

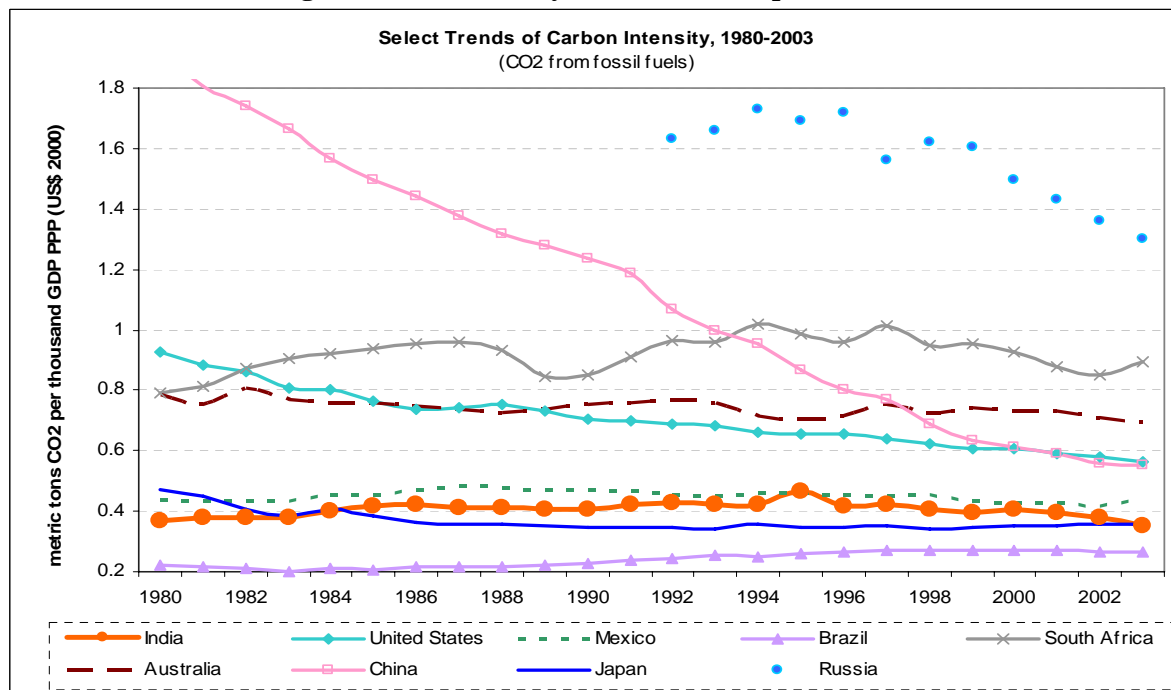
INDIA: STRATEGIES FOR LOW CARBON GROWTH¹

CONCEPT NOTE

Background

There is a broad scientific consensus that human-induced climate change is happening and poses a substantial threat to global development efforts. It risks undermining gains made in agriculture, health, and infrastructure and could impede progress towards meeting the Millennium Development Goals. Temperatures in India are projected to increase between 2.5 and 5°C by 2060, resulting in yield losses for many crops². An increased occurrence of extreme events (such as droughts, floods and cyclones) due to changing climate will affect the poor most, and can cause a significant loss of properties and lives. In the longer-term, a one-meter sea level rise would displace millions people in India³, and the costs to build walls along the zones vulnerable to sea level rise are deemed to be prohibitive. Therefore, successful global efforts to mitigate and moderate human-induced climate change are consistent with India's national interest.

Figure 1. CO₂ Intensity: India and Comparators



Source: International Energy Agency (IEA). 2004. CO₂ Emissions from Fuel Combustion (2004 edition), IEA, Paris.

¹ “Carbon” in this concept note refers to carbon equivalent of greenhouse gases. Greenhouse gas (GHG) emissions, causing climate change, consist of carbon dioxide (CO₂), which is the main contributor to the problem on a global scale, methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF₆). For example, carbon-intensity means the intensity of greenhouse gas emissions. Where only directly emitted carbon dioxide (CO₂) is meant, this note refers to CO₂ intensity.

² Kumar, K.S. and Parikh, J. (2001). “Socio-economic Impacts of Climate Change on Indian Agriculture”, *International Review for Environmental Strategies*, 2(2), pp. 277-93.

³ Asian Development Bank (1995). *Climate Change in Asia*. ADB. Manila.

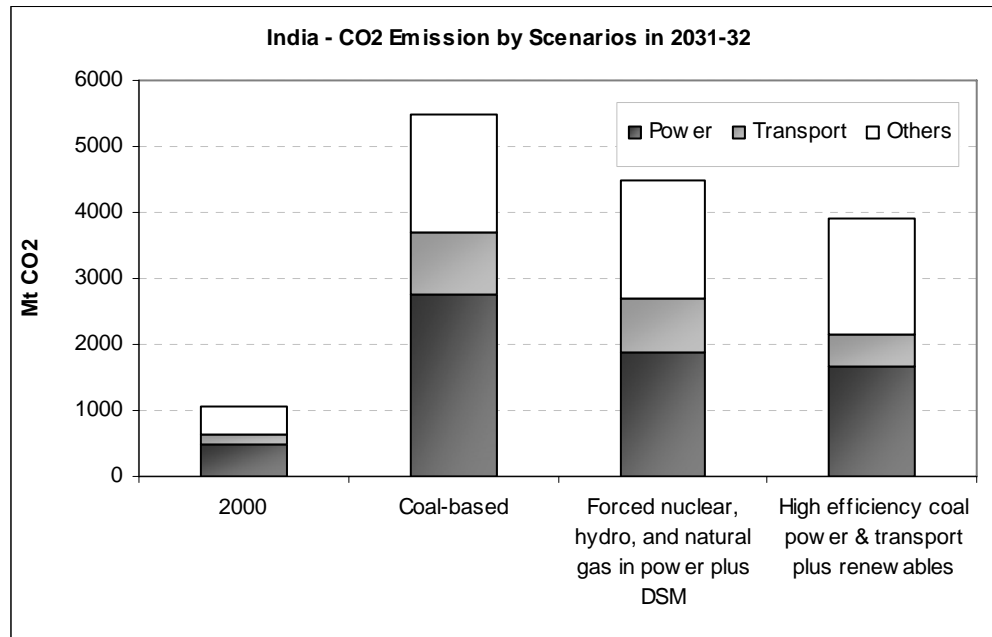
At the macro-economy scale, India is a *low-intensity* producer of CO₂ emissions. Its per capita CO₂ emissions are among the lowest in the world with around 1 metric ton (MT) per person compared with 4 for the world average and 20 for the United States. India also performs very well when compared to other economies on the basis of CO₂ intensity on per capita GDP (tons of CO₂ emissions per unit of GDP). India's CO₂ intensity, particularly when measured using PPP GDP, is among the lowest for "comparator" countries with significant aggregate CO₂ emissions and shares of coal (most carbon-intensive fossil fuel) in the energy mix. That is, it is much lower than the United States, Russia, China, South Africa, Australia, and close to that of Japan (see Figure 1).

Furthermore, despite being at a very low level in the early 1990s, India's CO₂ intensity remained stable and even declined slightly in the past decade, just as the rate of growth began to accelerate. There are several possible explanations of this macro-level performance despite significant inefficiencies and high energy intensities of certain sectors and segments of the economy. The economy's structure, with a sizable agriculture sector, and the service sector led growth have probably contributed to the low overall CO₂ intensity. India is also a relatively energy-scarce country, relying heavily on oil imports, and its power sector has not been able to meet the growing demand, resulting in poor reliability of grid power, significant supply shortages, and lack of access to electricity by about half of the rural population. The combination of exposures to power outages and oil price volatility might have affected the industry structure with respect to the use of energy and hence CO₂ intensity. These explanations are tentative and not complete, however. For example, the initiatives and plans proposed by the Integrated Energy Policy Report (GOI Planning Commissions, August 2006) are projected, if implemented successfully, to keep CO₂ intensity declining while massively expanding rural access and increasing power generation to meet the demands of a rapidly-growing economy. Therefore, the possible drivers for the past and projected CO₂ performance need to be explored and understood in more detail.

In absolute terms, reflecting India's status as the second most populous country in the world and the tenth largest economy with spectacular growth performance, its CO₂ emissions are at about 4 % of global CO₂ emissions -- following the United States (23%), China (17%), Russia (6%), and Japan (5%)—and rising rapidly. Currently at 1 billion metric ton (MT), CO₂ emissions are projected, accordingly to the Integrated Energy Policy Report, to be in a range of 3.9 to 5.5 billion MT by 2031 depending on the scenarios assessed in the report, which will include different power generation technology mix, demand-side management and some transport measures. In per capita terms, India's emissions of CO₂ will be 2.6 to 3.6 MT in 2031, below the world average level for 2004.

With respect to sources of national CO₂ emissions, power generation currently accounts for about 50 percent. Over time, its share will remain about the same or decline slightly (to 42 percent) in the above scenarios from the Integrated Energy Policy Report. The majority—50 to 60 percent—of future CO₂ emissions is projected to come from industry, transport, municipal and other sources. For example, in the scenario with the lowest total CO₂ emissions, 1.7 billion MT are attributed to power generation in 2031, and 2.2 billion MT to other sources, primarily industry (see Figure2).

Figure 2. India's CO₂ projections in the Integrated Energy Policy Report



Source: Planning Commission. 2006. Integrated Energy Policy. Government of India, New Delhi.

CO₂ emissions, however, explain only a part of the overall GHG story in India. India's CO₂ emissions currently account for 55 percent of total GHG emissions—against 90 percent in Japan, more than 80 percent in the United States and Russia, more than 75 percent in Brazil and Mexico, and about 70 percent in China and Australia. Methane and N₂O account for 23 and 22 percent of India's current GHG emissions, respectively. The largest source of India's total GHG is agriculture. Though agricultural emissions of CO₂ are below 1 percent of the country's total CO₂ emissions, agriculture dominates emissions of *other* greenhouse gases, accounting for 50 percent of India's methane (5 million MT) and even a large share of N₂O emissions (0.31 million MT). The primary sources of GHG emissions are from the large and growing livestock population—estimated to increase to 625 million by 2020, resulting in the highest density of cattle in the world—and the cultivation of paddy. The paddy area of India is approximately 42.3 million ha and is the largest in Asia. Flood irrigation of rice is the second major source of GHG emissions from agriculture, but India's *per hectare* emissions from rice cultivation are approximately 10 percent of the global average, reflecting the peculiarities of its soils, chemical applications, cultivars and planting regimes.

Table 1 illustrates the contribution of various sectors—and significant changes in relative contributions—to total GHG emissions vis-à-vis CO₂ only. Another special feature worth noting is that, unlike most developing countries where the on-going deforestation is a major contributor to GHG emissions, India's forest cover has stabilized thanks to its strong conservation policies and the pro-active interventions by the Supreme Court.

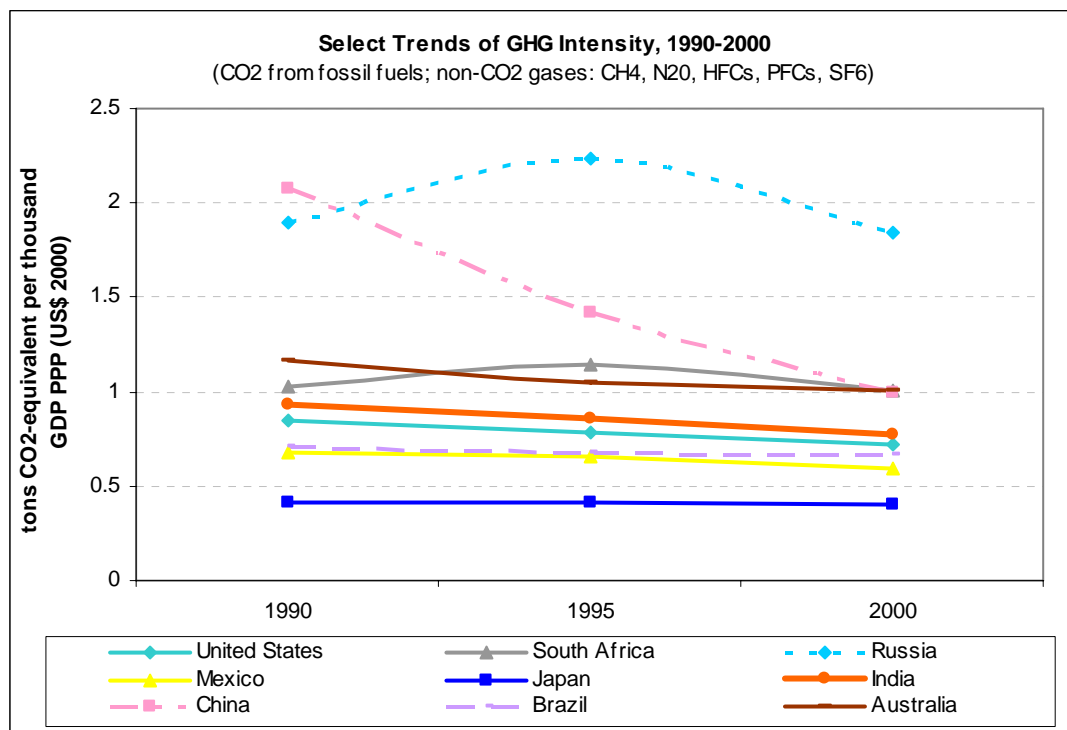
Taking account of non-CO₂ gases nearly doubles India's emission intensity, making it higher than those in Japan and the United States (see Figure 3), albeit lower than in China, Brazil, South Africa and Australia. On the other hand, *GHG intensity*, if anything, appears to have been slowly falling over time. This decline has been driven largely by structural changes in the India's economy (i.e. a decline in the share of agriculture GDP). Still, absolute emissions from agriculture will remain a significant contributor to total GHGs for a long time (available

projections by Shukla et al. for 2030 confirm this)⁴. The growing contribution of sectors other than power to CO₂ emissions, and significant contributions of non-CO₂ gases to overall GHG emissions, both highlight the critical importance of conducting a multi-sectoral analysis, combined with a need to better understand the unique features of India's GHG emission characteristics.

Sector	Share of total GHG emissions	Share of total CO ₂ emission
<i>Energy transformation and use</i>	56%	93%
Electricity/Heat	30%	53%
Manufacturing/construction	12%	21%
Transportation	5%	9%
Other fuel combustion	8%	9%
<i>Industrial processes</i>	3%	4%
<i>Agriculture</i>	34%	-
<i>Waste</i>	5%	-

Source: World Resources Institute, Climate Analysis Indicators Tool. (<http://cait.wri.org/>)

Figure 3. Total GHG Intensity: India and Comparators



Source: World Resources Institute, Climate Analysis Indicators Tool. (<http://cait.wri.org/>)

⁴ Shukla, P.R. et al (2003). "Future Energy Trends and GHG Emissions for India", in Toman, M.A. et al (ed.) Global Climate Change: Perspectives on Economics and Policy from a Developing Country. Resources for the Future, Washington DC, U.S.A. pp 11-35.

Strategic Context

Having signed the 1992 UNFCCC convention, India affirms the principle of “*common but differentiated responsibility*” for climate change. The initial focus in climate change negotiations, culminating in the Kyoto Protocol, has been on setting emission targets for the developed (so called “Annex 1”) countries and creating the Clean Development Mechanism (CDM), which enables GHG generating entities in developing countries to be paid for the incremental costs of reducing the emissions below a “baseline”. However, the 2005 Gleneagles Summit, attended by India, has presaged a new era where greater attention is being given to helping the developing countries reduce GHG emissions, and in particular those of “G+5” countries—comprising Brazil, China, India, Mexico and South Africa—whose emissions are both large and rising.

At Gleneagles, the G8 requested the World Bank and International Energy Agency (IEA) to take a leadership role for the climate change, clean energy and sustainable development agenda. IEA was asked to take the lead in energy scenarios and strategies and the World Bank in the creation of a new framework for clean energy and development including investment and financing. To date the scope of the problem has been estimated and the role of existing financial vehicles (GEF and carbon trading funds under the CDM) explored as well as the identification of possible new financial vehicles (the Clean Energy Financing Vehicle, the Clean Energy Support Facility and Carbon Continuity Fund) has started. India could benefit from the application of the existing financing facilities, help identify constraints and bottlenecks in availing of these resources effectively, and explore the possible need for new financial instruments.

These developments present India with *an opportunity* to evaluate and develop strategic options that address a major global and national concern about changing climate without compromising—but rather reinforcing—its growth and development objectives, by facilitating additional investments and transfer of technology. India has significant opportunities to accelerate growth while controlling the carbon intensity of its development path. This can be achieved by harnessing the substantial synergies between “low carbon” and economic performance through improving the efficiency of electricity generation, reducing technical losses in the power sector, enhancing end-use energy efficiency in various sectors, developing hydropower and renewable potential, and accelerating the adoption of new technologies. Moreover, there are many development benefits that India can capture with a well-designed low-carbon strategy including energy security, rural access through distributed renewable applications, cleaner air in cities and homes, reduced congestion, better waste management and even less water-intensive agriculture technologies for rain-fed areas. In short, a low-carbon growth strategy could be an opportunity to improve health, productivity and quality of life, particularly for the most vulnerable populations.

Carbon Finance will only make a significant contribution to a low-carbon economy in India through:

- **Participation of public sector and large emitters in the carbon market**
- **Moving away from current project-by-project approach, and scaling up to a program of investments**
- **Scaling up intermediation through the involvement of the financial sector across various sectors of the economy**
- **Increased confidence and credibility in the carbon market**
- **Designing and providing incentives for development of low carbon technology**
- **Systematically integrating carbon finance into public and private investment decisions.**

GHG Mitigation Modeling

The modeling efforts to estimate future CO₂ and GHG emissions and associated mitigation strategies under different development and policy scenarios in India have provided a good understanding of available opportunities, achievable goals, and the position of the country in the global arena. A number of studies have adopted the most advanced modeling techniques that combine top-down, bottom-up, and other approaches to project future emissions and assess policy options for India (see Table A.1).

A strand of studies considers the future scenarios that are consistent with those undertaken by IPCC. These scenarios are derived from a broad picture of future development paths based on specific technologies and policies. Another strand looks at more specific mitigation options, such as demand side management, renewable technologies, and alternative sources of energy. These two approaches are useful for evaluating different mitigation options for India and should be considered in parallel. These modeling exercises have been carried out at both the national and the international level, the latter treating India as a separate region.

The work undertaken for India has studied both medium-term (up until 2030-2040) and long-term (up until 2100) emissions. The majority of the studies were focused on CO₂ emission from the energy sector. However, the increasing international concern about climate change and the large proportions of both non-CO₂ gases and CO₂ emission from other sectors in India has drawn attention to the need to expand modeling capabilities to take account of various sectors and other greenhouse gases in the future emission scenarios. In addition, the growing national concern about the public health impact of local air pollution has motivated some studies to explore the policy links and potential co-benefits from managing GHGs and local pollutants.

Considerable efforts have been made to examine future GHG emission scenarios, but further developments and improvements of modeling capabilities are necessary to obtain more accurate and reliable results. There is a crucial need to improve the models to better reflect the realities of India and its developing economy characteristics, such as representation of subsistence agriculture and modeling the transition from rural to urban economy. Moreover, little efforts have been made to investigate the trade-offs associated with emission scenarios and policy options. Thus, there is a need to carry out a comprehensive cost-benefit analysis to lead the development of the optimal mitigation strategy for India. The integrated modeling approach, together with more detailed modeling of non-CO₂ gases from non-energy (e.g., agriculture, transport) sectors, is required to meet these challenges. India and global models that have been developed to take these additional considerations into account already exist and can provide a basis on which further model developments can be built.