the Bureau of Energy Efficiency. The energy surcharge collected from the industry could be used to establish a 'Carbon Trust' or an 'Energy Efficiency Fund' managed by Bureau of Energy Efficiency, in a manner that is participatory and involves the private industry. This fund could be supplemented by international funding, as well as block grants from the Government through the National Clean Energy Fund; and used to help finance energy efficient technology up-gradation of domestic industry, particularly small and medium enterprises. Since Energy Surcharge is simpler to implement than the PAT scheme; smaller industrial units should be permitted choice between the two, as part of an integrated Energy Efficiency Package to be carefully designed over the Twelfth Plan period. To the extent necessary, Energy Conservation Act, 2001 should be amended to make it a reality.

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. Given that India's net petroleum imports were about 85 percent of its consumption in 2010-11, this is a matter of concern[8]. GHG emissions from the transport sector have also grown at 4.5% 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 take an informed decision while purchasing a vehicle, whereas fuel efficiency standards are supply side measures for manufacturers to adhere to.

[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

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) comparing it with 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

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

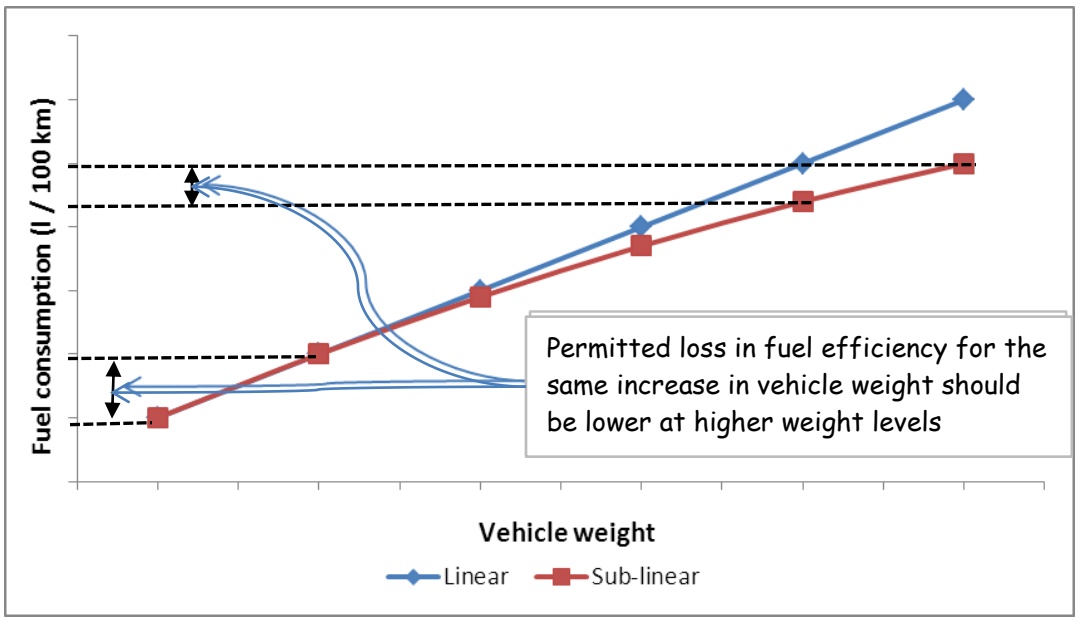
[10] Source: Top runner program: Developing the world's best energy efficient appliances, Ministry of Economy, Trade and Industry, Government of Japan

[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

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 the standards.



- 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.

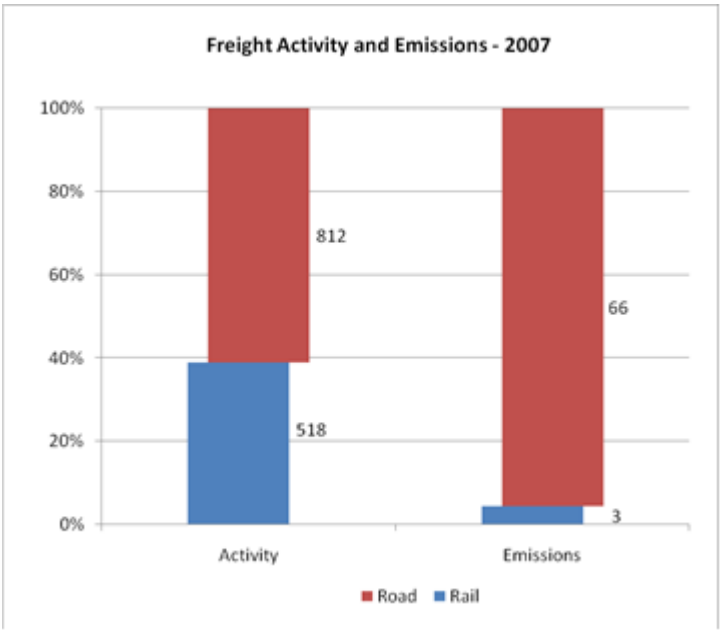
- The definition of fuel efficiency norms must not only be expedited, but also be based on public consultations with all stakeholders including the citizens groups and the automobile industry.

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 1, 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 1: Freight activity (billion ton-km) and GHG emissions (million tons) in 2007 [13]



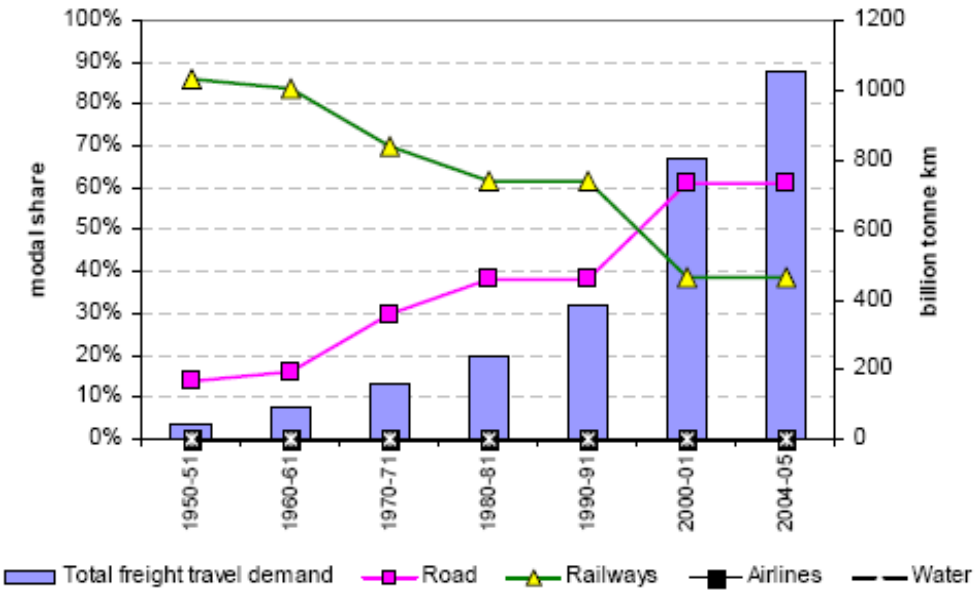
However, as can be seen from Figure 2, the share of rail in total freight carried has steadily deteriorated from about 88% at independence to about 40% currently, while the share of road

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

freight has increased correspondingly. Such a change in freight modal share not only increases the country's GHG emissions, but also has other impacts:

1. It hurts 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 2: 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 is 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.

1.1 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:

[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

1. **Dedicated freight corridors (DFC):** The Government of India initiated the DFC project by setting up a special purpose vehicle called DFCCIL for this purpose 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 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 crores, 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 crores – 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.

1.2 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 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.

1.3 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 Transport in India

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.

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

Figure 1: Passenger transport activity and emissions, 2007[16,17]

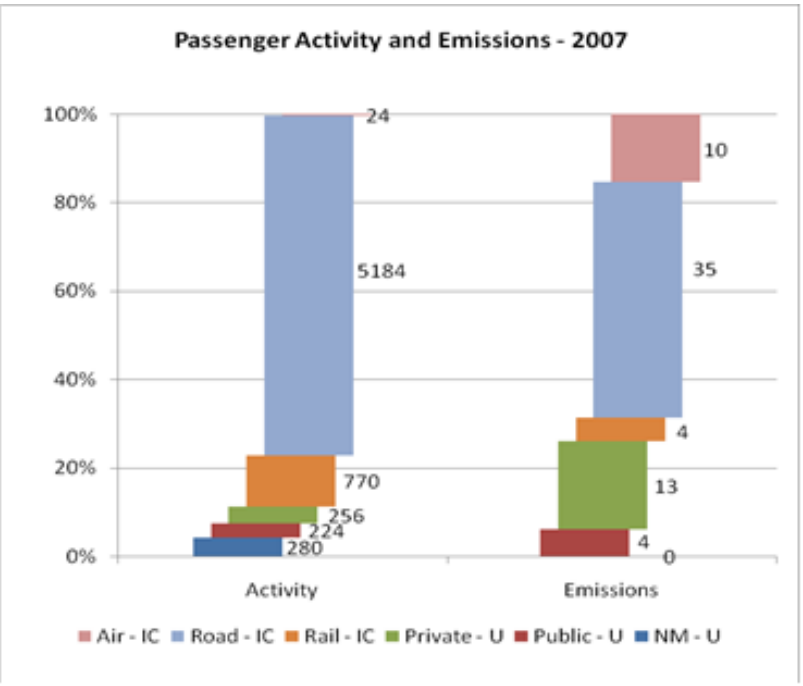


Figure 1 depicts passenger transport activity and emissions in 2007. The important points to note are:

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:

[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).

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 are 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].

3.4 Lighting, Labelling and Super-Efficient Equipment Programme [To be added]

3.5 Faster Adoption of Green Building Codes

3.5.1. Introduction

We define the building sector to include residential and non-industrial buildings. The latter are called commercial buildings, which includes 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.

[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

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.

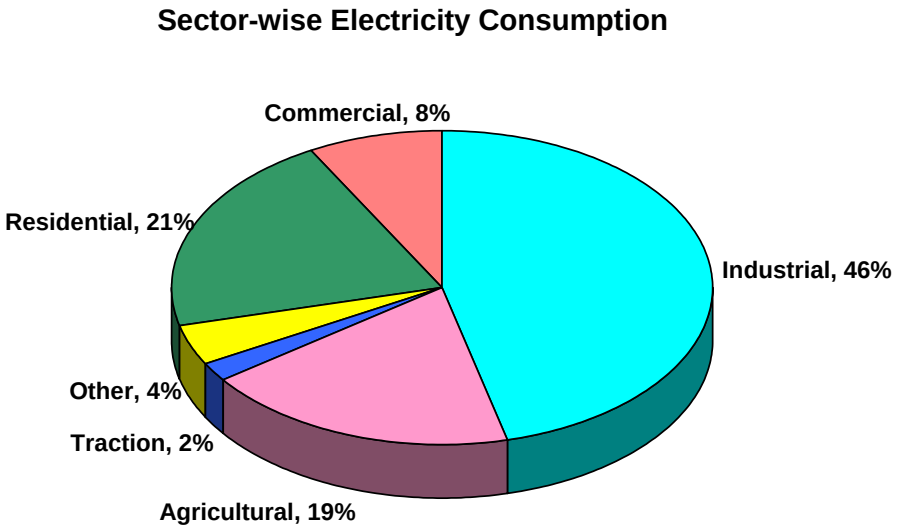


Figure 3.13: Primary electricity consumption in India (IEA, 2008)

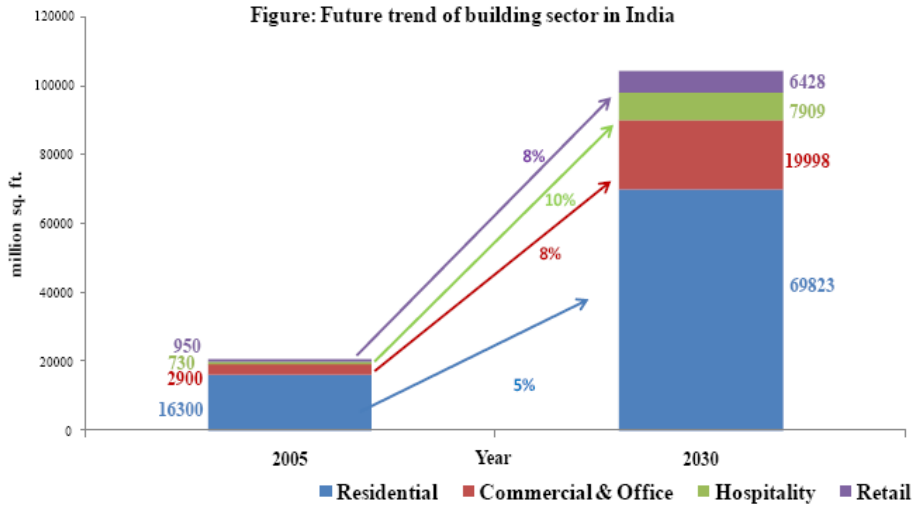


Figure 3.14: Growth of Indian Building Sector (CWF, 2010)

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 3.14 above highlights the projected growth in the residential, commercial, hospitality and retail sectors.

3.5.2 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[20] in India The share of various energy consuming equipments in the residential sector is indicated in Figure 3.15 below:

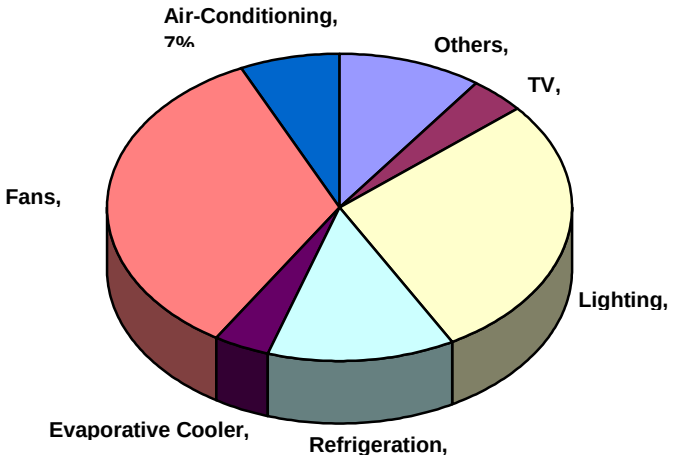


Figure 3.15: Energy consumption distribution in Residential buildings (Bureau of Energy Efficiency, Government of India)

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 has not been

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

accounted for. However, these would be small for residential buildings, and we do not estimate them here at this stage.

3.5.3 Commercial Sector

The major energy consuming equipment in commercial sector are lighting (60 percent); heating, ventilation and air conditioning (HVAC) (32 percent), and other office related equipment (8 percent), as illustrated in Figure 3.16 below.

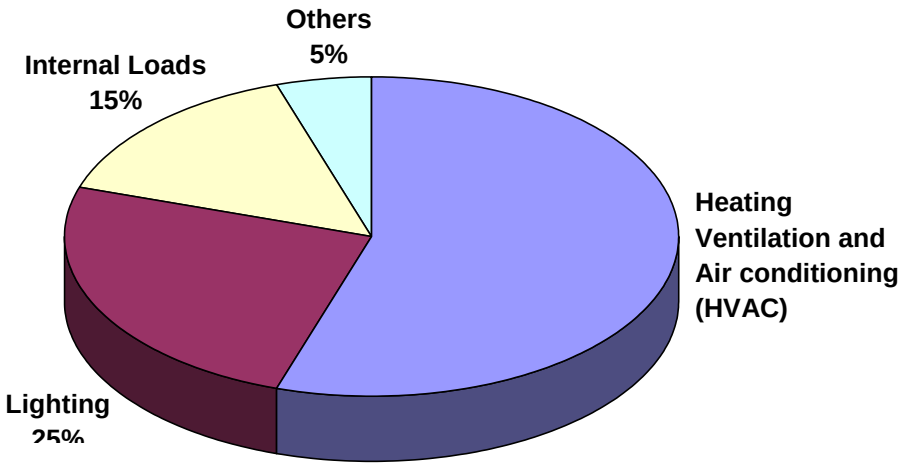


Figure 3.16: Energy consumption distribution in commercial building (Bureau of Energy Efficiency, Government of India)

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.

3.5.4 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:

3.5.4.1 Energy Conservation Building Code

Energy Conservation Building Codes, formally launched in May 2005, specifies the energy performance requirements of commercial buildings in India. ECBC has been developed by the Bureau of Energy Efficiency (BEE) and has been mandated by the Energy Conservation Act, 2001. The code covers buildings with a connected electrical load of 500 kW or more.

The purpose of this code is to provide minimum requirements for the energy-efficient design and construction of buildings. It is planned that the code shall be mandatory for commercial buildings or building complexes.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 the codes and standards, and in supporting compliance tools and procedures.

3.5.4.2 Green Building Rating Systems

Green building rating systems have come to India in a big way. One of the major green building rating systems currently operating in India is the Indian Green Building Council (IGBC) programme.

The number of green buildings indicating their aggregate area by rating categories by IGBC is given in the table below:

Green Building Rating Level	Number of Buildings rated	Built-up area (in sq.m)
Platinum	61	1,198,005
Gold	121	4,342,259
Silver	39	730,944
Certified	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 conventional buildings. Presenly, 95 percent of buildings coming up in the country do not conform to the ECBC/ ASHRAE codes.

The energy savings in green buildings (vis-à-vis ECBC / ASHRAE designed buildings) are in the following range:

- Platinum : 40-50 percent
- Gold : 30-40 percent
- Silver : 20-30 percent

- Certified : 15-20 percent

In some cases, buildings achieving certified rating have been designed for much higher energy efficiency than shown above. The large percentage of buildings that do not comply with ECBC/ASHRAE codes and the very large savings of some of the rated buildings indicate large potential for energy saving in the building sector.

- TERI – GRIHA > Eco housing

3.5.5 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 Sqft in 2005 to 15,200 Million Sqft 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 analyzed. 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.

3.5.6 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 Green Building Codes should be made a conditionality for finance under the new JnNURM in the 12th Plan. Similarly, 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 areas.

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.

As regards contribution of mitigation and adaptation actions in 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 1 mha 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)[21]. The cost of business-as-usual reforestation and afforestation activities is estimated at Rs. 5,000 crores 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 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 …) 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

[21] *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*

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. 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[22] suggest that incremental economic or investment costs incurred for mitigation of emissions will be sizeable and may divert resources from other critical sectors of our economy. During the 12th Plan, low carbon strategies must provide capital finance for improvements in technology, and mobilize both domestic and international sources of finance for enhanced deployment of renewable 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 the box 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)

[22] "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

Before deciding on the optimal strategy it is important to answer question 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. Trading should not be the only market based approach. Where markets exist, signals could be delivered through either price or quantities. Where they don't exist, and externalities are paramount; markets will need to be created as well as deepened.

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 the table 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 for Addressing Climate Change

The most obvious source of financing for climate action is the government budgetary support. Most of it comes as sectoral finance, though carbon mitigation is an important co-benefit. 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, and Metro-Rail Corporations etc. Additional budgetary allocations are available as grants from central resources as recommended by the 13th Finance Commission – three grants Rs. 5,000 crore each, viz. for forest cover, renewable energy and water sector have been recommended for the State Governments.

While the budgetary resources above flow through the Consolidated Fund, Government of India has created another window for climate action through the Public Account. With a view to generating 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 harnes 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; resource 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. Actions which generate climate benefits and 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 to complement 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 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 Performance, 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. The renewable power will achieve grid parity faster and may even be cheaper, if the fossil fuel power is market priced, and subsidy, if any, is transparent and timely paid up to the distribution utilities.

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.

5. Conclusion:

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 impacts of climate variability and 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.

As a matter of fact, India has already taken decisive steps in this regard. Over the Eleventh Plan Period, it has initiated the National Action 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. For any 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 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.

To achieve the objectives outlined in this chapter, a re-organized framework for the *National Action Plan for Climate Change* is suggested in the box below:

Re-organized 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 being released into the Rivers**
5. **Dedicated Freight Corridors along Major Routes**
6. **Improved Urban Public Transport**
7. **Climate Related Research through Scientific Departments**