Challenges for India towards a Low Carbon Industrial and Green Future.

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Abstract

Faster, Sustainable and more Inclusive Growth has been at the core of India's Policy and Planning during the last decade. In the Low Carbon Strategy, drawn up in 2014 for India, energy efficiency in household, buildings, Industry and Transport has been highlighted to play a major role. Low Carbon supply technologies such as solar and wind in the power sector, greater use of public transport and non-motorised transport are thought to be critical and increased sequestration through enlarged Green cover as important. It has been stressed that drastic reduction in the cost of renewable energy technologies can only assure achieving the GDP target along with reduced carbon emission, though benefits such as reduced, environmental pollution and imported energy will accrue. A macro model has also been evolved which provides insight into the inter-sectoral implications of different mitigation measures, which ensures that strategies recommended are mutually consistent. The paper discusses, the opportunities for energy savings in the Indian Iron,Steel and Cement Industries, sequestration of carbon dioxide through afforestation efforts and possible reduction in agricultural emission and the means to achieve them.

Introduction.

There is near consensus among the scientific community that ongoing global warming is an anthropogenic phenomenon, a result of carbon intensive activities since the industrial revolution. However, different countries are at different stages of development, and have had different emission trajectories in the past. On a per capita basis, India is one of the lowest emitters of greenhouse gases in the world, yet it is threatened by the impact of global warming and climate change.

In the year 2007, India's CO_2 equivalent emission was 1904.73 million tonnes of greenhouse gases, making it the sixth largest emitter of greenhouse gases in the world. India is, however, conscious of its global responsibility, and in December 2009, it announced that it would reduce the emissions intensity of its GDP by 20 to 25 percent, over the 2005 levels, by the year 2020. This voluntary commitment, which India has made to the international community, shows India's resolve to ensure that its growth process is sustainable and based on low carbon principles. With the approval of the Twelfth Five Plan by the National Development Council, sustainability has become an integral part of India's growth policy at both central and state levels.

Model evolved by the Expert Group

The Expert Group on Low Carbon Strategies for Inclusive Growth has evolved a macro-model to fully elucidate the inter-sectoral implications of different mitigation measures and ensure that the low carbon strategies being recommended are mutually consistent with each other. The Low Carbon Growth Model is a multi-sectoral, dynamic optimization model that maximizes present discounted value of private consumption subject to commodity supply, natural resource and technology constraints. The Expert Group takes the year 2007, for which India's official greenhouse gas inventory is available, as the base year, and makes projections going forward up to the year 2030.

The Model output is summarized through two endpoint scenarios: the BIG (Baseline, Inclusive Growth) and the LCIG (Low Carbon, Inclusive Growth). While inclusive actions remain unchanged between the two scenarios, low carbon strategies span the vector space between them. Pursuit of Low Carbon Strategies brings down the average GDP growth rate by 0.15 percentage points, while per capita CO_2 emissions (in 2030) fall from 3.6 tonnes per person in the BIG scenario to 2.6 tonnes per person in the LCIG scenario. However, in both the scenarios, the total carbon emissions continue to rise up to the year 2030.

The cumulative costs of low carbon strategies have been estimated to be around 834 billion US dollars at 2011 prices, over the two decades between 2011 and 2030. If these costs were borne entirely by domestic resources, the cumulative loss in output (GDP) between 2011 & 2030 would be 1,344 billion US dollars at 2011 prices.
While total power demand remains unchanged between the two scenarios, emission intensity of GDP declines by 22 percent, over 2007 levels (by 2030) in the BIG scenario, as compared to 42 percent, over 2007 levels (by 2030) in the LCIG scenario. Further, due to a massive change in the energy mix by 2030, demand for coal comes down from 1,568 Mt in the BIG to 1,278 Mt in the LCIG scenario, demand for crude oil comes down from 406 Mt in the BIG to 330 Mt in the LCIG scenario, while demand for gas marginally rises from 187 bcm in the BIG to 208 bcm in the LCIG scenario. At the same time, the installed wind and solar power capacities need to be increased to 118 GW and 110 GW respectively, by the year 2030, in the LCIG scenario.

Opportunity of energy savings in the Industry sector

The industries sector accounted for 21.7 percent of the total GHG emissions or 412.55 million tons of CO_2 eq in the year 2005. The sector comprises cement and iron & steel as well as other industries dealing with manufacture and processing of metals, mineralsand chemicals. Among all industries: cement,iron and steel are the largest; thereby feeding theboom in infrastructure growth in India. In theyear 2007, cement manufacturing and iron &steel production resulted in 6.8 percent emissions(129.92 million tons of CO_2 eq) and 6.2 percentemissions (117.32 million tons) respectively.Industries comprising other metals, minerals,chemicals, etc. released 165.31 million tons ofCO_2 eq i.e., 8.7 percent of the total GHG emittedin the year 2007. The GHG emissions from theindustry sector are a sum total of emissions fromfossil fuel/ biomass combustion as well as otherprocess related emissions.

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As per the EG LCIG report, the industry sector presents an opportunity for considerable energy savings, in the iron and steel, and cement sectors, which are the most energy intensive manufacturing sectors in the country. In Cement, use of high efficiency crushers and cooling fans, control of operations of kilns, installation of air-lifts with bucket elevators etc., have reduced displacement of particulate matter in the atmosphere and contribute to saving both energy and time. Additionally, in Iron and Steel, several energy efficient options like coke dry quenching, recovery of blast furnace gas and preheating of scraps have been introduced, that are also economically feasible. The main policy driver, the National Manufacturing Policy coupled with National Mission on Enhanced Energy Efficiency (NMEEE), has introduced the Perform, Achieve and Trade (PAT) scheme, which is estimated to lead to a cumulative energy savings of 6.7 Mtoe in the first round of the PAT cycle by 2015. An Energy Conservation Fund for promoting energy efficiency measures in the industry is also being explored as an alternative to PAT, as the former will addresses the latter's shortcomings of coverage and simplicity.

Promoting Energy Efficiency in Industry

Since Indian industries are growing rapidly, the industrial capital stocks will double every seven to eight years. Thus, concentrating on new industries to set up energy efficient plants is useful. Endorsement labelling of energy efficient industrial equipment such as waste heat recovery units, back-pressure turbines, variable speed drives, etc. should be encouraged as these inform investors' to select economically attractive equipment on their own. Energy efficient equipment can be promoted more effectively if energy prices are competitively determined. This, hopefully, will happen in the due course of time.

To promote energy efficiency in industries, a Perform, Achieve and Trade (PAT) Scheme has been introduced by the Bureau of Energy Efficiency. The PAT scheme covers some 400 large designated consumers (DCs) in 9 sectors including power generation. These together consumed 231 MTOE of energy, which is about 54 percent of the total commercial energy consumed in the country in the year 2007-08. BEE has made a heroic effort in getting DCs to agree on reduction targets, and over the first three-year period of 2012 to 2015, an energy use reduction target of 6.6 MTOE has been set, reflecting a reduction of around 1 percent per year. The main challenge is in setting firm specific mutually agreed upon energy targets. Energy consumption in a firm depends on the source and quality of raw materials, product mix location of plant, scale of operation, processes, vintage, capacity utilisation, etc. This will provide incentives and opportunity to firms for negotiating a low energy reduction target. The outcome of the PAT scheme should be carefully monitored and eventually adapted in line with the feedback of implementation experience in the first cycle. Another challenge is posed by the lakhs of small and medium enterprises and other industry not covered by PAT scheme, which the Twelfth Plan Document calls the non-PAT Industry. The Energy Conservation Act provides for an energy conservation fund to incentivise energy efficiency measures in such industrial units. Some of these SMEs are located in clusters. The BEE is examining about 25 clusters to see how there SMEs can be incentivized to improve energy efficiency. The cluster approach has not worked very well with regard to the functioning of common effluent treatment plants. Thus, getting a cluster of SMEs to act in a coordinated manner, in situations where opportunities for free riding exist, is difficult. The Twelfth Plan recommends that, while the PAT should continue to evolve, it would be useful to envisage a combined Energy Efficiency Package, consisting of the PAT scheme and an Energy Conservation Fund, to be implemented by a unified Central Government agency, namely, the Bureau of Energy Efficiency (BEE). The legal provision for this already exists in the Energy Conservation Act 2001, wherein under Section 13, the BEE is empowered to levy fees for services provided for promoting efficient use of energy and it conservation. Assistance for waste heat recovery systems, and preparation of detailed project reports to finance adoption of energy-efficient 119 technologies, are particularly important for non-PAT industrial units, which typically cannot arrange such help on their own. Unlike the coal cess which is deposited in the Government account, the energy efficiency fee will be deposited in the Central Energy Conservation Fund managed by the BEE (Section 20 of the Energy Conservation Act). The collections from the fee could be supplemented by international funding, as well as block grants from the Central Government through the NCEF. Energy Conservation Fund could be used to leverage and/or finance energy-efficient technology up-gradation of the domestic industry, particularly non-PAT industry, on terms softer than commercial borrowing. While participation under the scheme would be compulsory for non-PAT industry, industrial units participating in the PAT scheme could also be permitted after one or two PAT cycles are successfully completed. 10.2.6 Policy for Transport.

Sequestration of Carbon dioxide through Afforestation.

Forests are a significant part of the carbon cycle. A carbon sink absorbs CO2 from the atmosphere and stores it as carbon. In the case of a growing forest, carbon storage takes place in the form of wood, other vegetation and soil carbon. Investment in this sector not only increases the carbon sink, but also contributes to the national GDP. The mitigation efforts discussed for increasing the sequestration potential of forests are multi-pronged, involving sustainable management, conservation and improvement in the density of existing forests, facilitation of wood products use management and promoting efficiency in the use of fuel-wood at rural homes. Government of India needs to allocate more resources to the Green India Mission to enhance the stock of growing forests, and to improve the provisioning of ecosystem goods and services in the country. As far as implementation is concerned, a two pronged strategy is recommended; first, that chases the explicit low carbon targets, and second, that combines policy instruments like energy pricing, carbon tax, capand-trade, subsidies and regulation in the right mix. Since low carbon strategies are multi-sectoral and inter-disciplinary in nature, a body like the Planning Commission, whose mandate is to formulate growth policy and coordinate it across the Central Ministries and the States, is best placed to periodically monitor the achievement of these targets, and to place it before the Union Cabinet for information and direction. The Expert Group strongly recommends that this should be done on a yearly basis. As the Expert Group becomes functus officio, it leaves behind, a new model of growth policy, which incorporates faster, inclusive and sustainable growth in an integrated framework. Domestic policymakers and negotiators alike, will need to revisit and rerun this model, to better understand, in an endogenous framework, the growth and development implications of any proposed low carbon strategy, as also to monitor the achievement of low carbon targets from time to time.

Forests and tree vegetation play an important role in the mitigation of climate change by absorbing CO2 from the atmosphere and turning it into biomass comprising of microbes, herbs, shrubs, climbers and trees. Carbon is stored aboveground in biomass, and underground in biomass and soil. Use of forest products as fuel wood and in manufacture of household fixtures and furniture is also capable of enhancing the mitigation service provided by forests. The increase in mitigation can be affected by direct actions like increase and improvement of forest and tree cover; and also by indirect actions like promoting use of wood in household fixtures and furniture, and encouraging adoption of fuel efficient stoves to economize on use of fuel wood. Forestry assumes added significance as investment in this sector doubly reduces emissions intensity; firstly, by increasing the forest carbon sink, and secondly, by increasing the GDP. In a nutshell, the forestry sector positively influences the numerator as well as the denominator of emissions intensity. Thus, the forestry sector can reduce emissions intensity in two ways; by expanding and improving the present forest and tree cover to increase sequestration, and by promoting more efficient use of fuel wood and replacing energy intensive metal and plastic products with wood substitutes in the building sector. The responsibility to report on changes in forest and tree cover in India vests with the Forest Survey of India (FSI), which brings out the State of Forest Report (SFR), every two years. According to the FSI, the forest and tree cover in India has been registering an upward trend. The SFR 2009 shows that the forest cover grew from 69.02 mha in 2005 to 69.09 mha in 2007. The increase in tree cover for the same period has been estimated at 9.17 mha in 2005 to 9.28 mha in 2007. The general trend of growth in forest and tree cover of India indicates an increasing forest carbon sink. The National Forest Policy of India, 1952, aimed to bring 33 percent of land under forest cover. India has launched the national Green India Mission which aims to bring 10 million hectares of additional land under forest cover by 2021.. The overarching objective of the Mission is to increase forest Practices for management of wildlife protected areas and other specifically conserved forest areas resulting in saving and maintenance of existing forest carbon stocks can be grouped under conservation (CN) forests. These are best areas for carbon service. Other forest areas which are subject to harvests and are managed according to prescribed working or management plans can be put under sustainably managed forests (SMF). CN and SMF are the terms used in the Bali Action Plan in the context of Reducing emissions from deforestation and forest degradation (REDD)1 . Management practices of CN and SMF over a period of time would not only result in maintaining existing forest carbon stocks, but would also affect an increment in their quantum due to natural process of growth of conserved vegetation. Use of improved and more energy efficient wood-burning cooking stoves can also help in saving wood biomass and thus contribute towards conservation of forests and trees. Enhancement of forest carbon stocks can be achieved by increasing the forest area, or the carbon density and/or increasing the pool of carbon stored in a given forest or wooded area. In this case, the basic actions would comprise afforestation, reforestation, agroforestry, and energy plantations (fuel wood and biodiesel).

Carbon emissions in other sectors like energy can also be avoided to some extent by burning sustainably produced and harvested biomass instead of fossil fuels, e.g., using energy plantations to run a power plant, substituting industrial products that are currently fossil-fuel intensive in their manufacture (e.g., substituting cement by lumber) with wood products. Summary of carbon sequestration estimates of different forestry mitigation options is given in Table 8.1.

tree cover to 5 million ha and improve quality of forest cover for another 5 million ha between 2010-11 and 2019-20 through afforestation and eco-restoration activities by strengthening local community institutions like JFMCs and FDAs. Thus, the Mission will help in improving ecosystem services in 10 million ha of land, and increase flow of forest based livelihood services, and income of about 3 million forest dependent households. The Mission is innovative in several respects: • First, it proposes a fundamental shift from our traditional focus of merely increasing the quantity of our forest cover, towards increasing its quality and improving provision of ecosystem goods and services. • Second, the Mission proposes to take a holistic view of greening, not merely focus on plantations to meet carbon sequestration targets. There is a clear and more important focus on enhancing biodiversity, restoring ecosystems and habitat diversity. • Third, there is a deliberate and major focus on autonomy and decentralization. The Mission will be implemented through an autonomous organizational structure with a view to reducing delays and rigidity, while ensuring accountability. The mission will help local communities at the heart of implementation, with the Gram Sabha as the overarching institution overseeing Mission implementation at the village-level. The Joint Forest Management Committee would be revamped as Committees of the Gram Sabha. This is in consonance with the fact that forests are a source of livelihood for over 200 million people in the country, and hence centrality of their participation is critical. A key innovation is the idea of engaging a cadre of young 'Community Foresters', most of whom will be from scheduled tribes and other forest dwelling communities, to facilitate planning, implementation and monitoring of Mission activities at local level. 1 Reducing emissions from deforestation and forest degradation (REDD) is a mechanism that has been under negotiation by the United Nations Framework Convention on Climate Change (UNFCCC) since 2005, with the twin objectives of mitigating climate change through reducing emissions of greenhouse gases and removing greenhouse gases through enhanced forest management in developing countries.
Table 8.1 Summary of Carbon Sequestration Estimates of Different Forestry Mitigation Option Net Carbon Sequestration Conservation and Improvement of Existing Forests (1) Protected Areas (PAs) Avoided emissions from deforestation and forest degradation through conservation of existing protected areas (PAs) covering 16 mha of forest land and accounting for 5 percent of the geographical area of the country are capable of adding 2 tonne of dry biomass per ha on an

average every year. Continued protection of PAs will add 47 mtCO2 eq to forest carbon sink every year. (16*2.0*0.4= 12.8 mtC= 47.0 mtCO2 eq) (2) Sustainable Management of Forests other than PAs Unlike PAs where no harvests are allowed, other forests (53 mha) in general are subject to sustainable harvests. However, quantity of wood removed is less than annual increment resulting in net addition of forest carbon stocks. Such managed forests are capable of adding 0.8 tonne of dry biomass per ha every year. These forest areas being managed for sustainable harvests are adding 62.0 mtCO2 eq to the forest carbon sink every year. (53*0.8* 0.4= 16.96 mtC= 62.0 mtCO2 eq) (3)Improvement in Forest and Tree Cover Aims at improving 1 mha area each of open forests and medium dense forests with a view to upgrading these forests to the next higher category, i.e., open forest (OF) to medium dense forest (MDF), and medium dense forest to very dense forest category (VDF). Underlying assumption of carbon enhancement is that upgradation of OF to MDF and MDF to VDF will respectively add 0.2 and 0.3 tonnes of dry biomass per ha every year. This improvement is capable of adding 7.3 mtCO2 eq to the forest carbon sink every year. (10*(0.2+0.3)*0.4= 2.0 mtC= 7.3 mtCO2 eq) (4) Improved Woodburning Cookstoves Avoided emissions from excessive use of fuel wood in cooking stoves in rural areas (800 million people or 160 m families) can significantly contribute to increase in forest carbon stocks by replacing ordinary cooking stoves with improved fuel efficient cooking stoves. Carbon sequestration is enhanced because of fuel wood saved due to use of improved cooking stoves. Presuming that 75 percent of the fuel biomass used in rural areas comes from forest, and also that cooking stoves can reduce the fuel wood consumption by about 30 percent by improving energy efficiency, each rural family using fuel wood for energy can save about 300 kg of fuel wood annually, and consequently will not extract that much quantity of biomass from the forests. Since the forests from where the fuel wood is extracted are usually degraded, and still growing, the entire quantum of fuel wood saved would result in equal amount of biomass left intact in the forests, thereby offsetting corresponding amount of emissions equal to 58.2 mtCO2 eq. (160*0.75*0.3*0.4=14.4 mtC*44/12=52.8 mtCO2 eq). Afforestation (5) Increase in Forest and Tree Cover in Forest Fringe Villages Additional area of 17 mha can be added by creating forest and tree cover in and around 170,000 forest fringe villages. Every year, on an average, 1.7 mha can be afforested/ reforested every year. This option will sequester an additional 1 tonne of dry biomass every year. The village forests will include energy plantations raised for the purpose of replacing fossil fuel with renewables like fuel wood and biodiesel. Agroforestry can also substantially contribute in increasing the tree cover in and around forest fringe villages. For calculating, CO2 eq sequestered, it is presumed that 50 percent of the biomass every year will be removed by the villagers for meeting their household needs. This option has the potential of adding 12.5 mtCO2 eq to the forest carbon sink every year. (17*0.5*0.4=3.4 mtC*44/12=12.5 mt CO2 eq) (6) Green India Mission Although the mission is yet to be finalized, on a very conservative estimate, at least 6 mha of degraded forest lands can be planted under the Green India Mission under the Ministry of Environment and Forests. Wood Products Use Management (7) Harvested Wood Products Management (as substitutes) Wood products store carbon for a long time, and encouraging their use in building construction substituting cement by lumber, and metallic door and window frames and wall cabinets with wood based products has the potential of saving 2 tonnes of CO2 eq emissions for each cubic m of metallic hardware replaced (8) Replacement of office and domestic furniture using metals with wooden furniture It is estimated that at present 35 percent of furniture used in office and homes is made of metals and plastics (Anon. 2008). Replacing metallic and plastic furniture with wooden products would not only enable storage of carbon in wooden furniture, but would also replace more energy intensive metal and plastic furniture. Presuming that 50 percent of the furniture made of metals and plastics can be substituted by wood based furniture every year, such action would result in replacing about 1.5 million cubic m of metal and plastic furniture, sequestering an additional 3 million tonnes of CO2 eq every year. The proposed mitigation actions in the forestry sector should be completed by 2030. 8.2.2 Costs of Actions Mitigation actions proposed in this report are estimated to cost Rs. 11,400 crore every year over an action period of 10 years. The total amount required for the 10 year period will be Rs. 114,000 crores. The break-up for the annual cost of Rs. 11,400 crore is given below: Addition of 1 mha @ Rs. 50,000/- per ha=1mha*50,000 = Rs. 5,000 crores per year Upgradation of 2 mha of forest land @ Rs. 20,000/- per ha=2mha*20,000 =Rs. 4,000 crores per year Addition of 100 ha of forest in forest fringe villages @ Rs. 10,000/- per ha=1.7 mha*10,000 =Rs. 1,700 crores per year Improved 1 crore cookstoves =Rs. 300 crores per year @ Rs. 300/- per piece Wood based products as substitutes (lump sum) =Rs. 300 crores per year Total cost of forestry mitigation actions =Rs. 11,300 crores per year The activities that can contribute significantly in providing additional mitigation service over and above the present level of contribution in forestry sector are following: i) Increase in forest and tree cover by 1 mha every year: By afforesting/reforesting 1 mha of area every year, either under Green India Mission or otherwise, additional sequestration of 14.7 mt CO2 eq every year can be achieved. ii) Creation of 100 ha of forest in 170,000 forest fringe villages: This initiative will be able to capture additional 12.5 Mt CO2 eq every year. iii)Improvement in forest cover: Upgradation of 1 mha of open forest to medium dense forest, and another 1 mha of medium dense forest to very dense forest category can help in capturing an additional 7.3 Mt CO2 eq every year. iv) Harvested wood products as substitutes: If every year, 1 million cubic m of metallic hardware products are replaced by wood based products, an additional emissions reduction of 2 Mt CO2 eq every year can be achieved. v) Replacement of office and domestic metal and plastic based furniture: Replacement of all metallic and plastic furniture by wood based products is capable of reducing emissions by 3 Mt CO2 eq every year. vi) Use of improved wood burning cooking stoves: This is a very potent initiative and has the capability of reducing emissions by 52.8 Mt CO2 eq every year (NSSO. 2002). If the aforesaid options taken up simultaneously, there is a potential of capturing an additional 92.3 Mt CO2 eq every year, by the year 2023 onwards, thus neutralizing the quantum of emissions annually. The additional mitigation service provided will be able to offset an additional 5.3 percent of India's emissions at 2007 levels. This performance can be further accelerated if the industry comes forward as part of its corporate social responsibility. The industry sector could create awareness amongst village communities about raising tree plantations and orchards on private and community lands with a view to improve the socio-economic conditions of the rural people, and also contributing towards climate change mitigation. Needless to say, the initiative would be a win-win situation for both, local community as well as the industry sector. The former will benefit by enhanced income generation and latter by having access to increased availability of the wood based industrial raw material. Total cost of forestry mitigation actions is estimated at Rs. 11,300 crore per year, whereas the value of additional mitigation service2 after 2023 will be worth 2 Value of forest mitigation has been calculated at USD 10= Rs. 550 for each tonne of CO2eq added to the forest carbon sink. Rs. 5077 crore every year. If the value of present mitigation by India’s forest and tree cover (138.2 MT CO2eq) is added to the additional service by the measures proposed in this report, the total mitigation service from forest sector will be worth Rs. 12678 crore (7601+5077) annually 2023 onwards. Role of coordinating and implementing agencies will respectively be discharged by the Government of India in the Ministry of Environment and Forests (MoEF) and Forest Departments (FDs) of the State While the Green India Mission (GIM) targets may increase forest cover, pressures on land may reduce grasslands. We have assumed a reduction of 10 million hectares in grass land cover. We have also assumed that the use of fuel wood for cooking will go down as Governments. MoEF will be the central nodal agency for guiding, coordinating and monitoring implementation of the options. At the State level, this role will be discharged by the Forest Departments. 8.3 Estimate of Sequestration While the above describes the possibilities, we make an estimate based on somewhat modest assumptions. Table 8.2 describes GHG sequestration as per estimates in India’s national communication. We use these rates implied by this. incomes go up and as a part of inclusive growth clean cooking fuel in the form of LPG is provided as an entitlement to all households. Of course some amount of fuel wood burning will continue. Table 8.3 shows the projections. Table 8.2: GHG Sequestration in 2007 by Forests (Million Tonnes per Year) Table 8.3: Projected GHG sequestration from LULUCF (in million Tonnes of GHG/year) Source: MOEF (2010) Notes: 2007 data from India's GHG Emissions in 2007, MoEF Per hectare forest sequestration from green India Mission in Interim report Crop land assumed to change little in net sown area basis grass land loss assumed to stop at 10 million ha Fuel wood use will reduce as LPG is provided though some will continue Forests Crop Lands Grasslands Firewood Total MT of CO2 67.8 207.52 -10.49 -87.84 176.99 Area in Million Ha 67.8 181 61.3 Forests crop lands grass lands Firewood Total 2005 65 205 -10 -85 175 2010 69 207 -10 -90 176 2015 73 207 -10 -90 180 2020 83 207 -9 -75 206 2025 90 207 -9 -60 228 2030 90 207 -9 -60 228 2035 90 207 -9 -60 228 CARBON SEQUESTRATION 99 Other Ecosystem Goods and Services: Carbon sequestration is only one among the many ecosystem services provided by the forests. The other services from forests support and supplement livelihood needs like fuel wood, fodder, food supplement and medicinal herbs, etc. for a large number of forest dependent people, especially rural and tribal communities. Forestry actions aimed at reducing emissions intensity and described in this report take due note of this reality, and ensure 8.4 Implications and Policy Apart from implementation of the Green India Mission, the green cover can be enhanced by a number of measures that can augment sequestration. The government should allocate adequate resources under NCEF towards GIM. A framework should be evolved wherein the industry sector may be asked to allocate a certain percent of CSR funds for enhancing green cover in urban areas (city forests) and villages (village forests). that forestry mitigation options do not result in any hardship to the local communities on account of their livelihood needs. It may be mentioned that quantum of ecosystem goods and services is directly related to the extent of the forest and tree cover. Therefore, any efforts aimed at increasing and improving the mitigation potential of forests will have a positive bearing on all goods and services flowing from these forests. (See Box 8.2) Sequestration can also be increased by curtailing use of fuel wood for cooking by promoting use of improved wood burning cook stoves in rural areas and by replacement of wood burning cook stoves with less emission intensive fuels like LPG. Provision of clean cooking fuels is an important element of inclusive growth. While provision of LPG to all rural households may take time, other low emission and clean cooking technologies may be promoted. As growing forests sequester more carbon than a mature forest, the sequestration rate can be increased.

Agriculture: The sector comprises biogenic emissions of CH_4 and N_2O due to enteric fermentation in livestock, anaerobic emissions from organic manure and cultivation of rice, on site burning of agricultural crop residue, etc. Together, all these activities released 334.41 million tons of CO_2 eq in the year 2007, i.e., 17.6 percent of the total emissions. In the year 2007, livestock and rice cultivation together emitted 84.3 percent of the total CO_2 eq. emissions from the agriculture sector.

Energy Efficiency

The macro model considers several Autonomous Energy Efficiency Improvement (AEEI) options in the transition from the Baseline Inclusive Growth (BIG) to Low Carbon Inclusive Growth (LCIG) scenario. The resulting analysis indicates a reduction in 63 billion kWh of electricity, 741 MT of coal, 3 MT of petroleum products and 7 billion cubic meters of natural gas. Thus, there is 5.2 Iron and Steel Sector The iron & steel sector is one of the most energy intensive manufacturing industries, consuming about 25 percent of the total industrial energy consumption considerable scope for energy savings in industries. There are eight energy intensive sectors including thermal power plants, which collectively consume 156 Mtoe. Figure 5.1 shows the sectoral share of total industrial energy consumption in India. Cement, chemical, and iron & steel sectors are the most energy intensive industries. In this report, we have mainly focused on the technology policy interventions for these two sectors. (IEA, 2011) and accounting for about 117.32 Mt CO2 emissions in 2007 (MoEF, 2010). Figure 5.2 illustrates the projected estimates for the year 2020. The industry could reach production levels of 136 Mt with a capacity of 165 Mt. 5 Energy Efficiency in Industry Figure 5.1: Industrial Energy Consumption (2009), India (150 MTOE) ENERGY EFFICIENCY IN INDUSTRY 57 Figure 5.3 illustrates the expected trend of total emissions and specific emissions in the Indian steel industry, along the projected crude steel production. The National Steel Policy has developed a roadmap for the Indian steel industry with the objective of attracting domestic and foreign investments. Its target If the projected steel production trend is followed as shown in Figure 5.2, the total emissions could increase from 227 to 415 Mt. is to reach crude steel production capacity of 300 Mt with a production level of 275 Mt by 2025-261 . Figure 5.2: Projected Capacity and Production (2011-2020) Figure 5.3: Total and Specific Emission of Indian Iron & Steel Industry 0 20 40 60 80 100 120 140 160 180 2011-12 2012-13 2013-14 2014-15 2015-16 2016-17 2017-182 018-19 2019-20 Million Tonnes (Mt) 227 243 260 278 298 318 340 363 388 415 3.08 3.05 3.02 2.99 2.96 2.93 2.90 2.87 2.84 2.81 2.65 2.70 2.75 2.80 2.85 2.90 2.95 3.00 3.05 3.10 0 50 100 150 200 250 300 350 400 450 500 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2/tcs) Total Emissions (Million tons) Year Total Emissions 1 National Steel Policy 2012 58 LOW CARBON STRATEGIES FOR INCLUSIVE GROWTH Table 5.1: Strategic Goals for Indian steel industry Figure 5.4: Cement Production Estimates (million tonnes) Parameter/Area Unit Existing Level Strategic Goal/ Projection by 2025-26 Specific Energy Consumption GCal/tcs 6.3 4.5 CO2 emissions tCO2/tcs 2.5 2.0 Material Efficiency percent 93.5 98.0 Specific Make up Water Consumption (Works excluding power plant) T/tcs 3.3 2.0 Utilization of BOF slag percent 30 100 Share of continuous cast production percent 70.0 95.0 BF Productivity T/m3/Day 1.9 2.8 BOF productivity No. of Heats/ Converter/year 7800 12000 R&D expenditure/turnover percent 0.2 1.5 5.3 Cement Sector India is currently the second largest cement producer in the world. India’s per capita consumption of 150 kg in 2008 was about a third of the world average (Planning Commission, 2007). However, with a construction boom and infrastructure development, The minimum and the maximum values for the specific energy consumption (SEC) from 1950-60 to post 2000 are illustrated in Figure 5.5.5. During 1950 – 60, wet process was the predominant technology. This was gradually replaced by Dry Process. In 1980, this number is poised for a steady growth. Most of India’s cement plants are energy efficient. However, the presence of several smaller units with high Specific Energy Consumption (SEC) raises the country’s average SEC. Figure 5.4 illustrates the production estimates till 2030. several cement plants had a Dry-4 Stage Preheater (PH) and Precalciner (PC) installed with the Dry process. In 1990, Dry-5/6 Stage PHs/PCs, Vertical Roller Mills (VRM) & Pre-grinders, and advanced coolers had been installed in a few plants (dry 191 447 729 0 100 200 300 400 500 600 700 800 2007-08 2020-21 2030-31 ENERGY EFFICIENCY IN INDUSTRY 59 Figure 5.5: Historical thermal SEC over the last six decades process in 90 percent of plants). Post 2000, doublestream PH, pyrostep coolers, high pressure grinding rolls, advanced kiln control system and Information Technology (IT) based plant operation were in place in some of the cement plants. Moreover, 96 percent 5.4 Energy Efficiency Interventions 5.4.1 Iron and Steel Industry Steel is predominantly manufactured by blast furnace and direct reduction routes. The primer is treated with oxygen based furnace to produce steel. It later requires electrical furnaces producing specialised steel by mixing with scrap and other alloys. There are several possible energy efficiency intervention options in steel industries such as the following. Coke Dry Quenching (CDQ): This measure is an alternative to traditional wet quenching of coke. It mitigates emissions, reduces dust and provides the ability to recover sensible heat. Injection of Pulverized Coal into Blast Furnace: Pulverized coal injection is a process in which fine granules of coal are blown in large volumes into the blast furnace; this intervention saves part of the coke production, thereby saving energy and reducing emissions and maintenance costs. of the plants were based on the dry process. These innovations in technology have enabled India to progressively reduce its energy intensity in the cement sector. Top Pressure Recovery Turbines: Electric power can be generated by employing

blast furnace top gases to drive a turbine-generator. Although the pressure difference over the generator is low, the large gas volumes can make the recovery economically feasible. Recovery of Blast Furnace Gas: Blast furnace gas can be cleaned and stored in a gasholder for subsequent use as a fuel or alternatively to generate electricity in a gas turbine. It is often enriched with coke oven gas or natural gas prior to use as fuel. Preheating of Steel Scraps: Using this technology can reduce the power consumption of EAFs through using the waste heat of the furnace to preheat the scrap charge. Old bucket preheating systems had various problems, e.g. emissions, high handling costs, and a relatively low heat recovery rate. Modern systems have reduced these problems, and are highly efficient. The projected emissions for cement and iron and steel
sectors under BIG and LCIG scenarios are provided in Figure 6 below. The projections illustrate that in iron Similarly in the cement sector, from the baseline, about 5.8 and 23.3 MtCO2 is expected to be avoided during 2020 and 2030 respectively. 5.4.2 Cement Industry Cement manufacturing is a linear operation. The process largely involves making clinker from lime stone by heating it in a rotary kiln, and later mixed with additives and ground to a fine powder. Following are a few important energy efficiency measures implemented in a typical cement plant Replacement of the existing fan with high efficiency fans: There are numerous fans in a typical cement plant, and these consume large amounts of energy. Replacing these with efficient fans leads to significant energy savings. Use of high efficiency crushers before the cement mill grinding: This option leads to reduction in power consumption. Large boulders of clinkers or raw materials, which may end up in the rolling mills could consume more time to crush into powder. If a crushing mechanism is placed before the fine grinding, it leads to saving energy and time. and steel industries, 23.9 MtCO2 could be mitigated by 2020 and 74.6 MtCO2 by 2030. High level control system for kiln operations: The kiln is an important equipment in a cement plant. The steady and controlled operation of the kiln is essential for producing a good quality clinker, higher level of output and lower energy consumption. Reduction of RPM (Rotation Per Minute) of the Centrifugal Silo: Optimise the air supplied to the CF silo for aeration and avoid / minimise venting of air by reducing rpm of the blowers. Installing high efficiency fans at the clinker cooling section: This intervention helps in reducing the temperature of the hot clinker faster. Additionally, this intervention could be coupled with a venting system for displacing air through a wider area. Increasing the grinding chamber size: This design intervention could take more quantity of clinker at a time for crushing and hence yield more production output. Replacement of the air-lift with bucket elevator for raw metal transport to the silo: This technology intervention eliminates the large compressor load and reduces displacement of particulate matter in the atmosphere. Figure 5.6: Iron and Steel Emissions 2030 162.6 438.9 698.0 162.6 415.0 623.4 0.0 100.0 200.0 300.0 400.0 500.0 600.0 700.0 800.0 2007-08 2020-21 2030-31 BIG LCIG ENERGY EFFICIENCY IN INDUSTRY 61 5.5 Implications and Policy National Manufacturing Policy – In 2011, India announced its national manufacturing policy with an objective to enhance the share of manufacturing in GDP to 25 percent with an additional job creation for 100 million. The policy encourages Public Private Partnerships (PPP) with an incentivised approach for large infrastructure projects, adopt cluster level model of self-regulation, instrumentally under National Investment and Manufacturing Zones (NIMZs). National Mission on Enhanced Energy Efficiency (NMEEE) – Under the National Action Plan for Climate Change (NAPCC), NMEEE is one of the eight missions. The objective of this mission is to perform energy conservation and mitigation of GHG emissions activities with a market based approach, allowing cost-effective technological strategies. NMEEE has four broad initiatives to include: Perform Achieve and Trade (PAT): A market based mechanism to enhance cost effectiveness of improvements in energy efficiency in energyintensive large industries and facilities, through certification of energy savings that could be traded. Market Transformation for Energy Efficiency (MTEE): Accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable. Energy Efficiency Financing Platform (EEFP): Creation of mechanisms that would help finance demand side management programmes in all sectors by capturing future energy savings. Framework for Energy Efficient Economic Development (FEEED): Developing fiscal instruments to promote energy efficiency About

478 industrial units were notified as Designated Consumers. An estimated cumulative energy savings of 6.686 Million tonne of oil equivalent (Mtoe) is expected in the first round of PAT cycle by 2015. Figure 5.8 illustrates the energy savings expected to be achieved from each sector and the baseline SEC of each sector.

Figure 5.8: Summary of Sectoral Energy Savings from First PAT Cycle TPP Iron and Steel Cement Aluminium Pulp and Paper ChlorAlkali Savings (Mtoe) 3.211 1.486 0.8160 .478 0.456 0.1190 .066 0.054 BL-SEC (toe/t) 0.549 0.088 0.394 2.005 0.656 0.166 0.393 Numbers of DCs 144 67 85 29 103 1 90 22 MAEC (toe) 30000 30000 30000 30000 7500 30000 3000 12000 Baseline Energy 104.1 25.321 5.01 8.27 .71 2.09 1.2 0.88 0.00 0.50 1.00 1.50 2.00 2.50 3.00 3.50 Energy Savings (Mtoe) The small and medium enterprises (SMEs) are not covered by the PAT scheme. Some of these SMEs are located in clusters. The BEE is examining some 25 clusters to see how these SMEs can be incentivized to improve energy efficiency. The SME program has an objective to improve the energy intensity in the SME sector, accelerate the adoption of energy efficient technologies, monitor and evaluate the practice at 25 manufacturing clusters across India. The main project activities are: energy use and technology analysis, capacity building, implementation of EE measures and facilitation of innovative financing mechanisms. Currently PAT has focussed on eight energy intensive sectors. PAT initiative needs further enhancement in terms of Widening by sectors: Inclusion of more additional sectors such as petroleum, sugar, glass, chemicals etc. Deepening the sector: Identify more industrial units in the existing sectors and encourage them to take benefits from PAT framework. A study by Center for Study of Science, Technology and Policy (CSTEP) evaluated more than 1300 potential industrial units across six energy intensive sectors. The study estimated the likely savings that could be achieved in the next round of PAT Cycle. Utilisation of waste/by products: Fly ash generated from power plants could be effectively utilised in cement manufacturing as a form of compound mixture. Similarly, blast furnace slag from steel industry is also one of the wastes which has potential in cement industry as well. Better policy addressing effective waste utilisation could be framed to suit specific industry. Monitoring and evaluation mechanism: The improvements in energy efficiency by using technology need to be closely monitored and evaluated by placing an organised audit mechanism. The process and results eventually helps in benchmark the performance of equipment, process, and industry. Considering the various challenges in implementation of the PAT scheme, in particular with the SME sector, a carbon tax could be another policy option to reduce emissions from industries. It can be gradually introduced by having fuel prices that reflect opportunity costs including the cost of CO_2 initially priced at a modest level. Many studies have shown that there exist, economically justifiable opportunities for energy saving. Despite these, firms do not go for them. The barriers to seizing such opportunities are often perceived risks and availability of up front finance. A mechanism needs to be set up to deal with these barriers. The UK has set up a fund, called ENERGY EFFICIENCY IN INDUSTRY 63 Carbon Trust, which takes care of these concerns. It gets, at its own cost, firm specific project reports which are prepared by hiring Expert Energy Service Companies (ESCOs) for improving energy efficiency. If a firm agrees to implement the project, the Carbon Trust also arranges finance. On successful completion, it charges the firm for the cost of project preparation. This mechanism has been quite successful. Enabling a similar fund to encourage and facilitate SMEs to increase their energy efficiency in addition to promoting energy efficiency in buildings could prove beneficial. References 1. International Energy Agency,. Energy Transition for Industry-India and the Global Context. [Online] 2011. http://www.iea.org/papers/2011/india_industry_transition_28feb11.pdf. 2. MoEF. India: Greenhouse Gas Emissions 2007. 2010. 3. Planning Commission. Report of the Working Group on Cement for the 11th Five Year Plan. 2007. 4. Bureau of Energy Efficiency. PAT Booklet. 2012.