# Mitigating Carbon Emissions in India

## The Case for Green Financial Instruments

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# Glossary of Terms

| | |
|---|---|
| CAGR | Compounded Annual Growth Rate |
| CDM | Clean Development Mechanism |
| $CO_2e$ | Carbon Dioxide Equivalent |
| GDP | Gross Domestic Product |
| Gg | Gigagram |
| GHG | Green House Gas |
| GOI | Government of India |
| GWP | Global Warming Potential |
| IEA | International Energy Agency |
| INR | Indian Rupee |
| IPCC | Intergovernmental Panel on Climate Change |
| KCAL | Kilo Calorie |
| Kg | Kilograms |
| kWH | Kilo Watt Hour |
| Mha | Million Hectares |
| MT | Million Tonnes |
| MoEF | Ministry of Environment and Forests |
| MW | Mega Watts |
| Nm3 | Normal Cubic Meter |
| OECD | Organisation for Economic Co-operation and Development |
| SEC | Specific Energy Consumption |
| $tCO_2$ | Tonne Carbon Dioxide |
| Tg | Teragram |
| USD | United States Dollar |

# Executive Summary

With the sun gradually setting on the Kyoto Protocol (Phase One), it has become quite apparent that the global response to resource scarcity and climate change is going to be variable and disaggregated. Increasingly, countries and businesses across the globe are adopting various financial mechanisms and policies in order to manage such challenges. However, many such responses are restricted to advanced, developed countries, whereas the effects of climate change and the increasing cost of resources such as fossil fuels are likely to be more severe for developing countries. This dichotomy in response measures needs to be urgently addressed, and this report is an attempt to highlight the benefits of an inclusive growth oriented financial response mechanism with particular focus on India.

In its first chapter the report briefly outlines the relevance of GHG emissions mitigation through inclusive market based mechanisms in India. With shifting patterns of economic growth and increased global demand volatility companies and investors in emerging economies, such as India, need to recognise the value created through the supply chain of business deliverables by mitigating emissions. Mechanisms which exclude companies that do not meet global benchmarks, whether by way of shareholder advocacy and investment exclusion, or regulatory policies, will have a significant impact on the way that these companies choose to grow.

Low carbon strategies can only be implemented if the emissions landscape and its effects on sustainable growth are clearly defined and understood. The second chapter outlines emissions trends in India in order to map the carbon landscape and set the context for the rest of the discourse. Chapter 3 examines the trends of energy consumption and emissions at a sector specific and firm specific level (within the assessed sector). It is found that firms in the assessed sector (cement) are operating in sub optimal conditions, along with a lack of policy frameworks and market based emissions reduction incentives - there are no indigenous market based mechanisms to incentivise and stimulate change.

A firm level case study of one of the bigger private players in the Indian cement sector has revealed that the firm's financial performance could have been better. At the same time, capacity additions and increased output have caused the total emissions of the company to increase, which is not sufficiently offset by the revenue gains. As a result, the firm's emissions intensity has been rising consistently for clinker production. However, enhanced use of additives has kept the overall GHG intensity of cement based revenue lower. The average emissions intensity of the company was higher for three years than the sector average for the same period. The high correlation between the firm's environmental performance and its financial performance has been highlighted.

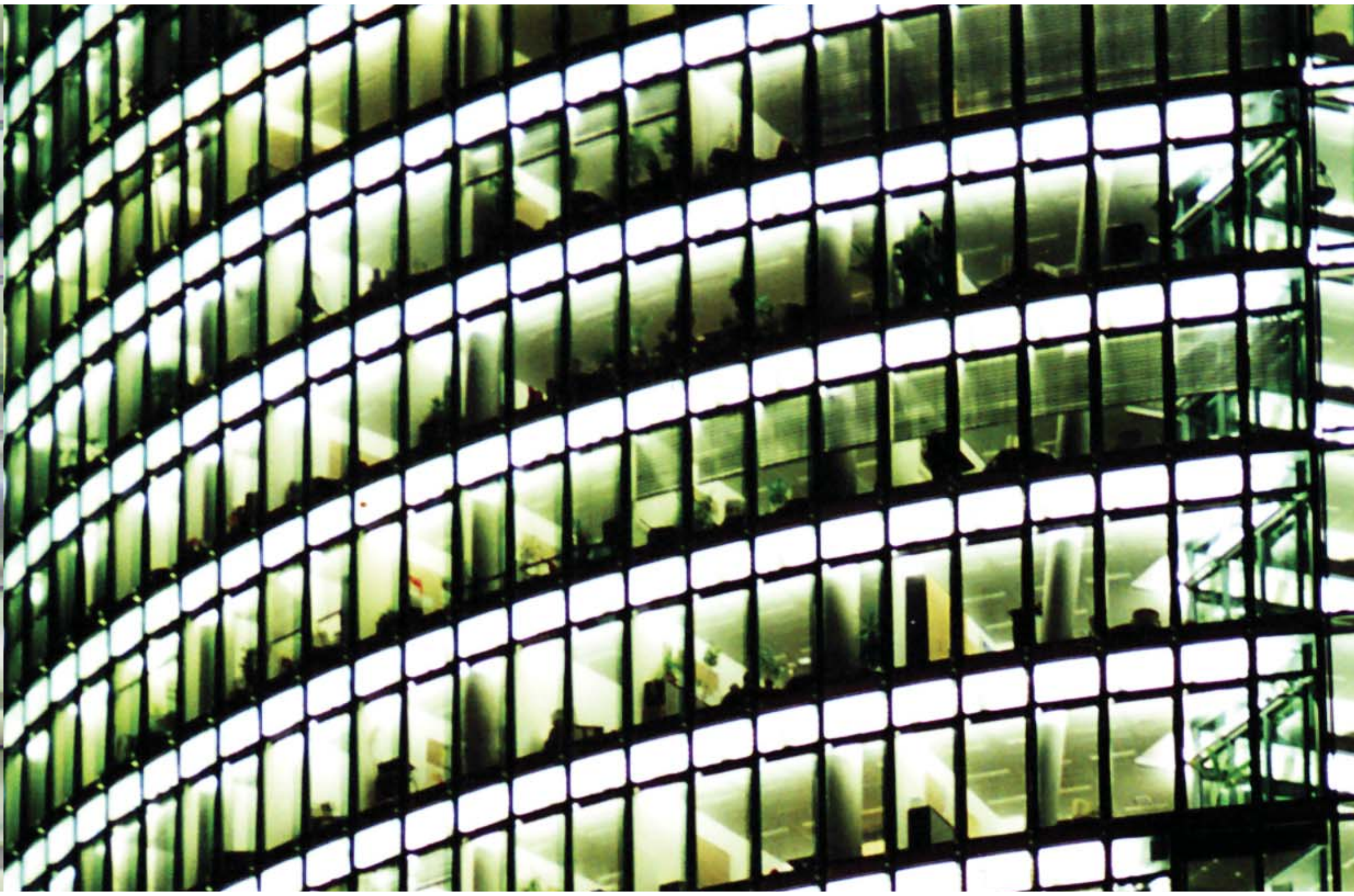
The results of chapter 3 are aligned with the philosophy that environmental performance must not be excluded from the range of parameters that are used by investors while choosing a stock, especially a long term investment. This is true since the two concepts are inherently interlinked under the overall aegis of sustainable growth. It highlights the need for developing market based mechanisms to signal investment opportunities based upon carbon efficiency and financial performance, as both tend to complement each other in the medium to long term.

Chapter four concludes that; **companies preparing for risk are not risk averse, but rather are risk prepared.** The difference is subtle but important. Market based mechanisms which incentivise good performance by channelling investments to firms that respond to risk better than their competitors in a given environment, help investors realise this distinction clearly. For "green" market mechanisms and investment vehicles to be viable and effective, they must efficiently ensure that the transmission mechanism works and only performance based, credible signals are relayed to the open markets. This becomes even more important in the context of a developing country due to the nascent capital markets, and urgent need for scaling up sustainability initiatives – both at the firm and policy levels.

Capital generation should not be looked at as the problem. Rather, redirecting existing and planned capital flows from traditional high-carbon to low-emission; resilient investment is the key challenge of financing transition to a low-emission economy. In order to facilitate such transitions, a universally replicable model will be used - a multipronged approach to achieve the above objectives. This would involve creation of innovative financial products based on purely quantitative data, create and publish sector wise and cross sectoral market reports, and facilitate progressive policy advocacy in order to enable market realisation for its products. It will further seek to replicate the model in other developing countries through a hub and spoke approach to expansion.

Chapter 1

# Relevance and Benefits of Mitigating Carbon Emissions through Market-based Mechanisms



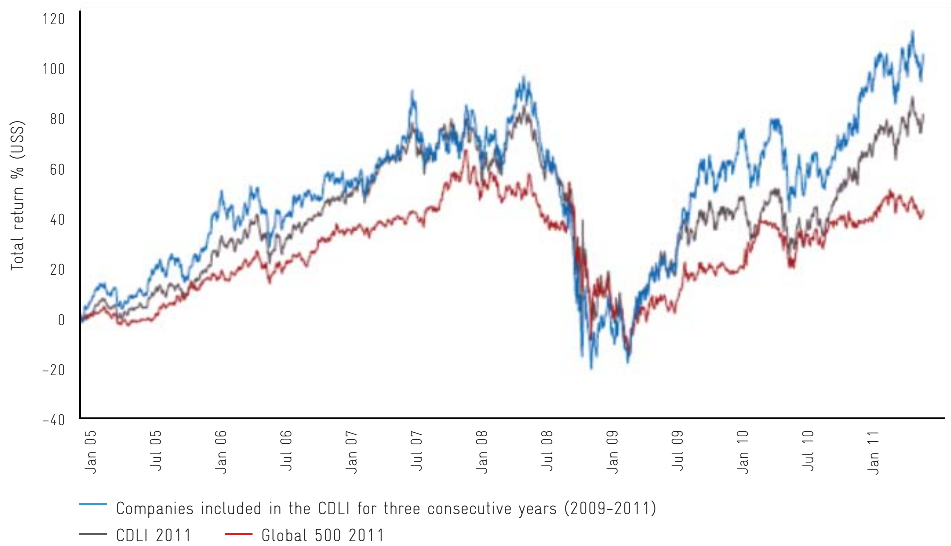
## I Relevance of Market-Based Mechanisms

The mitigation of greenhouse gas emissions (generically called carbon emissions) is an imperative that businesses, investors and governments must act upon. The global carbon mitigation market is largely a regulatory market, where different stakeholders act within the mandatory mechanisms imposed by governments in their respective regions. The European Union Emissions Trading Scheme (EU-ETS) is the largest such market for carbon mitigation in the world today. Almost a dozen trading platforms exist all over the world dealing in around 17 market based instruments. In India, only the MCX stock exchange trades in CER futures.

The relevance of carbon mitigation mechanisms for developing countries like India cannot be overstated. Carbon mitigation can be ensured through various steps by the private sector – including increasing resource efficiency, switching fuel types and reducing exposure to risks posed by carbon. All these steps would not only ensure that the carbon emissions profile of the country becomes sustainable, but also that the individual business and industries become sustainable.

For businesses to adopt the sustainability mantra, especially in the way they use their resources, historical market experience suggests that inclusive market based mechanisms cannot be substituted by government policies, or non-market based incentives. This is primarily because inclusive market based mechanisms are able to interface with each relevant stakeholder – whether a business, a

**Figure 1: Total Return in USD (%)**




**1,780** emissions reduction activities have been reported this year by **384** companies from amongst the largest global companies to the Carbon Disclosure Project.

government or an investor, and efficiently price the value of creating and investing in sustainable models of conducting business or running industries. The credibility of such an inclusive mechanism has no substitutes. Furthermore, such mechanisms are complementary to climate policy making imperatives, especially in the fragile and vulnerable developing world.

Globally, corporates are realising the importance of sustainable economic development and resource efficiency in their business and also of reducing their carbon emissions. A total of 1,780 emissions reduction activities have been reported this year by 384 companies from amongst the largest global companies (by market capitalisation) to the Carbon Disclosure Project (CDP), a voluntary disclosure platform created by private sector stakeholders[1]. This is indicative of a global mega-trend and such initiatives must be leveraged to build capacities and capabilities to mitigate carbon emissions in the developing countries as well.

Figure 1 illustrates the difference in financial performance between the top firms rated by CDP in their leadership index and the Global 500. The results are indicative of a fundamental truth about sustainability performance – firms that act to ensure they are on a sustainable growth path, are the long term winners in the profitability game. They are rewarded due to structural changes made in the way they consume energy, and by investors that take cognisance of their actions and realise the benefits of long term viability in the face of serious strains on global resources and disruptive policy regimes owing to climate change.

It is interesting to note that no Indian (or Chinese) company is represented in the top performers as illustrated in Figure 1. Although Indian companies are gradually beginning to realise the importance of emissions mitigation, such efforts need a comprehensive and convincing push. 42 Indian companies have reported their GHG emissions as per CDP, 2011 and almost 183 (out of BSE-500) have reported their annual energy consumption statistics that could be used to estimate their GHG emissions. However, in the absence of any regulatory mechanism and market based instrument, apart from a voluntary commitment by India to reduce GHG intensity of its economy by 20-25% during 2005-2020 at Copenhagen climate change summit in 2009, a strong signal has yet to be given to Indian companies to start realisation and minimisation efforts for their GHG emissions.

The opportune timing of such efforts to mitigate carbon emissions is an important advantage for

1 CDP Global 500 Report, 2011

developing countries. There is a shift in patterns of economic growth and increased global demand volatility. With this, companies and investors in developing countries such as India, need to recognise the value created through the supply chain of business deliverables by mitigating emissions. Mechanisms which exclude companies that do not meet global benchmarks, whether by way of shareholder advocacy and investment exclusion, or regulatory policies, will have a significant impact on the way that companies choose to grow while going forward.

## II Expected Benefits

Over the course of this report, the one overarching finding has been a clear need to integrate sustainability practices as part of core growth strategies. In Chapter two, where the patterns of national, regional and sector level emissions are mapped and in chapter three, where a comprehensive sector and firm level analysis of an energy intensive sector is mapped, the solution set for mitigation of carbon emissions through sustainability measures are highlighted. Furthermore, the direct relationship between "carbon performance" and financial performance at the firm level is made explicitly clear.

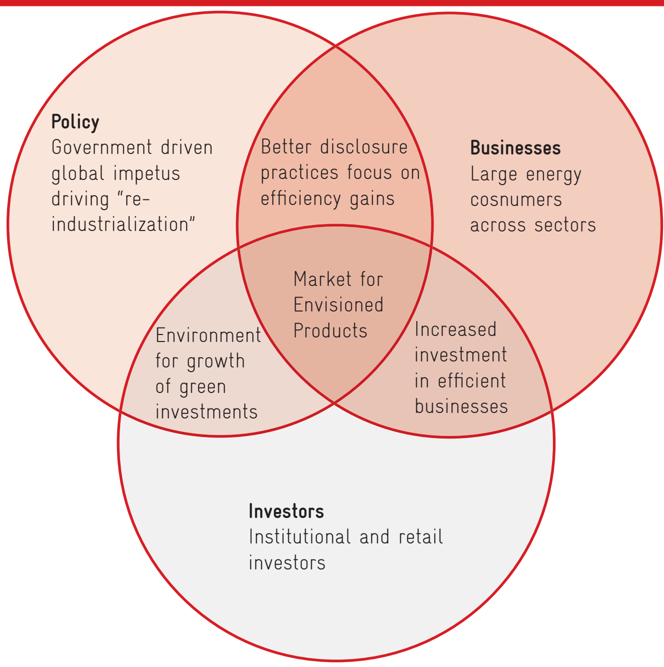
Governments, industries, and investors are looking for ways to measure and benchmark sustainability practices for long term growth. Yet, developing countries in particular do not have any existing inclusive and credible market based mechanisms to do so. There needs to be an integrated mechanism that will help all business stakeholders to reach common ground and move towards sustainable growth opportunities. Chapter four suggests such a mechanism. With the primary goal of showcasing technical and financial capabilities and capacities while building such a mechanism, a multi- stakeholder partnership will help foster an ethical investing environment and an increased energy efficient consciousness and impetus amongst business and industries in developing countries like India.

All the relevant stakeholders within the sustainability space and outside, as outlined in Figure 2, will be the key beneficiaries from such an endeavour. Businesses will benefit as they will be rewarded through market based mechanisms for making quantitatively verifiable efforts in becoming green. This would involve the creation of an effective market based incentive mechanism. This mechanism will ensure the efficient channelling of money to businesses which perform well across various environmental and financial parameters. Such a mechanism would include the major stock exchanges in the economy, the key asset management companies, brokerage houses, and large institutional investors such as pension funds.

Governments will benefit as the gap between ideal environment policy and actual practice will narrow. The creation of a market based mechanism will enable governments to institute a better feedback loop for environmental policies. It will also not be forced to make sweeping market regulations that may deter or create disincentives for economically important industries. Furthermore, in the current global environment, multilateral forums are increasingly creating the impetus for change in business as usual emissions scenarios. Governments facilitating the creation of market based mechanisms that are credible and efficient, would thus leverage their own bargaining positions. This is especially relevant in the context of developing countries – especially like India. To facilitate such markets, governments will need to play an active role in instituting international norms and standards, especially in the arena of

Governments, industries, and investors are looking for ways to measure and benchmark sustainability practices for long term growth.

**Figure 2: Benefits for Stakeholders and Formation of a Market**



disclosure, auditing and accounting practices – which will directly feed into the way businesses operate and report on their sustainability performance. This will in turn enhance the efficiencies within the envisioned market.

Investors will benefit by reaping the returns from investing in efficient, sustainable businesses that will generate consistently better revenues than the rest in the long run. In this report, the transmission of sustainability to profitability is outlined in the sector and firm level case study. The logic is flawlessly simple – businesses that care about the way they consume their energy, are likely to cut down on energy consumption costs in a timely manner, and are moreover likely to have instituted better corporate governance frameworks that prioritise long term sustainability over short term gains. This correlation works consistently across sectors and economies. Therefore, a conscious and risk prepared investor would acknowledge the systemic and sector specific risks posed by climate change and resource scarcity, and invest in companies that have aligned their vision for the future with their own. Furthermore, large institutional investors would have a significant role to play in the initial policy and market driven thrust in the creation of an efficient mechanism, such as that which is envisioned in this report.

Chapter 2

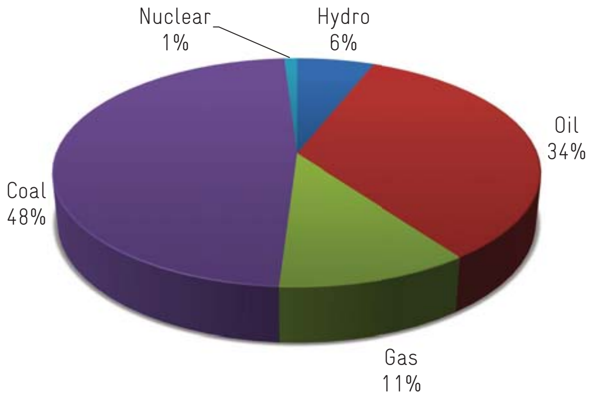
# The Carbon Landscape in India

## I Introduction

India is an emerging economy with a large population exceeding 1.2 billion people and clear cut priorities and imperatives. If India is to sustain growth and development at the same time, a fine balancing act is required by policymakers, businesses and individuals. This must incorporate the imperatives of job creation, infrastructure addition, increased access and mobility, at the same time emphasising sustainable development through low carbon strategies.

Even today, India is largely a coal based economy. According to various projection scenarios, India will continue to remain dependent on coal, gas and oil as primary sources of fuel for many years to come. Figure 1 shows that 48 percent of India's primary fuel consumption could be attributed to coal. At the same time, coal, especially low grade coal that is found in the country, is a heavy pollutant fuel, which contributes significant amounts to the overall $CO_2$ output of the country.

Figure 1: India's Primary Fuel Consumption in 2009




*Source: Ministry of Environment and Forests, India*

According to various projection scenarios, India will continue to remain dependent on coal, gas and oil as primary sources of fuel for many years to come.

The energy sector is the largest contributor of GHG emissions in most countries across the world. There is, however, variability in contributions of energy sector to total GHG emissions across countries. This ranges from 40 to 99 percent for developed countries and 1 to 99 percent for developing countries and economies in transition (Figure 2) (UNFCCC, 2011a; UNFCCC, 2011b). The high variability in developing countries is mainly due to least developed countries where energy consumption levels are very low compared to global averages. However, for large economies, either developed, emerging or in transition, the energy sector emissions contribute more than 60 to total national GHG emissions for the year 2009.

Emissions from the energy sector as a percentage of total emission increase as per capita incomes rise, is mainly due to more commercial energy consumption for economic growth. Power generation is the single largest emission source contributing around 29 percent of total national GHG emissions for developed countries in 2009. The transport sector is the next largest sector in energy followed by industries.

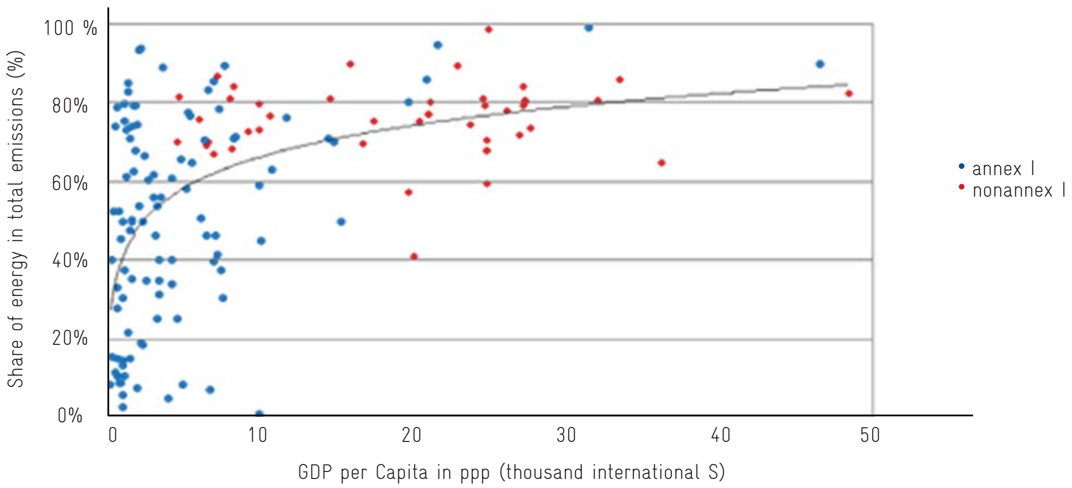
even access to electricity. The causality between economic growth and GHG emissions in India has been studied recently; reflecting no significant correlation between energy consumption and income in any direction in the long run. This implies that India can follow energy conservation and efficiency improvements without jeopardising economic growth (Alam et al., 2011). However, low carbon strategies can only be implemented if the emissions landscape and its effects on sustainable growth are clearly identified and understood.

## II National Emissions Trends

The total emissions for the major greenhouse gases have been estimated in this section using IPCC methodology[3]. The trends show that emissions of carbon dioxide, perfluorocarbons, and hydrofluorocarbons are on the rise, while methane and nitrous oxide emissions seem to have stabilised significantly[4]. (Figure 3).

The trends show that emissions of carbon dioxide, perfluorocarbons, and hydrofluorocarbons are on the rise, while methane and nitrous oxide emissions seem to have stabilised significantly

**Figure 2: Share of Energy in Total GHG Emissions and GDP per Capita**




*Sources: UNFCCC, 2011a and 2011b*

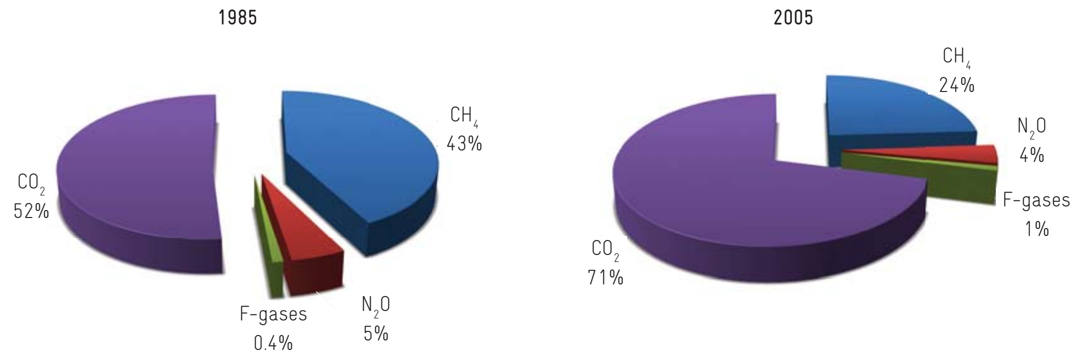
Policymakers in India seem to be aware of the clean energy imperatives, while at the same time acknowledging India's fuel poverty – with current emissions per capita hovering around a twelfth of U.S levels[2] and over 400 million people without

2 Current emissions per capita in India are around 1.4-1.5 $tCO_2$ according to government estimates.

3 The primary greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, and ozone.

4 Nitrous oxide sectoral shares indicate that of the total $N_2O$ emissions, 56% due to use of synthetic fertilizer and about 22% from indirect soil emissions due to $NH_3$ and $NO_2$

Figure 3: Changing Compositions of National Greenhouse Gas Emissions (in $CO_2$e Terms)




*Source: Garg et. al. (2006). Note: "F Gases" are chemicals that contain "Fluorine" within their chemical make-up. The Fluorine within the gases acts as a powerful green house gas.*

The share of electric power generation in India's $CO_2$ emissions has increased from approximately 33 percent to 52 percent during 1985–2005.

### Carbon Dioxide ($CO_2$):

Since the Industrial Revolution in the 1700's, human activities have increased $CO_2$ concentrations in the atmosphere. According to the Environment Protection Agency, USA, in 2005, global atmospheric concentrations of $CO_2$ were 35 percent higher than they were before the Industrial Revolution. Carbon dioxide is the most prominent greenhouse gas after water vapour. It contributed 1.5 percent to India's $CO_2$ equivalent GHG emissions in 2005. The official Indian $CO_2$ emissions of 817 Tg-$CO_2$ in 1994 are estimated to have grown to 1229 Tg-$CO_2$ in 2005[5].

Coal is the mainstay of the Indian energy system – and contributes approximately 72 percent of total carbon dioxide emissions (Appendix A1). The share of electric power generation in India's $CO_2$ emissions has increased from approximately 33 percent to 52 percent during 1985–2005 and majority of it comes from coal and lignite consumption (Figure 4). Transport sector forms the bulk of $CO_2$ emissions from oil product combustion. Railway transport sector has witnessed a negative growth in its $CO_2$ emissions due to phasing out of coal powered steam traction throughout India and enhanced electric traction on high - density corridors.

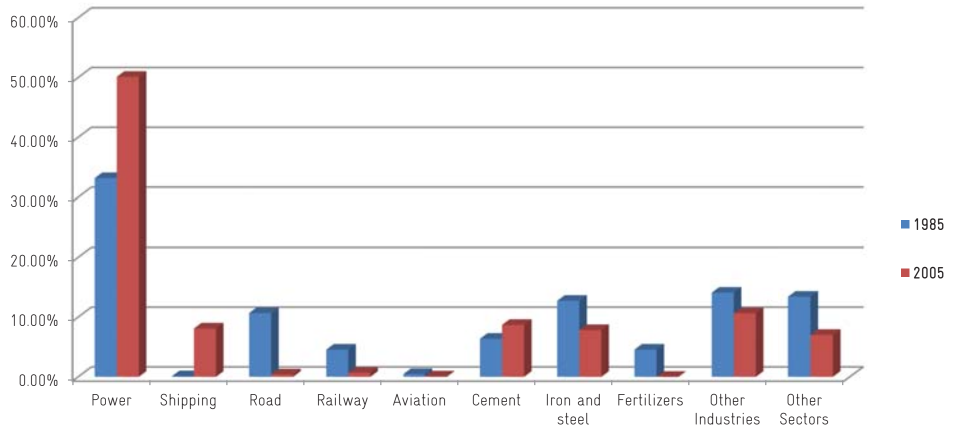
Table 1: Sectoral $CO_2$ Emissions in Tg-$CO_2$ as % of Total

| Sector | 1985 | 1990 | 1995 | 2000 | 2005 | 2007# | %CAGR (1985-2005) |
|---|---|---|---|---|---|---|---|
| Power | 33.15 | 37.56 | 46.19 | 50.11 | 51.91 | 51.18 | 8 |
| Road | 10.67 | 11.38 | 10.49 | 11.24 | 11.64 | 8.65 | 6 |
| Railway | 4.54 | 2.28 | 0.71 | 0.48 | 0.49 | 0.43 | -6 |
| Aviation | 0.45 | 0.41 | 0.35 | 0.39 | 0.41 | 0.71 | 5 |
| Shipping | 0.09 | 0.08 | 0.07 | 0.08 | 0.08 | 0.07 | 5 |
| Cement | 6.36 | 6.99 | 7.31 | 7.46 | 7.97 | 9.29 | 6 |
| Iron and Steel | 12.72 | 12.03 | 10.13 | 8.92 | 8.38 | 8.36 | 3 |
| Fertilizers | 4.54 | 3.58 | 2.71 | 2.23 | 1.95 | 1.72 | 1 |
| Other Industries | 14.08 | 13.33 | 10.96 | 9.69 | 8.87 | 9.65 | 3 |
| Other Sectors | 13.40 | 12.36 | 11.08 | 9.40 | 8.30 | 9.9 | 3 |
| **All India** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **5** |

*# - These numbers are taken from Government of India report (2007). Estimates for other years are taken from our own estimates that use latest methodology and India specific emission factors. In 2007, LULUCF has 98 Tg-$CO_2$ due to it. Total for 1985=440.40, 1990=615, 1995=849, 2000=1032, 2005=1229 & 2007=1497 Tg-$CO_2$.*

5 Removals from land use and land-use change activities are not considered.

Figure 4: Change in Sectoral Compositions of $CO_2$ Emissions over 1985-2005




## Methane ($CH_4$):

Methane is another major contributor to climate change. It is emitted from a variety of both anthropogenic and natural sources. The national methane emissions profile is dominantly agricultural (Appendix A2). Indian methane emissions contributed 27 percent to total Indian GHG emissions in 2008. The total amount of methane emitted from India increased from 19 Tg in 1995 to 21 Tg in 2008.

The agriculture sector contributed 61 percent of all India methane emissions in 2008 including 48 percent from livestock- related activities, 19 percent from rice paddy cultivation and 13 percent from biomass burning (Table 2). The largest contributing factors for $CH_4$ emissions in India are low digestibility of enteric fermentation and rice paddy cultivation under continuous submergence - the paddy area of 43.66 Mha in India, being the largest in Asia, is of special concern as it is double and at times triple cropped in a year to increase production[6]. Both these are widely dispersed activities. Although septic mitigation measures like strategic supplementation of feed through molasses urea, multi nutrient blocks and low bypass protein have been suggested for improving low digestibility of animal feed; their implementation may pose a formidable challenge. Methane emissions from disposal and treatment of industrial and municipal waste are mostly in large urban centres from India. Fugitive methane emissions from fossil fuels are relatively localised with only a dozen districts contributing more than 90% of all India coal and lignite production.

Indian methane emissions contributed 27 percent to total Indian GHG emissions in 2008.

Table 2: $CH_4$ Emissions from Various Source Categories in Tg-$CH_4$ as % of Total

| Source Categories | 1985 | 1990 | 1995 | 2000 | 2005 | 2007# | 2008 | %CAGR (1985-2008) |
|---|---|---|---|---|---|---|---|---|
| Enteric fermentation | 51.13 | 50.25 | 49.97 | 48.95 | 47.91 | 49.12 | 44.02 | 0.21 |
| Paddy cultivation | 23.30 | 22.45 | 21.64 | 20.55 | 20.02 | 16.20 | 18.50 | -0.14 |
| Biomass burnt for energy | 9.36 | 9.05 | 8.86 | 8.98 | 8.96 | 13.23 | 10.63 | 1.43 |
| MSW disposal | 3.60 | 3.80 | 3.98 | 4.28 | 4.78 | 2.94 | 8.15 | 4.51 |
| Manure management | 5.23 | 5.30 | 5.25 | 5.15 | 4.98 | 0.58 | 4.20 | -0.10 |
| Oil and natural gas related | 1.34 | 2.79 | 3.40 | 4.64 | 5.18 | 4.13 | 4.72 | 6.55 |
| Waste water disposal | 2.09 | 2.18 | 2.39 | 2.86 | 3.34 | 9.29 | 0.81 | -3.21 |
| Coal production | 2.96 | 3.18 | 3.55 | 3.67 | 3.93 | 3.16 | 5.10 | 3.27 |
| Agriculture crop residue burning | 0.99 | 1.01 | 0.96 | 0.93 | 0.91 | 1.10 | 1.96 | 3.90 |
| Total $CH_4$ | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 0.86 |

*# - These numbers are taken from Government of India report (2007). Estimates for other years are taken from our own estimates that use latest methodology and India specific emission factors. As per 2007 reporting, residential emissions have been shown under biomass burnt for energy and fugitive emissions have been distributed Oil and Natural Gas and Coal Production in the same ratio as 2007 data. Total for 1985=17.21, 1990=17.91, 1995=18.85, 2000=19.61, 2005=20.08, 2007=20.56 & 2008=20.97 Tg-$CH_4$.*

6 Ministry of Agriculture, 2008

### Nitrous Oxide ($N_2O$):

$N_2O$ along with $CO_2$ and $CH_4$ is a major GHG and is emitted from both anthropogenic and natural sources. $N_2O$ is one of the six Kyoto greenhouse gases contributing around 5 percent to the total global emissions (IPCC 2007). Nitrous oxide emission levels from a source can vary significantly across geographies and sectors, depending on many factors such as industrial and agricultural production characteristics, combustion technologies, waste management practices, and climate. India's nitrous oxide emissions increased from 178 Gg-$N_2O$ in 1994 to 253 Gg-$N_2O$ in 2005. $N_2O$ emissions are estimated using the latest methodologies (IPCC 2006), disaggregated activity data and indigenised emission factors (Table 3).

Activities of the agriculture sector account for more than 80 percent of the total $N_2O$ emissions including 60 percent from use of synthetic fertilizer, about 12 percent each from agriculture residue burning and indirect soil emissions and about 3 percent from manure management[7] (Appendix A3). Over a fourth of the total primary energy requirement for India and two third of rural Indian energy requirement are met by biomass energy. It is interesting to note that biomass burning is considered as carbon-neutral in case of $CO_2$ emissions (IPCC 2006), whereas the same source contributes a major portion of $N_2O$ emissions, even higher than fossil based emissions.

Activities of the agriculture sector account for more than 80 percent of the total $N_2O$ emissions.

**Table 3: $N_2O$ Emissions from Various Source Categories in Gg-$N_2O$[8] as % of Total**

| Source categories | 1985 | 1990 | 1995 | 2000 | 2005 | 2007# | % CAGR (1985-2007) |
|---|---|---|---|---|---|---|---|
| Direct $N_2O$ emissions | 54.17 | 57.46 | 57.67 | 58.40 | 59.55 | 48.26 | 1.79 |
| Synthetic fertilizer use | 40.28 | 45.30 | 46.98 | 47.06 | 49.06 | NA | - |
| N from crop residue left | 6.94 | 6.63 | 6.51 | 6.72 | 6.37 | NA | - |
| Organic N applied to the soil | 6.94 | 4.97 | 4.19 | 4.62 | 4.49 | 0.03 | -20.19 |
| Indirect $N_2O$ emissions | 11.81 | 12.15 | 12.56 | 12.61 | 12.73 | 10.33 | 1.71 |
| Field burning of agriculture residue | 2.78 | 2.76 | 3.26 | 3.36 | 3.00 | 2.51 | 1.86 |
| Biomass burning | 14.58 | 12.15 | 11.16 | 10.92 | 9.74 | 14.70 | 2.37 |
| Coal consumption | 4.17 | 4.42 | 4.65 | 5.04 | 4.87 | 7.35 | 5.01 |
| Petroleum fuels consumption | 0.69 | 0.55 | 0.93 | 1.26 | 1.12 | 1.69 | 6.56 |
| Gas consumption | 0.01 | 0.02 | 0.02 | 0.03 | 0.03 | 0.05 | 11.96 |
| Industrial processes | 5.56 | 4.42 | 5.12 | 3.78 | 3.37 | 8.60 | 4.38 |
| Waste | 6.25 | 4.97 | 5.12 | 5.04 | 5.24 | 6.61 | 2.59 |
| **Total $N_2O$** | 100 | 100 | 100 | 100 | 100 | 100 | 2.33 |

*# - These numbers are taken from Government of India report (2007). Estimates for other years are taken from our own estimates that use latest methodology and India specific emission factors. As the break-up of energy emissions was not given, these emissions have been distributed Biomass, Petrol, Coal and gas consumption in the same ratio as 2007 data. Total for 1985=144, 1990=181, 1995=215, 2000=238, 2005=267 & 2007=239 Tg-$N_2O$.*

7 $N_2O$ emission estimates from soils, including from use of synthetic fertilizers show a remarkable decline in 2007, however this is mainly due to the use of India specific emission factors that are lower by almost 30 than the IPCC default values. The revised emission factors used for rice–wheat systems are 0.76 for rice and 0.66 kg ha -1 $N_2O$–N(3) for wheat for urea application without any inhibitors.

8 An emission factor of 8.43 kg of $N_2O$ for per ton of nitric acid production is considered appropriate for Indian conditions (Mitra et. al., 2004).

PFCs are fully fluorinated hydrocarbons with very high global warming potential due to their extremely long atmospheric lifetimes.

## Other Gases

### Perfluorocarbons (PFCs):

PFCs are fully fluorinated hydrocarbons with very high global warming potential due to their extremely long atmospheric lifetimes (2,600–50,000 years).The major sources of PFC emissions in India are aluminium production and semiconductor manufacturing. Annual production data of major aluminium producing companies have been multiplied by a weighted average IPCC default emission factor of 1.4 kg of $CF_4$ per tonne of aluminium produced (IPCC, 1996). Further, the emission factor for $C_2F_6$ is taken as 10 times lower than that of $CF_4$[9] . It has been assumed that imports contribute about 8–10 PFC emissions annually.

most widely used HFC in India is HFC-134a, which is the popular choice for domestic and commercial refrigeration including automobiles. HFC-152a is used to a very limited extent in glass industries whereas HFC-227ea is used in Metered Dose Inhalers and as a fire extinguishing agent.

HFC- 23 is generated as a by-product at the rate of 2–4 percent of HCFC- 22 production (IPCC, 1996). HFC- 23 is mainly used in the semiconductor industry, as a refrigerant and in the air conditioning industry. HFC- 23 has very high global warming potential. The major contribution towards HFC emissions is due to HFC-23, which has grown at a fast rate from a low base. However, it also offers focused mitigation opportunities through its thermal oxidation[10].

Table 4: PFC Emissions from Various Source Categories in Gg-$CO_2$ Equivalents as % of Total

| Emissions | GWP | 1985 | 1990 | 1995 | 2000 | 2005 | CAGR (1985–2005) |
|---|---|---|---|---|---|---|---|
| $CF_4$ | 41.40 | 80.01 | 80.00 | 79.15 | 79.15 | 78.31 | 5.3 |
| $C_2F_6$ | 58.60 | 11.32 | 11.33 | 11.21 | 11.20 | 11.08 | 5.3 |
| Imports | N.A | 8.68 | 8.67 | 9.64 | 9.65 | 10.61 | 6.5 |
| Total PFCs | 100 | 100 | 100 | 100 | 100 | 100 | 5.5 |

Currently, the entire Indian requirement of $SF_6$ is imported since it is not manufactured within the country.

### Hydrofluorocarbons (HFCs):

HFCs are gaseous compounds that are replacing ozone-depleting chlorofluorocarbons (CFCs) as a refrigerant. Indian HFC emissions have been estimated by multiplying their annual national consumption with their respective global warming potential in $CO_2$ equivalent terms as per IPCC tier 1 methodology (IPCC, 1996). Currently, the

### Sulfur hexafluoride ($SF_6$):

Sulfur hexafluoride is an extremely stable atmospheric trace gas and has an estimated atmospheric lifetime of 3200 years and a GWP of 23,900. Its unique physiochemical properties make this gas ideally suited for many specialised industrial applications such as in transformers and circuit breakers. Most of its emissions in India origi-

Table 5: HFC Emissions in Gg-$CO_2$ Equivalents

| Emissions | GWP | 1990 | 1995 | 2000 | 2005 | CAGR (2000–2005) |
|---|---|---|---|---|---|---|
| HFC-134a | 1300 | N.A | N.A | 285 | 1437 | 38.2 |
| HFC-152a | 190 | N.A | 1 | 2 | 6 | 24.6 |
| HFC-227ea | 3800 | N.A | 61 | 137 | 271 | 14.6 |
| HFC-23 | 11700 | 873 | 2004 | 4936 | 9500 | 14.0 |
| Total HFCs | N.A | 873 | 2066 | 5361 | 11214 | 15.9 |

9 The compounded annual growth rate is assumed to be the same for $CF_4$ and $C_2F_6$ since their emissions are directly related to aluminum production.

10 Thermal Oxidation is the chemical reaction in which heat and oxygen initiates an exothermic reaction (i.e., generates heat) whereby organic compounds are converted into carbon dioxide and water. In air pollution control, this reaction allows us to destroy VOCs and HAPs up to levels greater than 99%.

nate from its use for insulation of high - voltage equipment. Only small amounts are emitted from magnesium foundries, where $SF_6$ is used to prevent oxidation of molten magnesium. There is considerable difficulty in acquiring $SF_6$ consumption data for India. Currently, the entire Indian requirement of $SF_6$ is imported[11] since it is not manufactured within the country. $SF_6$ emissions have been estimated by multiplying their annual consumption (equal to total imports) with their global warming potential as per IPCC tier 1 methodology (IPCC, 1996). Our estimates indicate total $SF_6$ emissions at 87 Gg-$CO_2$ equivalents in 2000 and 2084 Gg-$CO_2$ equivalent in 2005.

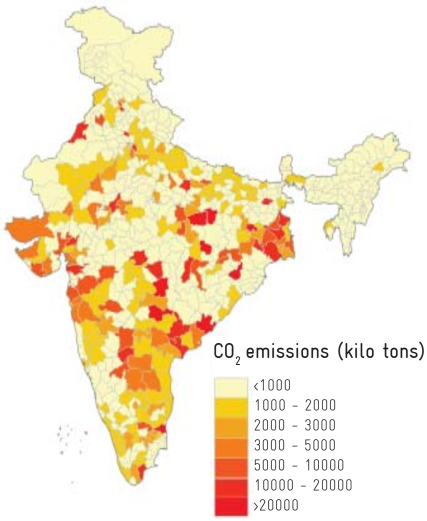
## III Regional Emissions Trends

In order to understand the carbon landscape in India, it is important to recognise and understand the inherent links between national and regional emissions profiles. With over 1.2 billion people, the disaggregated Indian demographic distribution (except for mega cities such as Delhi and Mumbai) and the dispersion of industries and sectors over states and regions, provides a significant challenge for carbon mitigation options unless properly understood. Furthermore, sub-regional estimation is useful for exploring focused mitigation opportunities. This section will present an analysis of regional distribution and concentrations of the greenhouse gases - carbon dioxide, methane and nitrous oxide.

### Carbon Dioxide ($CO_2$):

Figure 5 illustrates the aggregate $CO_2$ emissions from Indian districts in 2005. Darker spots indicate high emission hotspot areas. Thermal power plants with high coal consumption, large cities with high oil product consumption and industrial towns constitute most of these dark spots.

**Figure 5: Distribution Map of District level $CO_2$ Emissions in India in 2005**




As is evident from the figure, there is a significant amount of variability in the dispersion of $CO_2$ across different regions of the country[12]. There is no single explanation for this, but it can be attributed to any of the following:

- As mentioned previously, coal is the mainstay of the Indian energy system and contributes approximately 72 percent (as of 2005) of total $CO_2$ emissions. Coal consumption varies across regions and $CO_2$ emissions reflect this pattern. Uttar Pradesh consumed the highest amount of coal (48 MT) in 2005 and contributed to the largest $CO_2$ emission.
- $CO_2$ emissions also have a close relationship with population and the level of economic activities in a region. Uttar Pradesh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Tamil Nadu, Gujarat, West Bengal and Bihar are the top eight states in India in terms of population and net state domestic product.

The $CO_2$ emission hotspots in India synchronise with highest coal consuming districts and some oil consuming districts[13]. The 25 largest $CO_2$ emitting districts are considered to be hotspot

Currently, the most widely used HFC in India is HFC-134a, which is the popular choice for domestic and commercial refrigeration including automobiles.

The $CO_2$ emission hotspots in India synchronise with highest coal consuming districts and some oil consuming districts.

11 The Central Government, being satisfied that it is in the public interest to do so, levies only 5 percent import duty on $SF_6$ when it is imported into India for the manufacture of the finished goods – integrated circuits or semi-conductor devices as per section 25 of the Customs Act, 1952 (52 of 1962). Some of the major $SF_6$ producing regions include USA, Europe, Japan and South Africa, for more information see <http://www.epa.gov/magnesium-sf6/documents/smythep.pdf>.

12 The per capita $CO_2$ emission intensities vary considerably across various Indian states and union territories. The all India per capita $CO_2$ emissions were 0.84 tons in 1995 (0.23 tons carbon) and in 2005(tones) grew at 3.6 percent between 1985 and 2005; much below the absolute growth rate of emissions (6.4 percent). The difference is evidently due to India's population expansion over the same period.

13 These top emitter districts accounted for 30% of total national emissions in 1990 and 35% in 1995 and 60% in 2005.

| Table 6: Sector Break-Down of Top Hotspot Districts in 2005 | | | | | |
|---|---|---|---|---|---|
| Sector | Largest | Second | Third | Fourth | Fifth |
| Public electricity and heat production | Sonbhadra, Uttar Pradesh | Korba, Chhattisgarh | Angul, Orissa | Karimnagar, Andhra Pradesh | Sidhi, Madhya Pradesh |
| Transport | Mumbai (Suburban), Maharashtra | Thane, Maharashtra | North West | Pune, Maharashtra | Ahmedabad, Gujarat |
| Iron and Steel | Durg, Chhattisgarh | Bokaro, Jharkhand | Purbi Singhbhum, Jharkhand | Vishakhapatnam, Andhra Pradesh | Barddhaman, West Bengal |
| Cement | Gulbarga, Karnataka | Satna, Madhya Pradesh | Chandrapur, Maharashtra | Raipur, Chhattisgarh | Junagadh, Gujarat |
| Brick | Jalaun, Uttar Pradesh | Garhwa, Uttar Pradesh | Rae Bareli, Uttar Pradesh | Bankura, West Bengal | Rajkot, Gujarat |
| Other industries | Sonbhadra, Uttar Pradesh | Anugul, Orissa | Korba, Chhattisgarh | Mumbai (Suburban), Maharashtra | Surat, Gujarat |
| All India | Sonbhadra, Uttar Pradesh | Anugul, Orissa | Korba, Chhattisgarh | Chandrapur, Maharashtra | Vishakhapatnam, Andhra Pradesh |

districts . These are distributed over 12 states with four districts from Madhya Pradesh, three each from Uttar Pradesh, Tamil Nadu, Maharashtra and Andhra Pradesh, two each from Bihar, Gujarat and West Bengal and one each from Orissa, Punjab and Delhi. In almost all of these district, emissions were due to relatively excessive coal consumption with Delhi and Greater Mumbai being exceptions. These two had considerable oil product based $CO_2$ emissions as well[14].

10 percent of total Indian districts contributed 67 percent of India's total $CO_2$ emissions in 1995 indicating high concentration of emissions in specific areas. Bilaspur district (MP) was the largest $CO_2$ emitter in India and contributed 29.8 MT $CO_2$ in 1995 showing an increase of 13 percent over its 1990 emissions. In 2005, Sonbhadra district was the largest $CO_2$ emitter in India and contributed 6 percent of the total $CO_2$ in 2005.

Although $CO_2$ emissions do not have any direct effect on local environment, but relating these hotspots with local and regional carbon sinks in India is interesting. Some regions reporting high forest cover reductions over the last two decades, like parts of Madhya Pradesh and Uttar Pradesh, also happen to be near high carbon emitting regions. Therefore, in such regions the sources of carbon emission are increasing while the net forest sinks are reducing. Such unbalanced development may require policy interventions. Local environmental considerations may expedite these. The total $CO_2$ removals from India were about 50

Table 7: (a) Emission intensities for Hotspot districts ($tCO_2$/sq km) & (b) Emissions per Capita

| District | 1995 (MT) | 2005 (MT) | % CAGR (1995-2009) |
|---|---|---|---|
| Bilaspur, Chhattisgarh | 30.0 | 0.72 | -31 |
| Sonbhadra, Uttar Pradesh | 29.7 | 75.3 | 10 |
| South Arcot, Tamil Nadu | 23.0 | 23.2 | 0.1 |
| Giridih, Jharkhand | 21.2 | 1.3 | -24 |
| Chandrapur, Maharashtra | 21.2 | 32.3 | 4 |
| Raipur, Chhattisgarh | 20.1 | 13.6 | -4 |
| Delhi, Delhi | 18.6 | 27.34 | 4 |
| All India | 778 | 1229 | 5 |

| District | 2005* | Per capita (tonnes) | |
|---|---|---|---|
| | | 1995 | 2005 |
| Sonbhadra, Uttar Pradesh | 1.7 | 25.03 | 45.5 |
| Gandhinagar, Gujarat | 1.5 | 12.50 | 5.9 |
| Chandrapur, Maharashtra | 2.2 | 11.05 | 14.6 |
| Mirzapur, Uttar Pradesh | 2.3 | 10.03 | 0.323 |
| Rupnagar, Punjab | 1.2 | 9.19 | 14.2 |
| All India | 1114 | 0.84 | 1.3 |

**Census of India, 2001, Population (Million)*

14 Delhi and Mumbai are the top two transport sector $CO_2$ emitters in India.

MT in 1990 (ALGAS, 1998) with 44 MT due to abandonment of managed land where carbon accumulation is expected to occur whereas in 2007 the total $CO_2$ removals from India were 98 MT. It is also worthwhile to analyse $CO_2$ emissions at district level on the basis of total annual emissions and per capita emissions (Tables 7 (a) & (b)). Table 7 captures the most intense $CO_2$ emitter districts in India as per 2005 levels. It is interesting to note that South Arcot district was third in the top $CO_2$ emitting districts in 1995 but was at 95th place in 1990. This jump in its status was due to commissioning of a lignite based thermal power plant in Neyveli in the interim period. This illustrates just how much of an impact large energy intensive establishments can have on hotspot distributions.

### Nitrous Oxide ($N_2O$):

State and district level $N_2O$ emission in 2005 are shown in Figure 6. Out of a total of 35 states and union territories in India, twelve states contributed more than 10 Gg each in 2005. This accounted for 90 percent of total Indian $N_2O$ emissions, with Uttar Pradesh (UP) being the largest contributor at 52 Gg, followed by Maharashtra, Andhra Pradesh (AP) and Punjab contributing 30, 26 and 20 Gg respectively. The 50 largest emitting districts (including 12 from UP, 10 from Punjab, nine from AP, and five each from Gujarat and West Bengal and four from Maharashtra) contributed more than one fourth of the Indian national emissions in 2005 (UNFCCC 2008).

The 50 largest emitting districts (including 12 from UP, 10 from Punjab, nine from AP, and five each from Gujarat and West Bengal and four from Maharashtra) contributed more than one fourth of the Indian national emissions in 2005.

Figure 6: (a) State level $N_2O$ emissions in India, 2005 & (b) District Level $N_2O$ Emissions in India, 2005

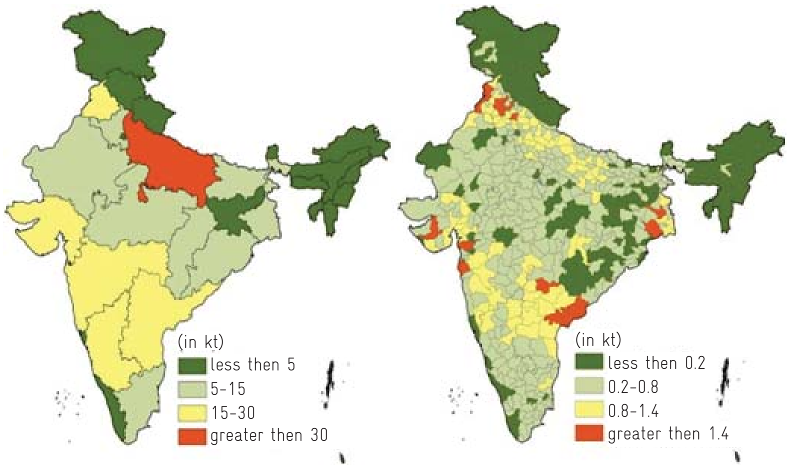
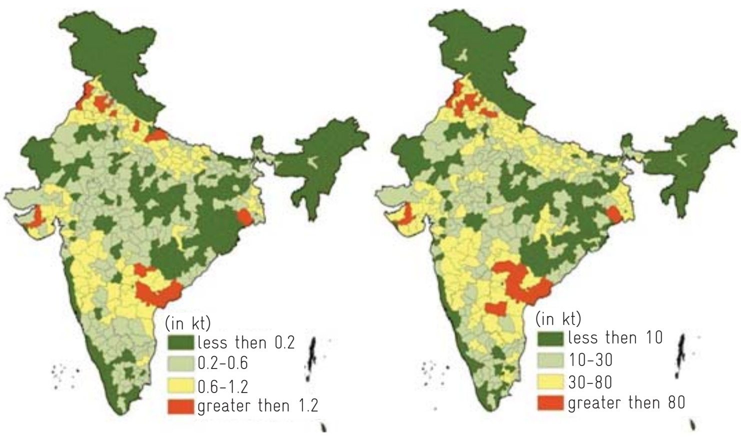



Figure 7: (a) $N_2O$ Emissions from Agricultural Activities in India, 2005 & (b) Nitrogenous Fertilizer Application in India, 2005



Around 70 percent of the synthetic nitrogen based fertilizers (N-fertilizers) are used for food grain production in India followed by oilseeds and the remaining for other crops (FAI 2006). This is the main reason why higher grain producing states like Uttar Pradesh, Punjab and Andhra Pradesh are top N-fertilizer consumers and in-turn top $N_2O$ emitters. Figure 7 shows the high degree of correlation between emissions from agricultural activities in general, and N-fertilizer application in specific areas. N-fertilizer application is the main source of emissions. Wheat–rice cultivation, in that order, appears to drive this.

On an average, 25.7 kg food grains were produced per kg of N-fertilizer applied in India in 2005. West Bengal had a high average of 37.3, while large grain producers such as Punjab, Haryana and Uttar Pradesh had it in the range 20–25 kg grains per kg fertilizer[15]. Meanwhile, efficiency of fertilizer application vis-à-vis grain production has gone down in many districts during 1990–2005. This has resulted in an increase in $N_2O$ emissions per unit area without corresponding gain in food grain yield per hectare, indicating a possible over application of synthetic fertilizers.

The district level $N_2O$ emission range analysis indicates decline in percentage share of largest emitter districts over 1995–2005. Thane (Maharashtra), Firozpur (Punjab), West Godavari and Guntur (Andhra Pradesh) and Amritsar (Punjab) are the highest emitting districts across India and contribute about 6.4 percent of national $N_2O$ emissions in 2005. 85 percent of all India nitric acid production happens in Thane contributing about 3% of the national $N_2O$ emissions in 2005 (Appendix A4). A systematic breakdown of the five largest districts which emit this gas attributed to specific categories is shown in Table 9.

### Methane ($CH_4$):

The largest methane emitter - Mumbai contributes almost 1.5 percent of the total $CH_4$ emitted from India in 2008 with 95 percent from oil and natural gas exploration, 3 percent from municipal solid waste disposal and 2 percent from biomass burning. Methane mitigation in Mumbai would therefore require management of oil and gas exploration emissions and efficient methods for collection and disposal of solid waste. There are large oil exploration companies in Mumbai that could be targeted through appropriate corporate

**Table 8: Sector $N_2O$ Emissions and Primary Drivers in High Emission States in India, 2005**

| | % Share of State Wise Emissions | | | | % Share All India Emissions | | | | |
|---|---|---|---|---|---|---|---|---|---|
| State | N-Fertilizer | Organic N Applied to Soil | Indirect | Others | Total Emissions | Livestock | N-Fertilizer | Rice | Wheat |
| Uttar Pradesh | 49 | 3 | 17 | 31 | 19 | 13 | 19 | 12 | 35 |
| Maharashtra | 37 | 3 | 5 | 55 | 11 | 8 | 8 | 3 | 2 |
| Andhra Pradesh | 61 | 4 | 8 | 27 | 10 | 12 | 12 | 13 | – |
| Punjab | 66 | 2 | 20 | 13 | 7 | 2 | 10 | 11 | 21 |
| Gujarat | 48 | 3 | 16 | 33 | 7 | 5 | 7 | 1 | 4 |
| Karnataka | 51 | 4 | 7 | 38 | 6 | 5 | 6 | 6 | 0.3 |
| West Bengal | 44 | 6 | 15 | 35 | 5 | 9 | 5 | 16 | 1 |
| Haryana | 62 | 2 | 20 | 16 | 5 | 2 | 7 | 3 | 13 |
| Tamil Nadu | 43 | 5 | 6 | 45 | 5 | 5 | 4 | 6 | – |
| Bihar | 54 | 5 | 18 | 23 | 5 | 5 | 5 | – | 5 |
| India (Tg) | 0.131 | 0.012 | 0.035 | 0.090 | 0.267 | 470.5a | 12.72 | 91.79 | 69.35 |

15 West Bengal mainly produces rice paddy which consumes lower nitrogen fertilizer as compared to wheat. West Bengal is also high in other agriculture inputs such as organic fertilizer and water, off-setting need for N fertilizer to some extent.

**Table 9: Hotspot Emitter Districts in Each Source Category, India, 2005**

| Source categories | Largest | Second | Third | Forth | Fifth |
|---|---|---|---|---|---|
| Synthetic Fertilizer | Firozpur, Punjab | West Godavari, Andhra Pradesh | Guntur, Andhra Pradesh | Sangrur, Punjab | Amritsar, Punjab |
| Crop Residue | Uttar Kannada, Karnataka | Viluppuram, Tamil Nadu | Erode, Tamil Nadu | Allahabad, Uttar Pradesh | Azamgarh, Uttar Pradesh |
| Organic Nitrogen (applied to soil) | Coimbatore, Tamil Nadu | Cuddapah, Andhra Pradesh | Barddhaman, West Bengal | Murshidabad, West Bengal | South Twenty FourParganas, West Bengal |
| Indirect Emissions | Firozpur, Punjab | Sangrur, Punjab | Amritsar, Punjab | Patiala, Punjab | Karnal, Haryana |
| Agricultural Residue Burning | Uttar Kannada, Karnataka | Viluppuram, Tamil Nadu | West Godavari, Andhra Pradesh | Allahabad, Uttar Pradesh | Erode, Tamil Nadu |
| Coal Combustion | Sonbhadra, Uttar Pradesh | Anugul, Orissa | Korba, Chhattisgarh | Bokaro, Jharkhand | East Godavari, Andhra Pradesh |
| Oil Combustion | Mumbai, Maharashtra | Jamnagar, Gujarat | Mumbai (Suburban), Maharashtra | Vadodara, Gujarat | Thane, Maharashtra |
| Nitric Acid Production | Thane, Maharashtra | Bharuch, Gujarat | Hyderabad, Andhra Pradesh | Ernakulam, Kerela | Kupwara, Jammu & Kashmir |
| All India | Thane, Maharashtra | Firozpur, Punjab | Guntur, Andhra Pradesh | West Godavari, Andhra Pradesh | Amritsar, Punjab |

policy for GHG mitigation efforts. The hotspot locations for methane emissions that could be targeted for mitigation are detailed in Table 10.

At a state level (Figure 8), Uttar Pradesh, Andhra Pradesh, Maharashtra, West Bengal and Madhya Pradesh were the top five emitting states in India

At a state level (Figure 8), Uttar Pradesh, Andhra Pradesh, Maharashtra, West Bengal and Madhya Pradesh were the top five emitting states in India in 2008.

**Table 10: Category Level Largest $CH_4$ Emitter Hotspot Districts in India, 2008**

| Source categories | Largest | Second | Third | Fourth | Fifth |
|---|---|---|---|---|---|
| Biomass for energy | Belgaum, Karnataka | *Medinipur*, West Bengal | North 24 Parganas, West Bengal | Gulbarga, Karnataka | Barddhaman, West Bengal |
| Coal mining | Anugul, Orissa | Sidhi, Madhya Pradesh | Surguja, Chhattisgarh | *Hazaribag, Jharkhand* | Raigarh, Chahattisgarh |
| Oil & Natural Gas | *Mumbai, Maharashtra* | Jamnagar, Gujarat | Vadodara, Gujarat | Panipat, Haryana | Dakshina Kannada, Karnataka |
| Field burning of agricultural residue | Uttar Kannada, Karnataka | Viluppuram, Tamil Nadu | West Godavari, Andhra Pradesh | Erode, Tamil Nadu | Allahabad, Uttar Pradesh |
| Enteric Fermentation | Barbanki, Uttar Pradesh | Khammam, Andhra Pradesh | *Jaipur*, Rajasthan | Vishakhapatanam, Andhra Pradesh | Alwar, Rajasthan |
| Manure Management | Barddhaman, West Bengal | Bankura, West Bengal | Udaipur, Rajasthan | Barbanki, Uttar Pradesh | *Jaipur*, Rajasthan |
| Rice cultivation | *Medinipur*, West Bengal | South 24 Parganas, West Bengal | Murshidabad, West Bengal | *Barddhaman*, West Bengal | Surguja, Chhattisgarh |
| Solid waste disposal | Thane, Maharshtra | *Mumbai (Suburban)* , Maharshtra | Bangalore, Karnataka | Pune, Maharshtra | North 24 Parganas, West Bengal |
| Waste Water handling | *Chennai, Tamil Nadu* | Hyderabad, Andhra Pradesh | Thane, Maharshtra | Pondicherry (Union Territory) | Aurangabad, Maharshtra |
| All India | *Mumbai*, Maharshtra | Anugul, Orrisa | Jamnagar, Gujarat | Surguja, Chhattisgarh | *Medinipur*, West Bengal |

*Note: The names in the italics indicate the presence of these districts as hotspot districts in 1995 emissions inventory for the same respective categories (Garg and Shukla, P.R., 2002. Emissions Inventory of India)* in 2008. While methane from enteric fermentation and manure management is the main reason for high emissions from Uttar Pradesh and Andhra Pradesh; methane from municipal solid waste generation and oil and gas exploration are the main reasons for Maharashtra's emissions.

The methane emissions per district in 2008 averaged 0.035 Tg compared to 0.04 Tg in 1995. This was mainly due to fragmentation of districts in creating almost 20 more districts[16]. The major sources of methane emissions are different in high emission profile districts. Methane as part of total GHG emissions profile would also be different for different districts. For instance, Anugul district has per capita methane emissions which are almost double the national $CO_2$ equivalent per capita emissions, with methane contributing over 8 percent of the district's GHG emissions.

The methane emission distribution for all the Indian districts shows an increasing mean as well as an increasing variability (over 1990 to 2008). A shift of the Gaussian Curve (Figure 9) towards the right implies that district level emissions would have a higher probability of moving to a higher value in the future than reducing. A fattening of the curve implies that difference between districts over annual methane emissions is reducing and more districts are now crowding up the space in higher emissions per district.

The methane emission distribution for all the Indian districts shows an increasing mean as well as an increasing variability.

**Figure 8: Total Methane Emissions in India for 2008 (Gg) (a) State Level (b) District Level**

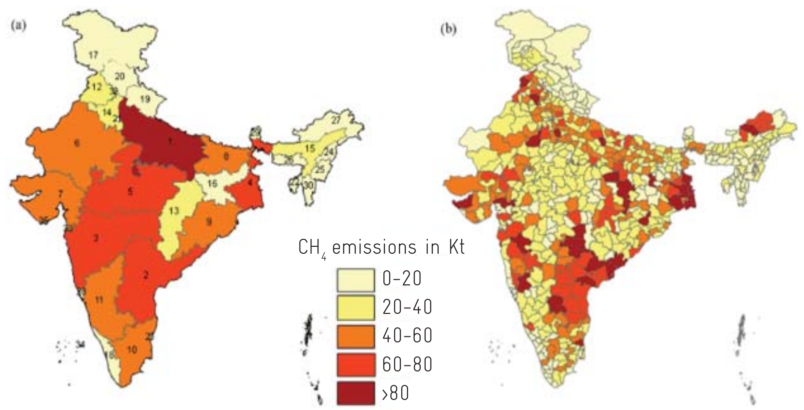
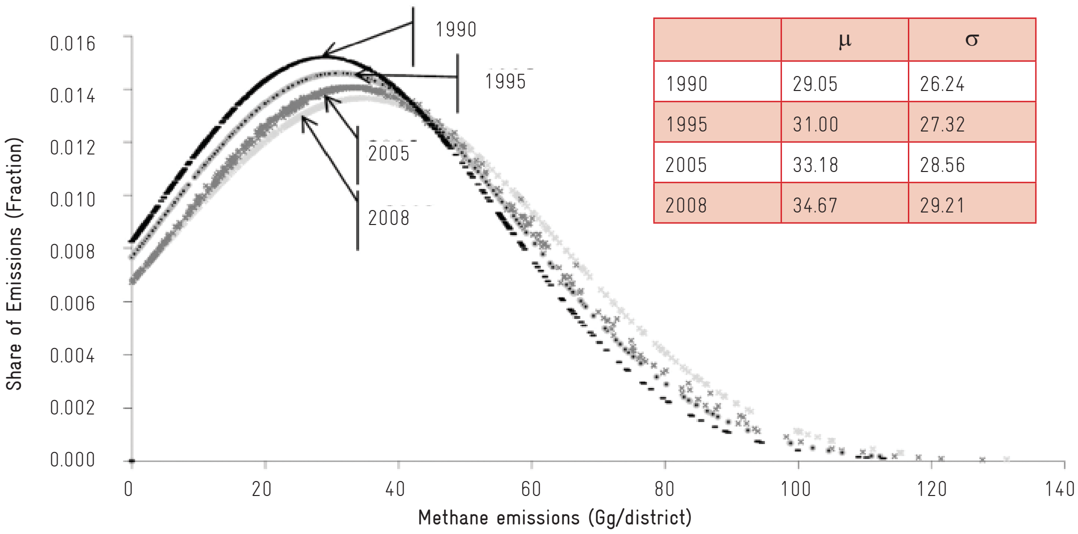



**Figure 9: Gaussian Distribution of Indian $CH_4$ Emissions**




| | μ | σ |
|---|---|---|
| 1990 | 29.05 | 26.24 |
| 1995 | 31.00 | 27.32 |
| 2005 | 33.18 | 28.56 |
| 2008 | 34.67 | 29.21 |

*Source: Methane emissions in India: Sub-regional and sectoral trends, Amit Garg, Bhushan Kankal, P.R. Shukla (Journal: Atmospheric Environment, www.elsevier.com)*

16 The top 25 hotspot districts have an average annual growth rate of 0.74 during 1995 to 2008 compared to 0.84 percent growth of all India methane emissions

The districts with low methane emissions per GDP are industrial districts with high GDP and also high populations. Their per capita emissions are also comparatively lower. For instance, from an agricultural perspective alone, Tuensang of Nagaland and Idukki of Kerala have relatively low intensity, while Anugul, Sidhi and Surguja have relatively high intensity. The latter are high fertilizer consuming agrarian districts. In fact, Kerala and those in the North-East are efficient states (Figure 6), that have considerable tea plantations and spice cultivation. These cash crops do not contribute lesser methane emissions but add tremendous economic value.

## Emissions Trends across Sectors

Emissions trends for carbon dioxide, nitrous oxide and methane are analysed in this section. What becomes clear from this analysis is that each type of gas has one or two main emitting sectors. This presents good scope for mitigation options through targeted emphasis on each type of gas. Later in this report, ideal market mechanisms are put forward in the context of creating incentives for mitigation in developing countries beyond the existing CDM mechanisms and to encourage mitigation at maximum efficiency and at least possible cost.

A recent OECD-IEA document on sectoral approaches to carbon mitigation states; "It is clear that sector-based market mechanisms, regardless of the design option chosen, will require some significant upfront effort both nationally and internationally to set appropriate baselines, ensure adequate measurement, reporting and verification, to generate economically valuable and environmentally-credible credits"[17]. However, the existence of an independent, inclusive market based mechanism, as is described in later chapters, will not require explicit policy coordination or intervention between or within countries, but rather, be able to put a price on operational inefficiencies and incentivise market based reward and punishment behaviour from the investment community.

17 "Sectoral Approaches and the Carbon Market", Richard Baron, Barbara Buchner (IEA) and Jane Ellis (OECD), June 2009

### Carbon Dioxide:

Each type of gas has one or two main emitting sectors.

Carbon dioxide is emitted from a number of sources - especially when fossil fuels are burned to produce energy the carbon stored in them is emitted almost entirely as carbon dioxide. As a result, various sectors are responsible for the overall carbon dioxide emissions in the country (Table 1).

Electric power generation contributes almost half of India's $CO_2$ emissions and majority of it is through coal and lignite consumption. India's electric power generation mix is biased in favour of thermal, which is coal dominated. Coal use contributes three fourths of total national $CO_2$ emissions especially from power generation steel and cement sectors. The transport sector forms the bulk of $CO_2$ emissions from oil product combustion. The gross power generation in India has increased by 50 percent, thermal power generation by 60 percent and $CO_2$ emissions from power sector by 7 percent between 1995 and 2005[18].

The steel sector emissions are highly concentrated in India with five largest integrated steel plants contributing above 80 percent of the sector emissions. The Steel Authority of India, which controls these integrated steel plants, has taken up a massive modernisation project to improve plant efficiency and add capacity[19]. The $CO_2$ emission coefficient for coking coal, which is a higher-grade coal and is used in this industry, is 2.75 ton $CO_2$ /ton coking coal; compared to an average of 1.76 for the other coal grades.

Coal use contributes three fourths of total national $CO_2$ emissions especially from power generation steel and cement sectors.

Emissions from cement production are relatively much more dispersed all over India due to dispersed industrial base. In 2005, energy use contributed 37 percent of total cement sector emissions while the remaining was due to the

18 $CO_2$ emissions from electric power generation sector can be reduced by reducing generation, efficiency improvement of power utilities, employing more efficient technologies, substitution by cleaner fuels or a combination of these. Coal substitution by natural gas and renewable energy offers long term $CO_2$ reduction possibilities. The marginally lower rate of $CO_2$ emissions vis-à-vis thermal power is due to efficiency improvement of power generation.

19 <http://www.sail.co.in/BSP_list_of_packages_in_CPFR.pdf>

calcinations process[20]. The cement industry is covered in detail in the following chapter of this report.

Brick, textile, metal, sugar, chemical, paper, engineering and other manufacturing industries together accounted for 109 MT $CO_2$ in 2005. A major portion was contributed by the brick industry. These industries are well spread over the country and mostly comprise of small firms. Their individual carbon emissions are low while their carbon intensities are high, indicating inefficient production[21].

Transport sector forms the bulk of $CO_2$ emissions from oil product combustion. The sector contributed 143 MT $CO_2$ in 2005, majority of which was due to diesel oil combustion. Road transportation's share in total transportation is increasing fast due to its inherent advantages in terms of door-to-door service, flexibility and reliability (however the efficiency of rail transport is about 3 to 4 times higher than that of road transport - on average, trains use three times less energy than cars to transport a given number of people; and for moving freight, trains use six times less energy than trucks and emit just one-fifth the amount of carbon dioxide)[22].

The agriculture sector accounted for around 75 percent of total $N_2O$ emissions in 2005.

### Nitrous Oxide:

The agriculture sector accounted for around 75 percent of total $N_2O$ emissions in 2005 including roughly 49 percent from nitrogen fertilizer use, 13 percent from indirect soil emissions, 6 percent from decaying of crop residue, 4 percent from livestock manure used as organic fertilizer and 3 percent from (onsite) agriculture residue burning (Table 3). Sources other than the agriculture sector namely; biomass (offsite) burning, fossil fuel combustion, municipal waste management and nitric acid production contribute 10 percent, 6 percent, 5 percent and 4 percent respectively in 2005.

There has been a significant growth of the Indian agriculture sector during last several decades. Food grain production in 1951–1952 (52 Tg) rose to above 232 Tg in 2004–2005 (Department of Food, GOI, 2006). Such tremendous success in the agricultural sector was not possible without a significant role of the chemical fertilizer. During the same period, use of synthetic fertilizer (63 share of N-fertilizer) grew from 0.066 to 20.34 Tg with 11.4 CAGR (FAI 2006). Besides higher application of N fertilizer, increased area under different crops and increase in animal population also increased the $N_2O$ emissions from the agriculture sector.

### Methane:

The total amount of methane emitted from India increased from 19 Tg in 1995 to 21 Tg in 2008. The agriculture sector (Enteric Fermentation, Manure Management and Rice Cultivation)

**Table 11: Source wise Methane emissions in India for 2008**

| Sources | 2008 (Tg) |
|---|---|
| All Energy* | 4.7 |
| Biomass | 2.23 |
| Coal Mining | 1.07 |
| Oil and Natural Gas | 0.99 |
| Agriculture | 14.4 |
| Field burning of agriculture residue | 0.41 |
| Enteric fermentation | 9.23 |
| Manure management | 0.88 |
| Rice cultivation | 3.88 |
| Waste | 1.87 |
| Solid Waste | 1.71 |
| Wastewater | 0.17 |
| Total | 20.97 |

**Sources such as biogas for energy have also been estimated, but found miniscule and thus not reported here.*

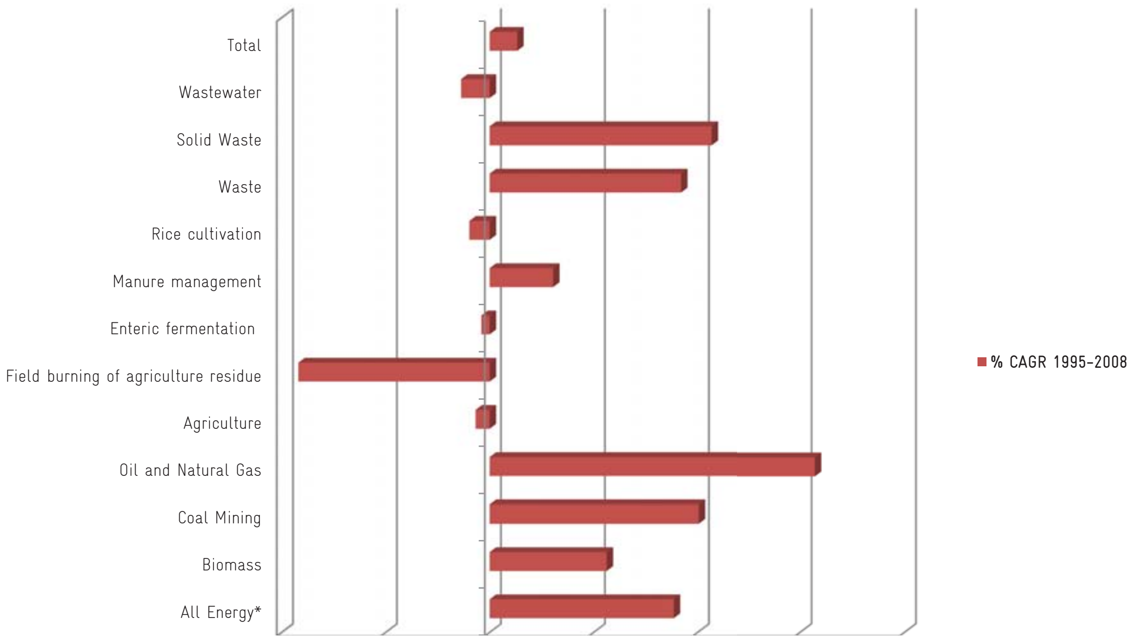
20 Higher penetration of dry clinker manufacturing technologies with preheaters, pre-calcinators and better process control equipment will reduce energy-related emissions from the cement industry.

21 Efficiency improvement measures for these units would offer benefits in the form of higher profit margins, better compliance with local pollution control norms and in turn improving the local environment.

22 For reference see: http://www.voxeu.org/index.php?q=node/658, http://www.heritage-cartman.co.in/myworkpdf/Transport%20System.pdf

In India in particular, with a shortage of good quality roads, and availability of high density and networked railway lines, the difference in efficiency especially over long distances (500 km +) is significant.

Figure 10: % CAGR of Methane over 1995-2008




A dozen companies in coal mining and oil and gas exploration sectors contribute around 10 percent of Indian methane emissions.

accounts for 61 percent of the total methane emissions in India, with 40 percent from Enteric Fermentation, 17 percent from Rice Cultivation and 4 percent from Manure Management (Table 11, Figure 10)[23]. Among the South-Asian countries, India had the highest methane production in 2000, with 11.8 Tg $CH_4$ from livestock; primarily cattle and buffaloes (Yamaji et.al. 2003).

The sectoral analysis has implications for national methane mitigation strategies. The nature of sectors and sources would determine the ease of implementing mitigation options and their relative costs. A dozen companies in coal mining and oil and gas exploration sectors contribute around 10 percent of Indian methane emissions. These firms could target project level interventions (including clean development mechanism projects), hire technical experts and arrange project financing.

Higher emission growth rate of $CO_2$ (approx 5.6 percent per annum) vs. methane (approx 0.53 percent per annum), in the future, is likely to increase the share of $CO_2$ at the expense of methane's share (Garg et.al, 2002). This would mean that the fall in methane's share could be compensated by the productive extraction of methane. Increasing emissions from landfills in mega-cities would offer possibilities of methane recovery for domestic use. Similarly, as coal consumption increases in future, especially from deeper mines, there would be higher methane emissions and therefore become good potential for harvesting coal-bed methane.

## IV Conclusion

The causality relationship between economic growth, energy consumption and $CO_2$ emissions have been studied by many scholars for different parts of the world[24]. Soytas et al (2007) indicate that income does not (Granger[25]) cause carbon emissions in the US in the long run, but energy use does[26]. Hence, income growth by itself may not become a solution to environmental prob-

23 Dispersed agriculture sources contribute more than 70 of national methane emissions. An evaluation of various methane mitigation options indicate that some of the available technologies like, diet supplementation with feed additive and molasses urea product are highly cost effective in reducing enteric methane emissions.

24 Coondoo and Dinda 2002; Soytas et al., 2007; Zhang and Cheng, 2009; Acaravci and Ozturk, 2010; Chang, 2010; Lotfalipour et al., 2010; Pao and Tsai, 2010; Al-mulali, 2011; Alam et al., 2011; Fei et al., 2011; Hatzigeorgiou et al., 2011; Pao and Tsai, 2011; and Wang et al., 2011.

25 The "Granger causality test" is a statistical hypothesis test for determining whether one time series is useful in forecasting another.

26 The Granger causality test is a statistical hypothesis test for determining whether one time series is useful in forecasting another.

lems. Coondoo and Dinda (2002) indicate three different types of causality relationship for different country groups. For the developed country groups of North America and Western Europe (and also for Eastern Europe) the causality has been found to run from emission to income; implying that a shock in the growth rate of emission tends to generate a corresponding shock in the growth rate of income. For the country groups of Central and South America, Oceania and Japan a reverse causality is obtained, and finally for Asia and Africa the causality is found to be bi-directional indicating that the income and the emission growth rates seem to reinforce each other.

There is little doubt that curbing GHG emissions will prove to be costly especially for a country such as India, which is still in early stages of economic development. Energy-efficiency measures are often expensive, and alternative energy sources are not yet as competitive as the fossil fuels they replace. However, this also provides opportunities for leap-fogging the conventional development pathways and building a green and low carbon economy. India can therefore avoid historical lock-ins of developed countries in carbon intensive economy. Incentive mechanisms for various sectors of the economy and industry, and international cooperation have to be worked out. A steep price on carbon emissions will ripple through the economy. In the case that welfare costs of mitigation of emissions are equal to the welfare gains, a country such as India can consider the stalling or reversal of some of the pre-existing emissions patterns, especially in specific polluting regions or energy intensive sectors. In this regard, extensive studies need to be conducted and in particular, region and sector specific analysis – to find the optimal solutions for each respectively. Furthermore, these solutions need to be complementary to the global impetus of pricing carbon emissions and building capacities and capabilities to finance transitory phases for businesses and industries.

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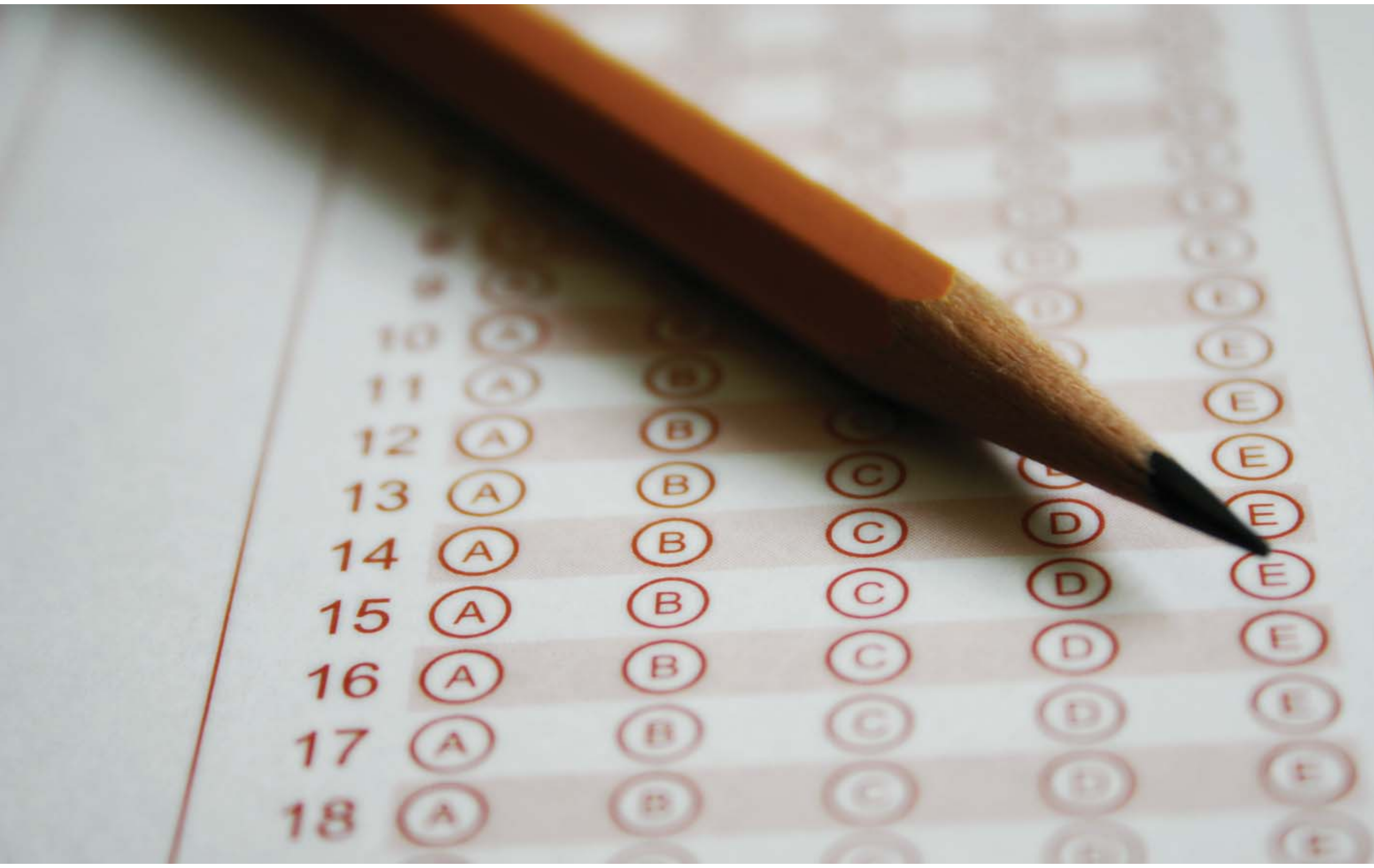
## Chapter 3

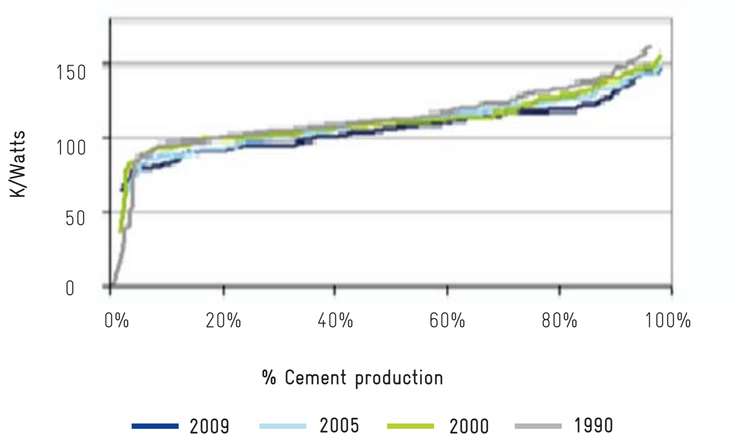
# The Case of the Cement Sector



## I Cement - An Essential Commodity

Cement is an essential commodity for a variety of development and growth activities including infrastructure building, housing and construction. It is one of the most consumed materials on the planet (the mixture of aggregates, cement and water makes concrete, which is estimated to be the second most consumed material after water[27]). The cement industry is also one of the most energy intensive industries, largely owing to the massive amounts of energy used to manufacture clinker – a key component of cement. About 3.3 billion metric tonnes of cement was sold globally in 2010[28] emitting more than 2.5 giga tonnes of $CO_2$ into the atmosphere, mostly generated through the energy consumed at the time of manufacturing (see Figure 1).

Figure 1: Electric Energy per Tonne Cement




*Source: World Business Council for Sustainable Development's Cement Sustainability Initiative*

27 World Business Council on Sustainable Development (2002) World Business Council on Sustainable Development (2002).

28 See: The ninth edition of International Cement Review's Global Cement Report

Cement is a hydraulic powder material, which reacts with water to produce strength-bearing lattices. The chemistry behind the manufacture of cement is complex. Cement is a mineral structure created at high temperatures, mainly comprising lime (CaO), Silica ($SiO_2$) and oxides of aluminium and iron ($Al_2O_3$ and $Fe_2O_3$). The cement making process is essentially a two stage process. In the first stage, "clinker" is produced at temperatures around 1400 degree centigrade in the rotary kilns[29]. The clinker is then cooled using air flows, and once it's ready to be ground, it is known as Portland cement. In the second stage, it is milled with other minerals in different proportions to produce the powdered form of cement.

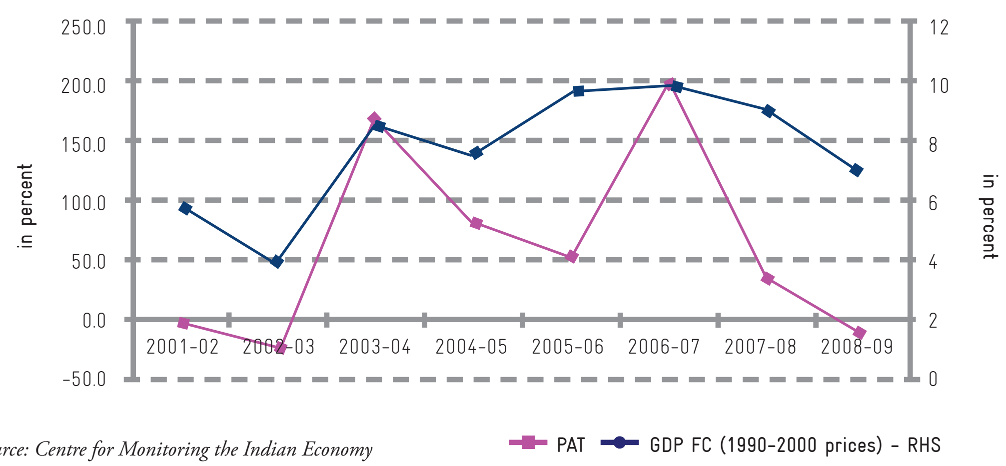
About **3.3** billion metric tonnes of cement was sold globally in 2010 emitting more than **2.5** gigatonnes of $CO_2$ into the atmosphere.

Cement production is either "wet", "semi-wet" or "dry" depending upon the water content at the time of processing in the kiln. The wet process is older, and it is easier to facilitate chemical reactions using this process, especially when wet raw materials are used at the input stage. However, this is also a high energy consuming process (owing to the heat needed to absorb the slurry water) and has been largely phased out in most parts of the world where energy efficiency is a concern. According to industry estimates[30], the wet process requires 0.28 tonnes of coal and 110 kWh of power to manufacture one tonne of cement. Alternately, the dry process requires 0.18 tonnes of coal and 100 kWh of power.

There are different varieties of cement based on different compositions according to specific end uses; namely, Ordinary Portland Cement (OPC), Portland Pozzolana Cement (PPC), White Cement, Portland Blast Furnace Slag Cement and Specialised Cement. The main difference lies in the percentage of clinker used. While OPC is the most widely used cement, PPC is steadily catching up, since it is a more specialised type of cement and it uses fly ash/burnt clay/coal waste as the main ingredient and is the most widely used cement type in India.

Studies have shown that as is the case with many of the essential commodities in existence, there is strong positive correlation between cement consumption and global macroeconomic growth. Such trends have been previously visible during the OPEC oil shocks of the seventies and after the Asian Financial Crisis of the late nineties. These distinct trends of the cement sector are further corroborated in this paper. The strong winds of the global economic crisis of 2007-2008 caused a significant stir in the cement sector in India (Figure 2).

Figure 2: Correlation between GDP Growth Rate and Cement Sector




*Source: Centre for Monitoring the Indian Economy*

29 The kiln is the world's largest piece of industrial equipment. Fuel is fired directly into the rotary kiln and ash, as with the calciner, is absorbed into the material being processed

30 Newsletter of the Confederation of Indian Industry: <http://newsletters.cii.in/newsletters/mailer/trade_talk/pdf/Cement%20Industry%20in%20India-%20Trade%20Perspectives.pdf>

## II Cement Sector in India

### II.a. Introduction:

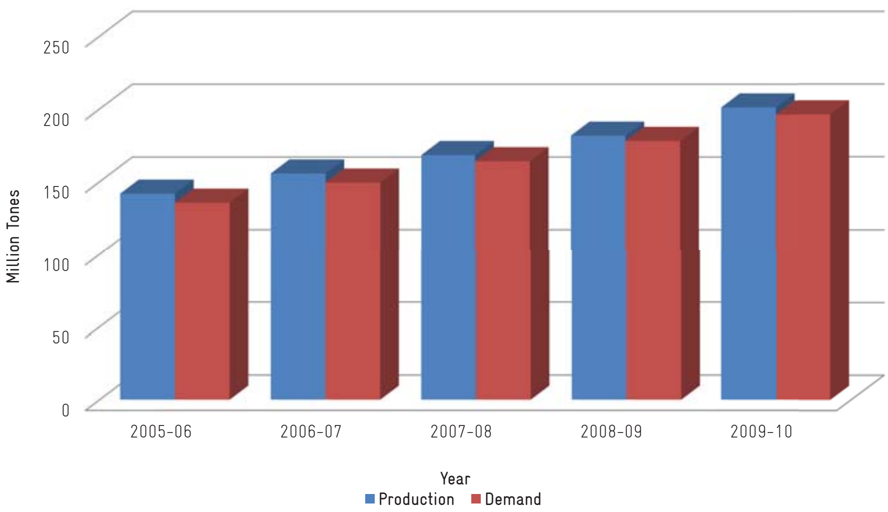
India is the second largest cement manufacturer in the world after China, accounting for around 6 percent of total global production. While it is far behind China (China's cement sector's capacity is over five times that of India), cement is a core economic sector in India. The sector provides direct employment to over 135,000 people and contributes over 1.3 percent of the total GDP[31]. There are a total of 154 large cement plants, with an installed capacity exceeding 230 million tonnes.

The Indian cement industry was essentially born in 1914, with the establishment of the Indian Cement Company Ltd. in Porbandar, Gujarat. The initial stages of growth were slow, and the industry was not able to meet indigenous demand. This led to a dependence on foreign imports (apart from price and distribution restrictions to regulate supply). With the gradual phasing out of the license and price control policies to completion of the liberalisation process in the Indian economy in the early nineties, the cement sector has managed to pick up steam[32] to match indigenous demand (Figure 3).

The Ministry of Commerce has estimated that the cement sector has added about a 100 million tonnes in capacity over 1999-2009. The Eleventh Five Year Plan of the Planning Commission suggests that the total demand increases for cement are projected to lead to the capacity addition of 118 million tonnes in the sector. This would bringing the total to 298 million tonnes over the planning period 2007-2012, requiring an investment of INR 55,000 crores (calculated at 500 crores per million tonnes addition[33]). The sector has grown at a steady pace and achieved this target in the period 2009-2010, adding a record breaking capacity of 37 million tonnes in the year. Of this, around 54 percent was added due

India is the second largest cement manufacturer in the world after China,

Figure 3: Demand and Production of Cement



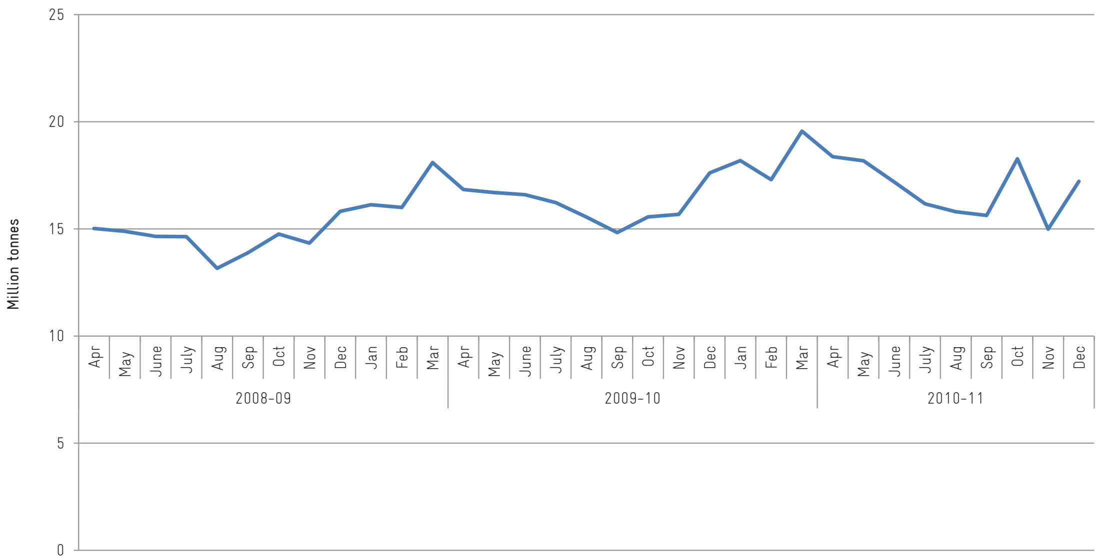

*Source: Cement Manufacturer's Association, India*

31 According to the Ninety Fifth Report on the Performance of the Cement Industry by the Parliamentary Standing Committee on Commerce, India, 2011

32 The price and distribution control was removed in 1989 and the sector was de-licensed in 1991. Furthermore, the industry has also been deleted from the list of essential commodities. (The Essential Commodities Act, 1955 provides for the regulation and control of production, distribution and pricing of commodities which are declared as essential for maintaining or increasing supplies or for securing their equitable distribution and availability at fair prices. The enforcement/ implementation of the provisions of the Essential Commodities Act,1955 lies with the State Governments and UT Administrations.)

33 Estimates from the Cement Manufacturer's Association suggest that for every one million tonnes of production, a baseline investment of INR 500 crores is required.

Figure 4: Cyclical Fluctuations in Cement Production



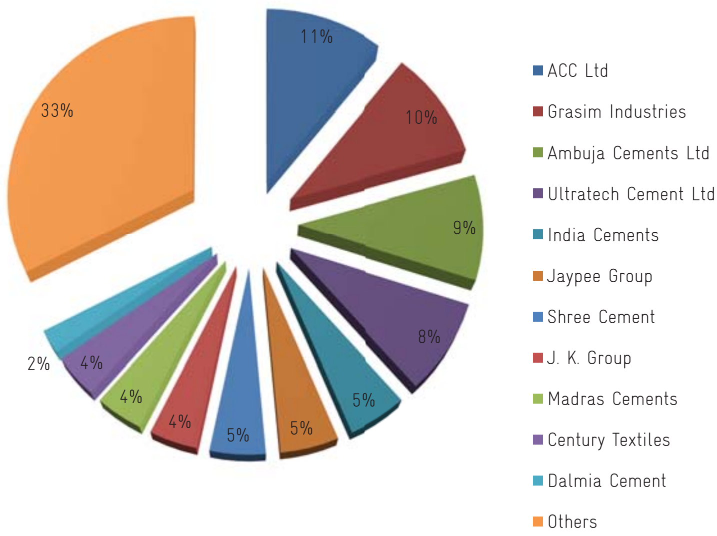

*Source: Central Statistical Organisation, India*

Eleven major companies and conglomerates account for much over half of the total production of cement in the country.

to Greenfield projects and expansions accounted for the rest[34]. As cement is a decontrolled, market led commodity, it is also subject to market fluctuations of demand and supply (Figure 4).

From Figure 4, it is sufficiently visible that a distinguishing feature of the cement industry is that production tends to peak in March and reaches its lowest in the months of August and September. The cyclical variations in the sector are inherently linked to the economic and climatic cycles that prevail within the country. The volatility has contributed to the existence of only a few players in the market – those that are big enough to survive such cyclical patterns by taking advantage of the economies of scale and monopolistic competition. Eleven major companies and conglomerates account for much over half of the total production of cement in the country (Figure 5).

Figure 5: Market Share of the Largest Companies (%)




*Source: Cement Manufacturer's Association, India.*

34 See: Annual Report of the Cement Manufacturer's Association, 2009-2010.

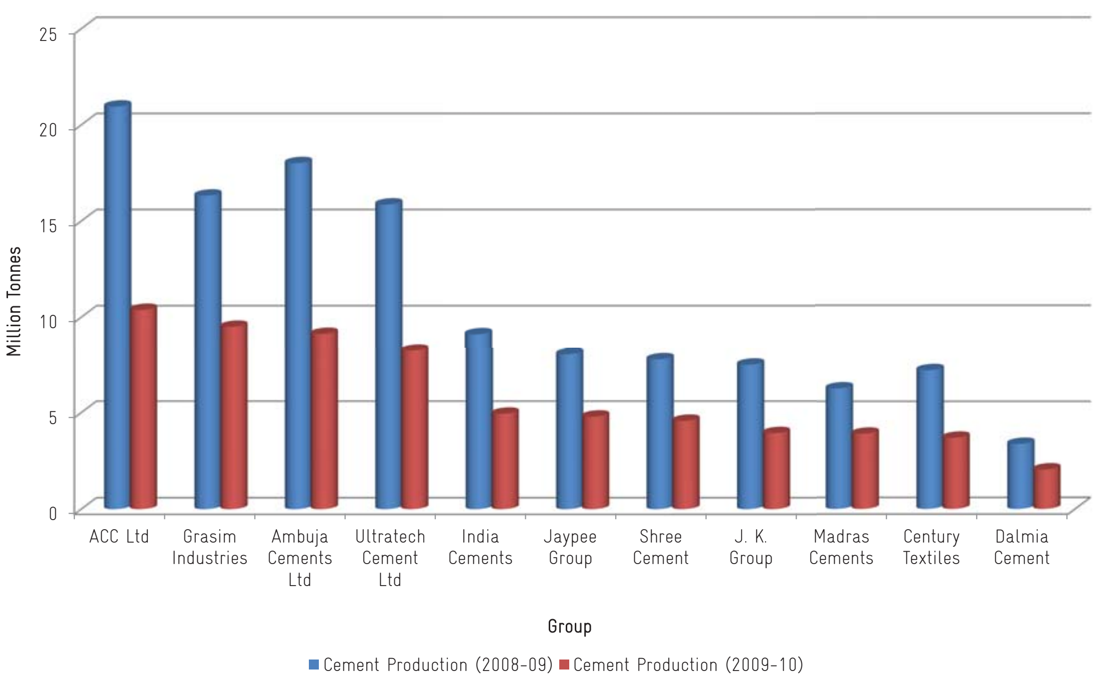
Although the sector sees volatility in output, according to the Planning Commission cement consumption has been growing steadily in the country, outpacing the growth of GDP by 2 to 3 percent on average. Thus, if the Indian economy is projected to grow at an average rate of 7 to 8 percent over the next decade, the cement sector will grow at an average of around 9 to 10 percent per year. This is a significant growth pattern, and the prominent role of the cement industry in infrastructure building, which is undoubtedly a necessity for the country's growth and development, would help to leverage this growth even further.

Another reason for the existence of large players in the cement sector is that the sector is highly capital intensive. Since it is a highly energy intensive industry, energy costs are high, with many companies generating power from captive plants. Capital intensive production which requires sustained investment in energy and core production resources means that small players find it hard to compete. It is no surprise then that the production from large cement plants with capacity above 1 million tonnes per annum (97 such plants exist currently) account for nearly 90% of the total production[35] (Figure 6).

The Indian cement industry was remarkably resilient in the face of the recent global financial crisis. It posted a growth rate of 7.9 percent in 2008-2009, a slight decrease of 0.2 percent from the year before. Stabilising after the initial financial shock to the economy, both through demand and supply mechanisms (Figure 6 illustrates the decrease in production by largest companies in 2009-2010 to adjust supply to the lagged demand shock transmission) and through the financial support/stimulus provided by the Government of India through infrastructure activities etc., Growth rate of the sector reached a record high of 12.7 percent in 2009-2010. Figure 7 helps to illustrate the significant increases in production capacities over the five year planning periods in terms of percentage.

Since it is a highly energy intensive industry, energy costs are high, with many companies generating power from captive plants.

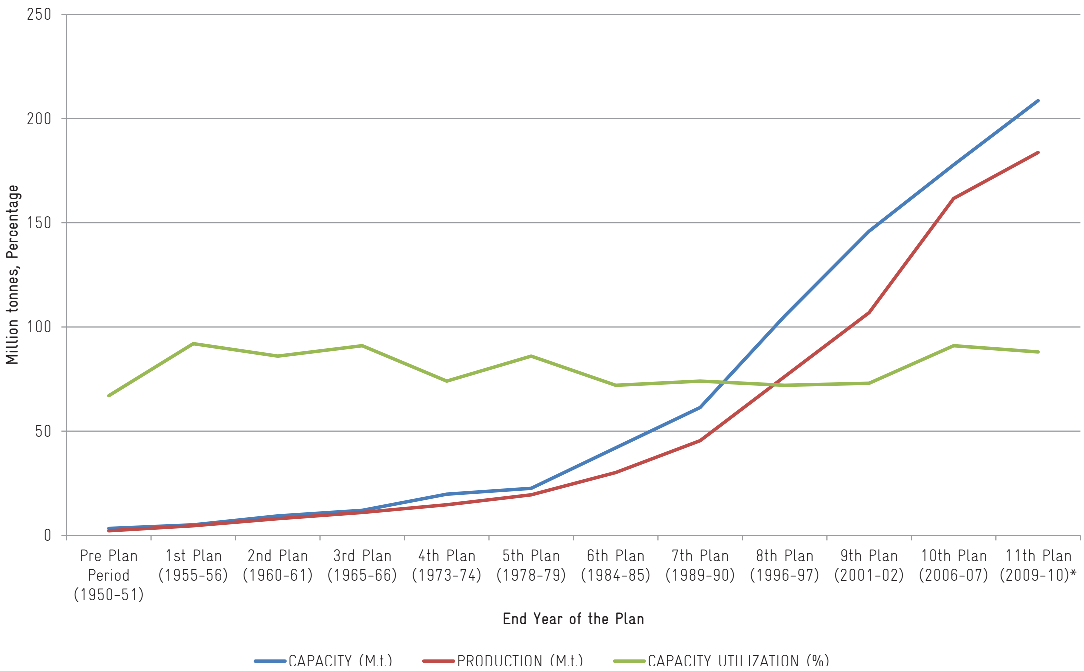
Figure 6: Cement Production by Largest Companies (2008-2010)




*Source: Cement Manufacturer's Association, India.*

35 According to the Ninety Fifth Report on the Performance of the Cement Industry by the Parliamentary Standing Committee on Commerce, India, 2011

Figure 7: Production Metrics of the Cement Sector




*Source: Cement Manufacturer's Association, India.*

The cement sector emitted **129.92** million tons of $CO_2$ in 2007; 56 percent of these emissions were from process and 44 percent from fossil fuel combustion.

Given the emphasis on investment in housing, infrastructure and commercial real estate sector, there is scope for tremendous growth in the Indian cement sector. The growth of this industry has also encouraged many foreign cement manufacturers to get in agreements and deals with companies in India to utilise it at a global level. These engagements have been primarily through various mergers and acquisitions deals. Some of the major M&A deals between domestic and foreign cement manufacturers in recent years are:

**Lafarge India:** This is a subsidiary of Lafarge, the world's largest cement company1. It was established in 1999 in India with the acquisition of TISCO and Raymond cement plants. Lafarge currently has four cement plants in India: two integrated plants in the state of Chhattisgarh, one grinding station each in Jharkhand & West Bengal. Total cement production capacity of Lafarge in India was approximately 6.5 million tons in 2009 and the company planned to increase the growth to 15-30 MT per annum in the next 10 years[36]. The company produces different types of cements like Portland Slag Cement, Portland Pozzolana Cement.

**HeidelbergCement:** In March 2006, HeidelbergCement acquired 50 percent stake in Indorama Cement for an undisclosed amount[37]. HeidelbergCement is the leading German cement manufacturing company. It has two manufacturing units in India - a grinding plant in Mumbai with a capacity of 750,000 TPA and a cement terminal near Mumbai harbour. In 2006, Heidelberg acquired a majority participation in the cement manufacturer Mysore Cements and Cochin Cements. This added two cement plants and three grinding plants to the company's production capacity. As a result of the good growth outlook, HeidelbergCement is planning to commission new facilities in Damoh and Jhansi plants in the first quarter of 2012. HeidelbergCement will then have a total capacity of 6 million tonnes in India.

**Italcementi Group:** In 2006, Italcementi Group with the help of the Ciments Français, a subsidiary for its global activities, acquired 50% stake in Zuari Cement for approximately INR 500 crore[38]. Italcementi Cement is among the largest

36 Lafarge sees larger pie from India (Economic Times)

37 Heidelberg Cement takes 50% in Indorama (Economic Times)&Heidelberg Website

38 Italcementi set to buy 50% in Zuari Cement (ET) & Zuari Website

cement manufacturing companies in the world. The company entered the Indian market in January 2001 when it acquired 50% of Yerraguntla cement plant in Andhra Pradesh in southern India. With two plants under its fold, Zuari Cement had a total capacity of 5.5m tonnes in 2006. By 2010, they had increased their capacity to almost 6 million tonnes.

**Holcim Group:** In January 2005, Holcim announced its plans to enter into a long-term strategic alliance with the Ambuja Group by acquiring a majority stake in Ambuja Cements India Ltd., which at the time held 13.8 percent of the total equity shares in the ACC Limited. Holcim simultaneously made an open offer raising its stake to 34.69 percent of the equity share capital of ACC. Holcim Group now has a simple majority in ACC and Ambuja Cements, which enables it to consolidate the revenues of its two Indian subsidiaries in its balance sheet.

The increasing concentration of the Indian cement industry with distinct patterns of consolidation and mergers in order to reap the benefits of economies of scale, tax shelter, and increased access to foreign markets is overall positive for the long term sustainability of the sector. The sector seems to be converging with the prominent global trends; that of less fragmentation than the Indian markets have seen so far, where two or three cement producers dominate the markets. This is good for sustainability, as mergers with multinationals ensures enough capital, access, quality control, international experience and more importantly some momentum towards convergence with global standards of energy efficiency.

However, this does not mean that the sector is bereft of its own set of challenges to overcome going forward. There are a few major hurdles that come in the way of faster expansion and export competitiveness of the cement sector. These challenges are important to highlight, especially from the point of view of economic and environmental sustainability:

a. The Department Related Parliamentary Standing Committee on Commerce has reported that many companies claim to have limestone (key component of cement) reserves which would last them only another 15 - 20 years.

b. There is a worrying trend of cartelisation (amongst the larger cement manufacturers) in the cement sector, which is always a concern in terms of competitiveness.

c. As per the New Coal Distribution Policy notified in October 2007, by the Ministry of Coal, the Fuel Supply Agreements will be signed for only 75 percent of the "Normative Requirement".

d. While the European Union emission standards for large cement plants is 30 mg/Nm3, the Indian emission standards for existing large cement plants is 100 mg/Nm3 including grinding units, located in critically polluted or urban areas with a population of 1,00,000 and above 150 mg/Nm3 for plants other than those falling under above category. For mini cement plants the standard is an appalling 400 mg/Nm3[39].

While the European Union emission standards for large cement plants is 30 mg/Nm3 the Indian emission standards for existing large cement plants is 100 mg/Nm3 .

## II.b. Carbon Performance of the Cement Sector in India:

The global cement industry contributes about 5 percent of the total man-made $CO_2$ emissions to the atmosphere[40] and this figure is nearly 6 percent in India (The cement sector emitted 129.92 million tons of $CO_2$ in 2007; 56 percent of these emissions were from process and 44 percent from fossil fuel combustion)[41]. The energy required to produce cement is significant and the main pollutants released are oxides of nitrogen, sulphur dioxide, particulates and carbon dioxide. The heavy dependency on natural resources, and more specifically primary raw materials and fossil fuels (the Central Pollution Control Board of India estimates that the cement industry consumes 30 million tonnes of coal and 303 million tonnes of limestone) along with the generation of waste, are the main challenges for environmental sustainability.

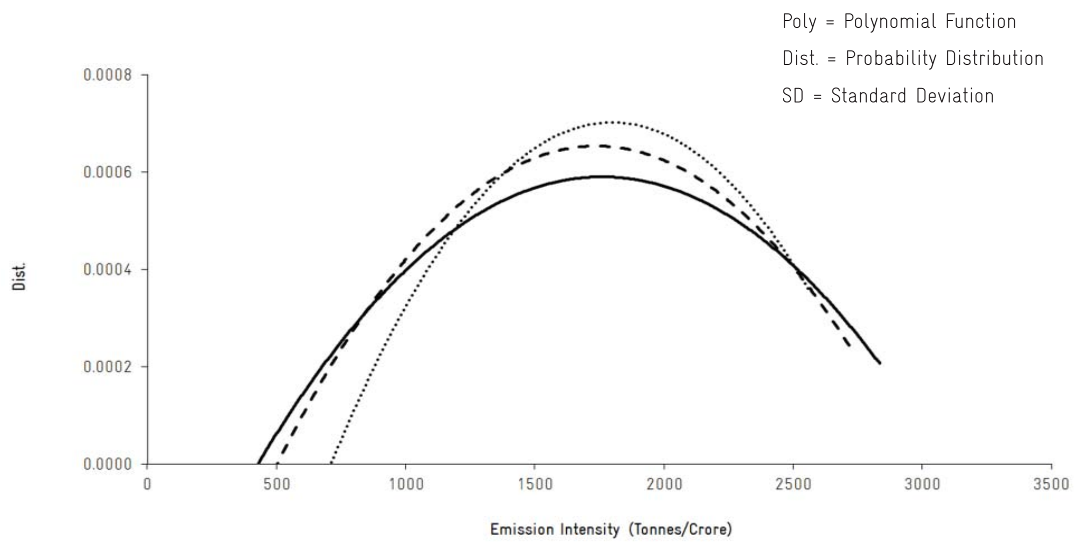
39 According to the Ninety Fifth Report on the Performance of the Cement Industry by the Parliamentary Standing Committee on Commerce, India, 2011
40 WBCSD 2005
41 "India Greenhouse Gas Emissions 2007", Ministry of Environment and Forests, 2010

Various stages of production are responsible for the emissions of GHG gasses in the atmosphere; starting from mining of limestone and other raw materials up until the loading/unloading of finished product. The actual manufacturing process (as described in the first section of this report) requires heat generation and electricity. The average thermal energy consumption for the sector in 2009 - 2010 was 725 kCal/kg per clinker and average electricity consumption was 667kCal/kg per clinker and 68kWh/tonne of cement respectively[42].

There is a steep correlation between the speed and momentum of macroeconomic growth in the country and the revenue generation in the sector. The dynamics behind this are fairly simple – higher macroeconomic growth creates positive demand for the manufacturing sector as a whole. This is true particularly for the housing and construction sector, which further leads to greater capacity utilisation by the cement plants, and higher overall sales. Traditionally, this would lead to exaggerated emissions profiles, as companies would produce and consume more energy. However, this simple correlation is now changing.

Figure 8 illustrates the emissions intensity profiles of the cement sector in India. The Gaussian Curves[43] have been estimated based on financial and energy consumption data, which is publically available, for 16 of the largest cement manufacturers in the country[44] that have captured a majority of the market share. It is interesting to note that the mean energy intensities between 2008 and 2010 are falling.

**Figure 8: Gaussian Curve of Emissions Intensities**




*Source: Annual Reports and Consolidated Financials of the Assessed Companies*

| Indicator | 2008 | 2009 | 2010 |
|---|---|---|---|
| Mean | 1884 | 1873 | 1838 |
| SD | 527 | 582 | 635 |
| Skewness | -1.0 | -1.1 | -1.1 |
| Kurtosis | 0.5 | 1.4 | 0.9 |

42 According to the Ninety Fifth Report on the Performance of the Cement Industry by the Parliamentary Standing Committee on Commerce, India, 2011

43 Wikipedia defines Gaussian Curves as: In probability theory, the normal (or Gaussian) distribution is a continuous probability distribution that is often used as a first approximation to describe real-valued random variables that tend to cluster around a single mean value.

44 ACC, Ambuja Cements, India Cements, JK Lakshmi Cements, Madras Cements, Shree Cements, Ultratech Cements, Grasim, Jaiprakash Associates, Dalmia Cement, Binani Cement Ltd., Birla Corporation Ltd., Heidelberg Cement India Ltd., J K Cement Ltd., Orient Paper & Inds. Ltd., Prism Cement Ltd. (Note: Century Textiles have been excluded due to its emissions profile being an outlier in the data set).

The following pertinent sector trends can be highlighted which explain the distribution of emissions intensities for the assessed companies:

- The standard deviation was the maximum in 2010 (and least in 2008), indicative of the maximum amount of dispersion in emissions intensities around the mean. This is also clearly evident in Figure 8; emissions intensities in 2008 are tightly dispersed around the mean, and there is gradual increase in the dispersion from the mean over 2009 and 2010. This increase in dispersion is expected after a financial crisis, with the difference in firm's performances and responses being highlighted. There is a clear improvement in the energy efficiency of the sector over the three years.
- The net increase in kurtosis from 2008 to 2010 is indicative of the movement of probability mass from the shoulders of distribution into its center and tails[45].
- There is addition of new capacities in the cement sector which are based on improved and cleaner technologies. Cement companies are also indulging in energy efficiency measures that may not be large scale, but help de-couple GHG and revenue.
- Companies in the sectors are diversifying into other business activities which are relatively low on emission as compared to cement.
- Inflation has played an important role in underpinning cement prices and prices of other products in general. This has led to realisation of higher revenues for companies while the emissions have not increased in the same proportion.
- The clinker to cement ratio is going down (more additives) which is not increasing GHG emissions as much as the growth in cement production, therefore decoupling GHG emissions and revenue.

Besides the trends highlighted above, there are several visible trends in terms of economic and environmental sustainability, and the responses generated, both by industry and policy. Some of the more significant trends are:

45 Kevin P. Balanda and H.L. MacGillivray, "Kurtosis: A Critical Review", The American Statistician 42:2, May, 1988

**a. The Phasing Out of the Wet Process:**

The gradual phasing out of the wet process of manufacturing cement has led to expected gains in energy efficiency within the sector. By 2008-2009, 0 percent of the total cement manufacture in the country was using the wet process. This was a rather steady decline from approximately 20 percent at the start of the decontrol era in the early nineties (Appendix B2). 2 percent of overall output was from the semi-wet process and 98 percent from the dry process. The wet process requires 0.28 tonnes of coal and 110 kWh of power[46] per tonne of cement produced; whereas the dry process requires 0.18 tonnes of coal and 100 kWh of power (Thermal energy consumption for wet and semi wet/dry plants are generally 63 percent and 13 percent higher than a dry plant and electricity consumption for wet and semi wet/dry plants are generally 10 percent and 5 percent higher than a dry plant).

**b. Increasing Coal Requirements:**

According to the Department Related Standing Committee on Commerce[47], against a total consumption of 29.57 million tonnes of coal by the cement sector in 2009-2010, the two primary indigenous suppliers of coal (Coal India Ltd. and Singareni Colleries Co. Ltd.) supplied 14.29 million tonnes. The deficit was accounted for by cement manufacturers at much higher costs in the open markets, and through imports and substitute fuels. According to the New Coal Distribution Policy[48], (instituted on 18th October 2007, mandates a switchover from the linkage regime of coal distribution to firm Fuel Supply Agreements between Coal India Limited's subsidiaries and their respective consumers with demand greater than 4200 tonnes per annum) up to 75 percent of the

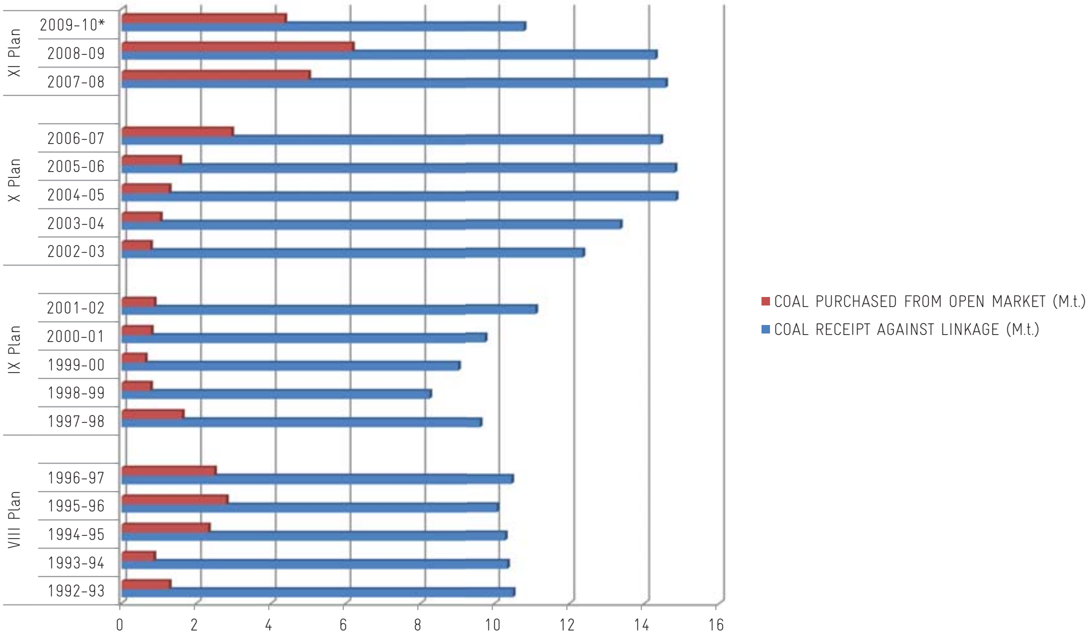
46 IBEF estimates <http://www.ibef.org/industry/cement.aspx>

47 According to the Ninety Fifth Report on the Performance of the Cement Industry by the Parliamentary Standing Committee on Commerce, India, 2011

48 New Coal Distribution Policy (NCDP) of Govt. of India specifies the policy for distribution of coal. Depending upon the category of the consumer and requirement of coal, the policy provides for appropriate procedure for obtaining coal.

The gradual phasing out of the wet process of manufacturing cement has led to expected gains in energy efficiency.

Figure 9: Open Market Purchases vs. Receipt from Linkage for Coal




*Source: Cement Manufacturer's Association* [50]

As on 31st March 2010, the total captive power generation capacity installed in the cement sector was **2,354** MW.

"Normative Requirement"[49] for coal can be fulfilled by Fuel Supply Agreements (FSA). However, the two indigenous suppliers could only provide for 48 percent of the requirement in 2008-2009. The steady relative decline of coal provided to cement manufacturers through FSAs is evident in Figure 9. The simultaneous depletion of higher quality indigenous coal, and increasing open cast mining, is not promising in terms of financial competitiveness.

### c. Trends in the Usage of Alternate Sources of Energy:

The uninterrupted provision of power is a major point of concern in the manufacturing industry. The cement sector in particular, owing to the quality and intermittent supply of power by the different State Electricity Boards in India, have adapted to the operational conditions by generating their own power. In some cases 100 percent power requirements are self generated. As on 31st March 2010, the total captive power generation capacity installed in the cement sector was 2354[51] MW, of which 56 percent (1323 MW) was based on thermal and 44 percent (1031 MW) on diesel. In addition, wind farms of approximately 85 MW have also been installed. During the year 2009-10, cement production with captive power was roughly 59 percent[52]. Overall, there is much scope for use of renewable off-grid energy generation in India. However, the choice of energy has to be carefully considered if revenues (Appendix B3) are to stay robust since some forms of alternate energy are costlier than others.

### d. Transport Costs on the Environment:

According to the Confederation of Indian Industry (CII)[53], cement manufactured for road transportation beyond 200 kilometres is not financially viable. Furthermore, it adds to overall environmental damage within the scope of the supply chain in the cement sector. Nearly 55 percent of cement is transported by rail and 1 percent by sea. Globally 70 percent of cement movement is by sea; which, in comparison to the efficiency or cost pa-

49 These requirements for the supply of coal at 75 percent of the normative quantity are decided in terms of industry wise norms after physical verifications carried out by Coal India Limited.

50 *Excludes data from two cement companies that discontinued Membership with CMA during 2009-10.

51 Provisional Estimate

52 Annual Report of the Cement Manufacturer's Association, India, 2009-2010

53 "Cement Industry in India: Trade Perspectives", Confederate of Indian Industry, 2010

rameters, outperforms land transport. Furthermore, costs on the environment are also heavy in the input process of supplying raw materials like limestone (1.6 tonnes of limestone is required for production of 1 tonne of cement) which is primarily transported to the manufacturing units by road. Moreover, bulk transportation of cement in the country, with lower costs on the environment, is not common and accounts for only 5 percent of the total. This is opposed to a global average of 70 percent owing to a shortage of bulk cement terminals in the country[54].

e. **Promising Technological Trends:**

Substitution of clinker by using fly ash and blast furnace slag has increased energy efficiency of cement manufacturing plants. According to the Ministry of Environment and Forests, the sector has taken "many steps for pollution control and installed systems like Multicyclone (installed during the pre 1990 era), Electrostatic Precipitator, Bag Filer and Hybrid Filter for control of particulate matter emission"[55].

## III Firm Level Sustainability Analysis: Ambuja Cements Ltd.

### III.a. Introduction:

Ambuja Cements Limited (ACL), formerly known as Gujarat Ambuja Cements Limited, was incorporated in 1986 with 0.7 Mt installed capacity at Ambujanagar in Gujarat. ACL, a part of Holcim group, is the third largest cement producer in India with a total installed capacity of 27 million tonnes[56]. The company has maintained its strong position of approximately 16.5 percent market share in its primary markets, and roughly 10 percent on an all-India level[57]. Principal products of ACL are OPC (Ordinary Portland Cement) and PPC (Portland Pozzolana Cement). PPC accounts for 93 percent of ACL production. Production and operating profits of ACL have increased on an average by 13 percent and 18 percent per annum respectively since 2000. In 2010, clinker production increased 23.4 percent, to 14.1 million tonnes. Cement production increased by 6.9 percent to reach 20.1 million tonnes. All the 12 plants have dry clinker making process and operate at an average of 98 percent capacity utilisation with 7 of them working above 100 percent[58 59].ACL has built a large network of over 7,500 dealers and 20,000 retailers across 18 states in India (See appendix B5 for general performance details overview).

At present, ACL is one of the cheapest cement producers in the world. Major cost saving initiatives taken by ACL include producing clinker in-house, bulk transport by sea route and captive power generation accounting for about 80 percent of electricity consumption. By considerably substituting in-house produced clinker for purchased clinker, total raw material costs reduced significantly by INR 368 crore in 2010 as compared to 2009. However, the costs of other raw materials, principally fly ash and gypsum, including transportation costs, showed an increase.

ACL's network of port, bulk terminals, and bulk cement ships has supported it in maintaining a sustainable strong market position in India. In the area of logistics, one of three new ships for western coastal transportation was delivered in 2010. The remaining two were expected to be brought into service during 2011, bringing the total fleet size to ten. A number of projects to improve efficiency of logistics operations, including rail connectivity at various locations, are also currently in progress.

Fuel and power costs also increased in 2010, largely as a result of steadily rising international coal and freight prices. A lower percentage of the ACL's total coal requirements could be satisfied through linkages as compared to the previous year. Therefore, it was necessary to procure greater quantities of imported and e-auction coal. Even where linkage coal was available, deterioration in quality has increasingly become an issue,

54 Estimates of the Planning Commission of India in the Eleventh Five Year Plan of the Government of India.
55 Ministry Website <http://moef.nic.in/modules/public-information/publications-reports/>
56 Motilal Oswal Financial Report
57 Annual Report 2010, Ambuja Cements Ltd.

58 Cement Statistics 2009, CMA
59 Annual Report 2009, Ambuja Cements Ltd.

necessitating blending of linkage coal with higher quality imported coal (appendix B6).

Partially compensating for higher fuel prices, debottlenecking initiatives at plants began to bear fruit in terms of improved energy consumption, with the average consumption rate reducing from 757 kcal per kg of clinker in 2009 to 750 kcal per kg in 2010. Some progress was also made in developing alternative fuels and raw materials business, in order to reduce dependence on coal in the future, as well as improve environmental performance. These initiatives result in lower SEC, lower costs and lower greenhouse gas (GHG) emissions per unit of output.

Major awards and appreciation for energy efficiency and GHG emissions reduction achieved by ACL are:

- National Award by the Prime Minister of India for Outstanding Pollution Control
- National Award by the Prime Minister of India for Commitment to Quality
- Award by CAPEXIL for Highest Exports
- Certification of ISO 9002 for Quality and ISO 1400 for Environmental Systems
- National Award for Excellence in Water Management – 2010 by CII
- Award for Corporate Excellence from Harvard Business School Association

In January 2006, Swiss- based global cement major Holcim Group acquired a 14.8 percent stake in Ambuja Cements for approximately INR 21 billion and later made an open-offer of 20 percent, making it the majority stakeholder in ACL. As of 31st December 2010, maximum shares of ACL were held by foreign promoters (45.45 percent) and foreign investors (27.72 percent).

The company has a strong corporate governance structure with an admirable track record. At the end of 2010, ACL had 10 directors on its Board. The company has revisited its sustainability initiatives after acknowledging the threat posed by climate change. To accelerate the pace of sustainable operations in a systematic manner the company has engaged faculty from the Harvard Business School to provide recommendations for improvement in certain sustainability areas.

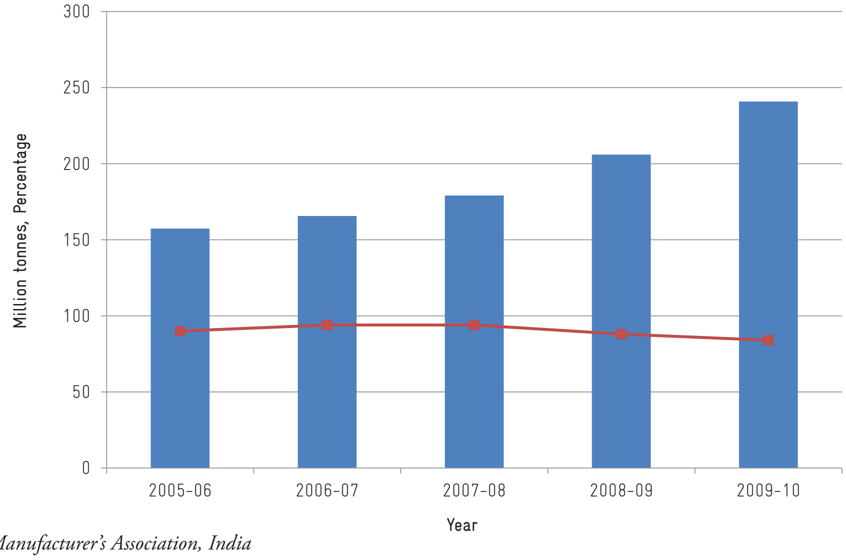
ACL's books are audited by two accounting firms; SR Batliboi & Associates and Suresh Pareek & Associates. Both firms have given assurance certificates to the company. According to them, the current accounts give a true and fair picture of the company's current operations.

### III.b. Financial vs. Environmental Performance (2008-2010):

The steady revenue growth of ACL since 2008 (Figure 10) reflects the Indian economy's rapid recovery from the global crisis. An increased GDP growth rate of 7.4 percent in 2009-2010 as compared to 6.7 percent in 2008-2009 has led to overall favourable revenue growth for ACL of INR 1140 Crore during the same period. This was achieved through consistent increase in sales over in this stage (domestic cement sales grew by 8.3 percent and total sales by 6.4 percent per year in 2010).

An overall capacity addition of 60 million tonnes by the industry as a whole in 2008-2010 has led to a fall in the capacity utilisation in the same period (Figure 10). In the case of ACL, two new clinker plants at Bhatapara and Rauri, which were commissioned in December 2009 and January 2010, are now fully operational. Two new cement grinding facilities, at Nalagarh in Himachal Pradesh (H.P.) and Dadri in Uttar Pradesh (U.P.) were commissioned during the first quarter of 2010. This increased ACL's cement production capacity to 25 million tonnes. In addition, coupled with an approximate 90 million tonnes capacity addition over 2008-2010 by the industry has resulted in significant downward pressure on cement prices in the country. ACL's strong dealer network and penetration have allowed it to withstand these price shocks to some extent.

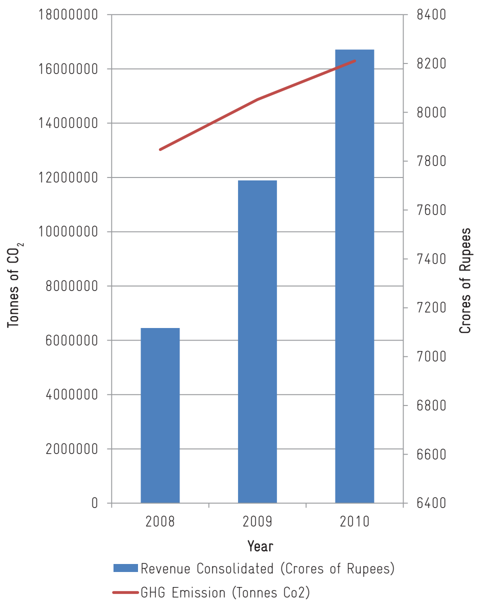
**Figure 10: Capacity Utilisation and Installed Capacity of ACL**




*Source: Cement Manufacturer's Association, India*

The total GHG emissions of ACL have risen steadily during 2008-2010 (Figure 11). An increase of 3267913.918 tonnes of $CO_2$e during this time indicates an approximate rise of 2867 tonnes of $CO_2$e per crore of revenue gain for the period.

**Figure 11: GHG Emissions vs. Consolidated Revenue, ACL**




*Source: Annual and Financial Reports of ACL (2008-2010)*

According to the 2009-2010 annual report, ACL claims to have increased thrust on sustainable development and specifically on efficient energy use patterns. ACL has undertaken various measures to this effect (Appendix B1). The company has instituted Continuous Emissions Monitoring Systems at 7 out of 9 kiln stacks, and Continuous Ambient Air Quality Monitoring Stations at 5 of its plants. Environment Management Systems have been installed at 'most of its plants' and all integrated plants are ISO 14001 certified[60].

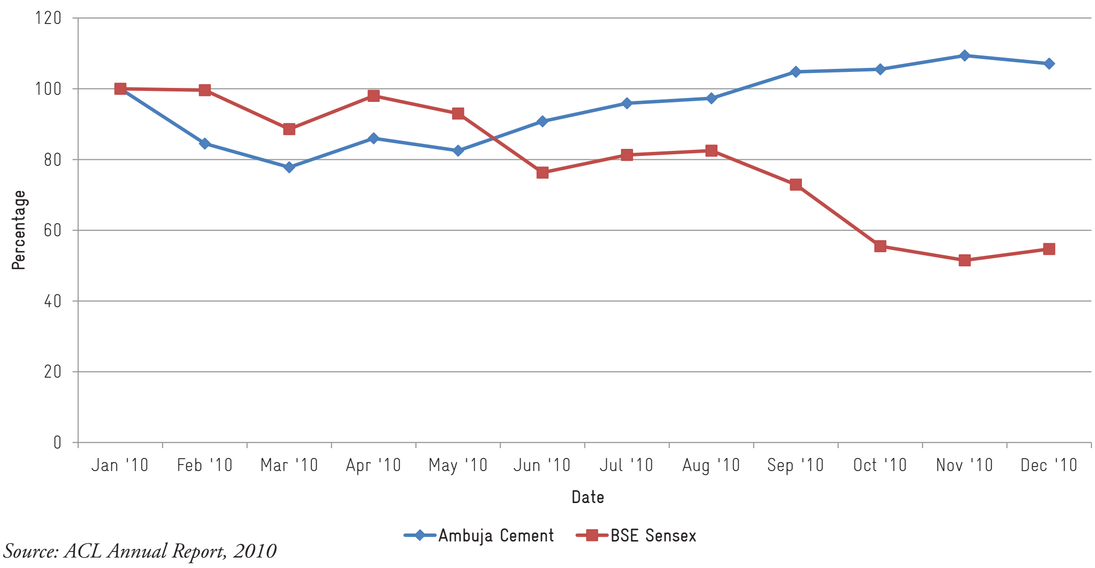
However, even with the focus on environmental sustainability, emissions intensity of the company has been consistently climbing every year (Figures 13 & 14). Figure 13 illustrates that while the primary earnings per share[61] of the company have been volatile, with a substantial drop off in 2009 perhaps as a result of the financial shocks following the crisis and build-up of production infrastructure, emissions intensity has been constantly rising. Even though primary earnings per share took a distinct hit in 2009, the price to earnings ratio[62] kept growing through 2008-2010 (Figure 14). Given that the price to earnings ratio of the BSE Sensex was 23.6 on 31st December 2010, the stock was undervalued compared to the index.

60 ISO 14001:2004 specifies requirements for an environmental management system to enable an organisation to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organisation subscribes, and information about significant environmental aspects. It applies to those environmental aspects that the organisation identifies as those which it can control and those which it can influence. It does not itself state specific environmental performance criteria.

61 Calculated as Net Income/No. of Outstanding Shares

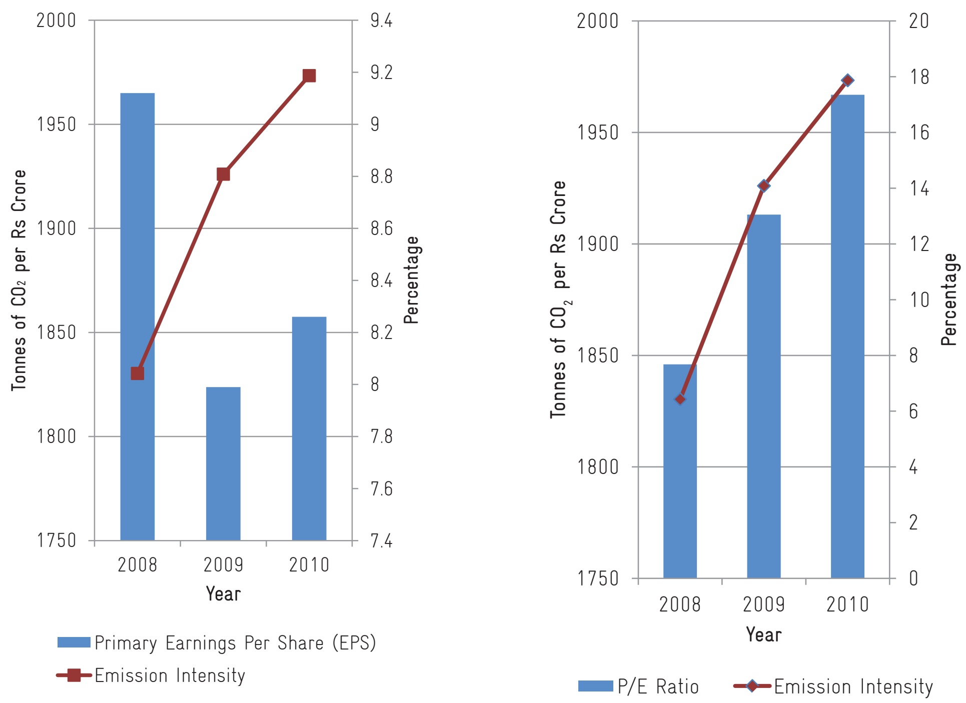
62 Calculated as Market Value Per Share/Earnings Per Share

Figure 12: Share Performance of ACL vs BSE Sensex




*Source: ACL Annual Report, 2010*

Figures 13 & 14: Emissions Intensity vs. Financial Performance, ACL




*Source: Annual Reports/Financial Statements of ACL*

The price action on the ACL stock also outperformed the BSE Sensex composite index for a greater part of 2010 compared to the monthly percentage gain (Figure 12).

The increments in input costs for the cement sector were noticeable in 2010 including resource and electricity costs (Table 1). This probably had a distinct role to play in the consistent rise in emissions intensity (As input costs for power generation increase, the bottom line takes a hit, while the company keeps growing based on overall growth in consumer demand in the market and capacity additions to the company's production facilities).

**Table 1: Increments in Input Costs**

| | Q4, 2010 | Q4, 2009 | Basis Point Change (per year) |
|---|---|---|---|
| Material costs | 9.0 | 12.5 | (349) |
| Personnel costs | 4.2 | 4.4 | (14) |
| Power and fuel costs | 24.4 | 18.3 | 611 |
| Freight cost | 22.3 | 20.9 | 141 |
| Other overheads | 20.7 | 18.7 | 193 |
| **Total costs** | **80.7** | **74.9** | **581** |

*Source: India Infoline Research*

Shareholder's got lesser returns while the overall emissions performance of the company also deteriorated.

A profit after tax growth of around 4 percent per year in 2010 reflected slow growth and this is also reflected in the return on assets[63] and return on equity[64] for the stated period (figures 15 & 16). The return on assets and equity saw approximate declines of 23 and 24 percent respectively per year in 2009. Therefore, shareholder's got lesser returns while the overall emissions performance of the company also deteriorated with an approximate increase of 5 percent per year in 2009.

**Figures 15 & 16: Emissions Intensity vs. Financial Performance, ACL**

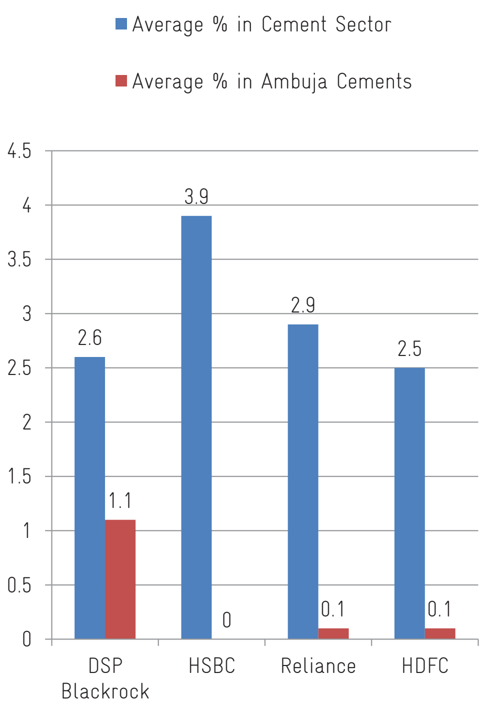

*Source: Annual Reports/Financial Statements of ACL*

63 Calculated as: Net Income/Total Assets
64 Calculated as: Net income/Shareholder's Equity

## III.c. Financial Sector Survey: Mutual Funds investing in Cement Sector in India

Most of the indigenous mutual funds have put a small amount of investment in the cement sector. It should be noted that this may only be a temporary view on the cement sector. Since sector and fund allocations are reviewed periodically, in the future the market may be more positive or negative on the stocks in this sector.

Figure 17: Data Based on Mutual Fund Schemes Investing in Cement Sector (Percentages are as per total scheme fund)




Out of the 23 equity linked mutual funds scheme managed by Reliance Mutual Fund, only 9 schemes had one or more companies from the cement sector[65]. Similarly, only 6 out of the 26 equity linked mutual funds schemes managed by HDFC mutual fund had one or more companies from the cement sector[66]. Since sector and fund allocations are reviewed periodically, in the future the market may be more positive or negative on the stocks in this sector.

Operating in sub optimal conditions, there is a requirement for progressive policy frameworks and market based emissions reductions incentives.

Ambuja Cement was not favoured much amongst the stocks selected to make up the cement sector portfolio. In the above figure, with the exception of DSP Blackrock which had more than 33 percent of its investment in the cement sector allocated in Ambuja Cements' stock, the average investment across the sector was negligible.

## IV Conclusion

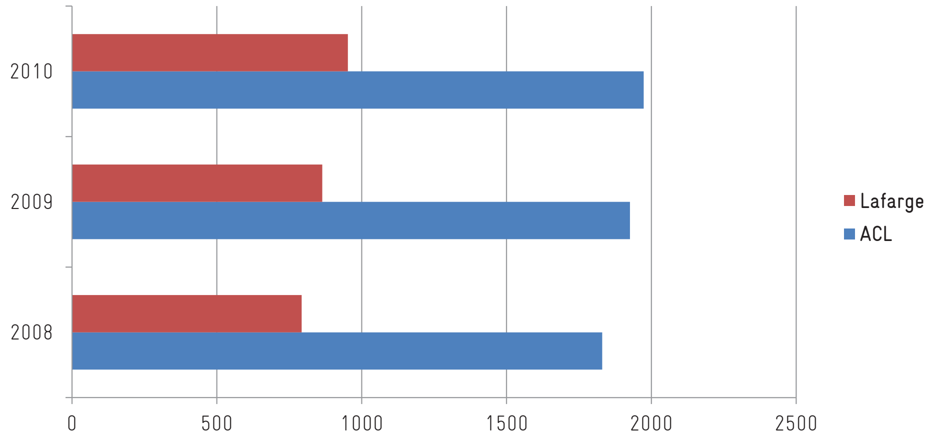
The Indian cement sector has made positive headway in terms of improving energy efficiency in 2008-2010. At the same time, like many other manufacturing industries, the cement industry is faced with issues ranging from the lack of coal supply and electricity shortage to the lack of support infrastructure like roads and ports. Operating in sub optimal conditions, there is a requirement for progressive policy framework and market based emissions reductions incentives (apart from the Clean Development Mechanism of the United Nations, for which Indian cement industry has total 22 registered CDM projects, with more than 50 percent of these from cement blending[67]). There is also a need for indigenous market based mechanisms to create incentives and stimulate change.

The firm level case study of ACL has revealed that the firm's financial performance could have been better based on the high degree of correlation with the rest of the economy (Appendix B7). At the same time, capacity additions and increased output have caused the total emissions of the company to increase, which could not have been sufficiently offset by the revenue gains. As a result, the firm's emissions intensity for clinker production has been rising every year during 2008-2010. However, enhanced use of additives has kept the overall GHG intensity of cement based revenue lower. The emissions intensity of ACL on average was higher for the three years than the sector average for the same period[68]. The high degree of correlation between the firm's environmental performance (total emissions increase of approximately 25 percent) and its financial performance (rev-

65 Reliance Mutual Fund AR 2010-11
66 HDFC Monthly Factsheet Oct-2011

67 Sustainable Cement Industry, Workshop on International comparison of Industrial Energy efficiency<http://www.iea.org/work/2010/india_bee/singhi.pdf>
68 As calculated earlier on the basis of 16 of the largest companies in the country

Figure 18: ACL vs. Lafarge - Intensity Performance




*Source: Annual and Financial Reports of ACL and Lafarge, 2008-2010*

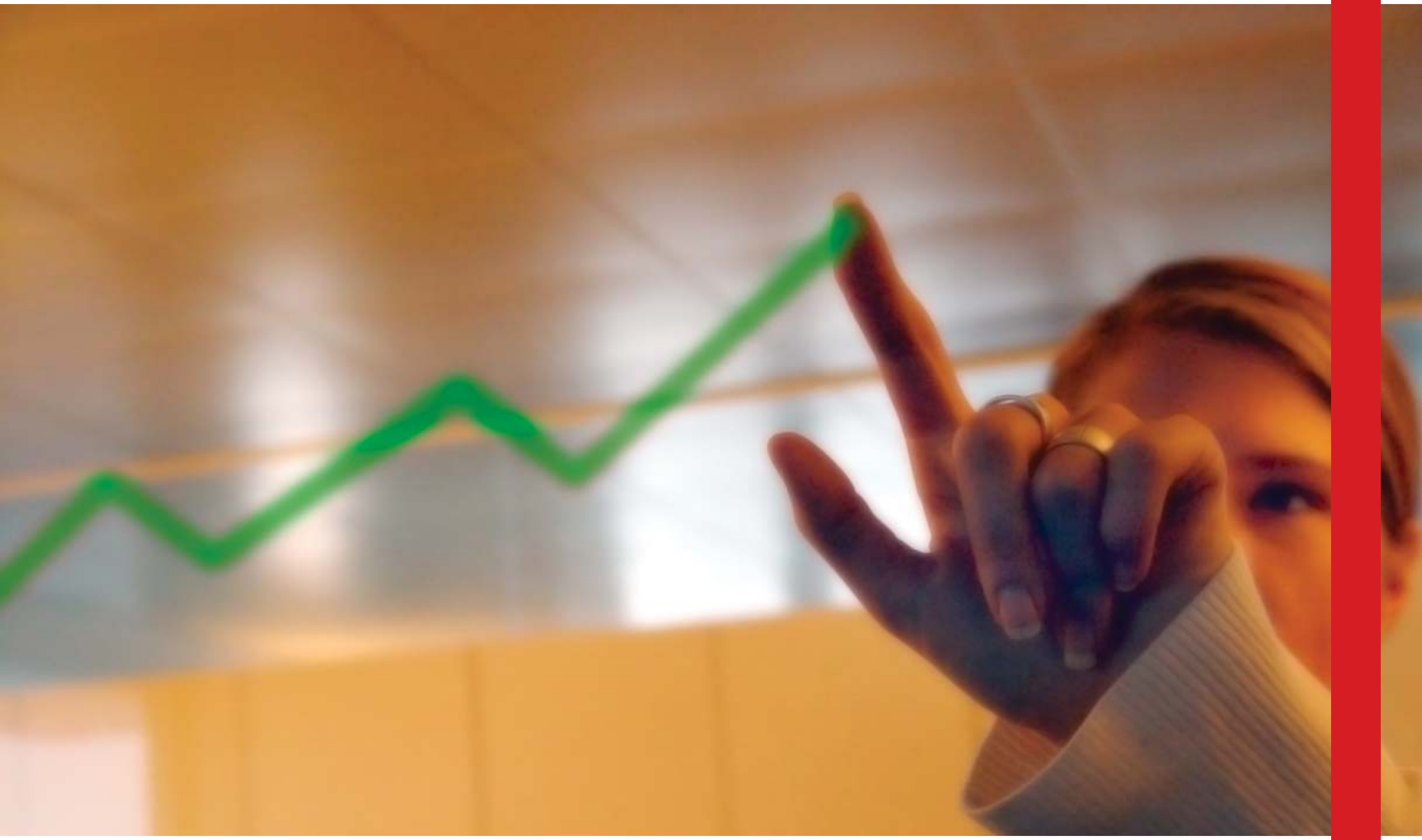
Environmental performance must not be excluded from the range of parameters that are used by investors while choosing a stock.

enue gain of approximately 16 percent) over the given years is easily observed. There is adequate room to improve the sustainability performance of ACL which is highlighted when its emissions intensities are compared with the global leader in sustainability performance – Lafarge (Figure 18).

Critics of the triple bottom line approach to investing would be disheartened by these results. There is a clear conclusion to be drawn – environmental performance must not be excluded from the range of parameters that are used by investors while choosing a stock. This is especially true for a long term investment, since the two concepts are inherently interlinked under the overall aegis of sustainable growth. There is a need for developing market based mechanisms to signal investment opportunities based upon energy efficiency and financial performance, as both tend to complement each other over the medium to long term. A forward looking energy intensive company is unlikely to ignore resource constraints and energy costs and a direct result of this is increased emphasis on energy efficiency and triple bottom line approach towards growth.

## Chapter 4

# The Green Financial Instruments Market

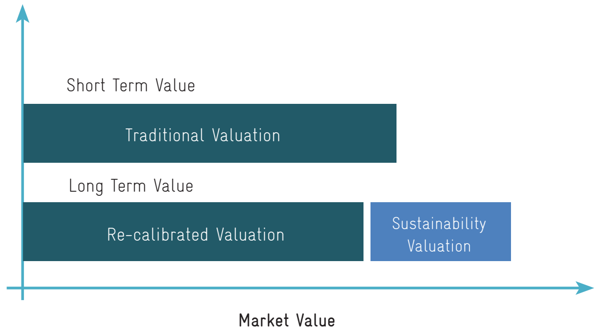


## I Introduction

In the current global economic environment there are only two certainties that present themselves to investors: the correlations across different asset classes are not as consistent as they were in the better part of the last decade, and the long term performance of companies must be evaluated through a much broader prism than just extrapolated financial viability based on historical performance. This has a clear implication on the way that companies should be analysed and the priorities for investors while choosing their asset classes, especially over the medium to long term.

Traditional valuation techniques have focused on parameters that determine the short term performance of companies. The imperative for a new approach – one that accounts for a "sustainability valuation" -- requires the existence of viable "green financial instruments". Firms that lag behind in sustainability performance cannot sustain their business models given the risks posed by policy, regulatory uncertainty and loss in competitiveness through increased input costs - especially of resources. This report suggests that the new method of valuation must resemble Figure 1; that is, traditional valuation techniques should be given relatively less weightage in the long term.

Figure 1: Traditional vs. Sustainable Approach to Firm Valuation



The total value of the carbon market in 2010 was 144 billion USD with 8.7 billion $tCO_2$ traded.

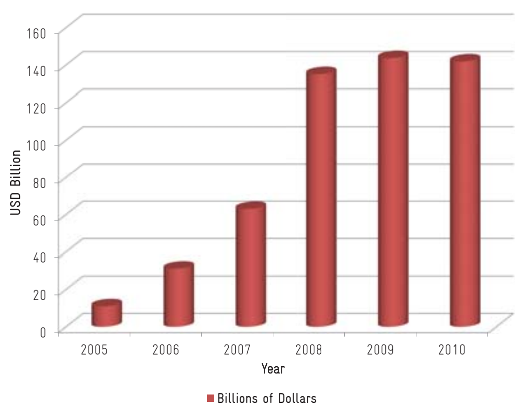
A recent 2010 survey of asset owners/ managers with collective assets totalling USD12 trillion by the Institutional Investors Group on Climate Change found that “there continues to be a lack of analysis of climate change issues” and a key challenge is that the shorter term investment horizon is “not always aligned to sustainable investment practices”

A recent 2010 survey of asset owners/managers with collective assets totalling USD 12 trillion by the Institutional Investors Group on Climate Change found that “there continues to be a lack of analysis of climate change issues” and a key challenge is that the shorter term investment horizon is “not always aligned to sustainable investment practices”[69]. Climate risk is no longer a niche social issue as there has been a veritable shift in perceptions making it a mainstream concern. This report will dissect the existing mechanisms (and vehicles) for doing so, and suggest viable and credible options for creating better mechanisms for developing countries in particular.

## II Size of the Global Carbon Markets

The total value of the carbon market in 2010 was 144 billion USD with 8.7 billion $tCO_2$ traded. Figure 2 shows the value of the carbon market from 2005-10. The European Union Emissions Trading Scheme (EU-ETS) remained the engine of the carbon market (Appendix C4). A total of USD 120 billion worth of allowances and derivatives changed hands.

**Figure 2: Value of Carbon Markets 2005-2010**




*Source: World Bank, 2011, BNEF 2011*

By 2020, the carbon market is expected to increase in size to approximately USD 2.2 trillion[70] and energy efficiency is expected to drive the gains.

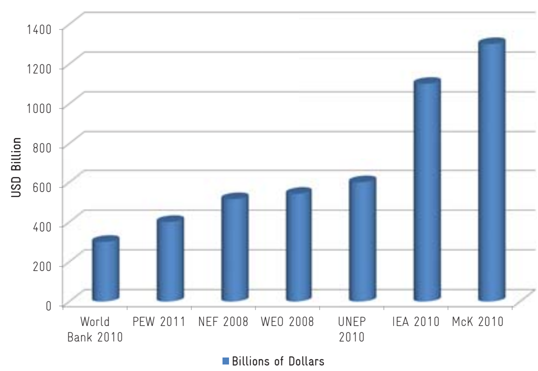
69 See: <http://www.iigcc.org/__data/assets/pdf_file/0014/15224/Global-Investor-Survey-on-Climate-Change-Report-2011.pdf>

70 “Sizing the Climate Economy”- HSBC Global Research 2010

From a low-carbon perspective, energy efficiency and a switch to domestic sources of renewable energy are among the key strategies. According to the IEA’s latest Energy Technology Perspectives report, a low-carbon economy could deliver USD 112 trillion in fuel savings by 2050 for an upfront capital cost of just USD 46 trillion[71].

$CO_2$ emissions reductions will be achieved by a combination of renewable energy and energy efficiency playing a major role at all stages of the supply chain. The scale of investment required has been estimated by various different institutions like PEW, International Energy Agency (IEA), United States’ Energy Information Administration (EIA), United Nations Environment Programme (UNEP), World Bank, Stern Review, McKinsey Global Institute (McK) and New Energy Finance (NEF) are illustrated in Figure 3. The benchmark used for emissions mitigation is the “BLUE” scenarios in the IEA’s Energy Technology Perspectives publication of 2008 describing pathways to a long-range concentration of 450 ppm $CO_2$ equivalents[72].

**Figure 3: Investment Estimates for 450 ppm Scenario**




*Sources: IEA WEO 2008, McKinsey, PEW 2011, WEF 2009, New Energy Finance 2008, World Bank 2010*

The total value of global financial assets was approximately USD 212 trillion in 2010 and is representative of the fact that the tremendous scope, size and depth required to step up to the investment challenge already exists in the capital markets[73]. Figure 4 shows the financial depth (de-

71 See: <http://www.iea.org/techno/etp/index.asp>

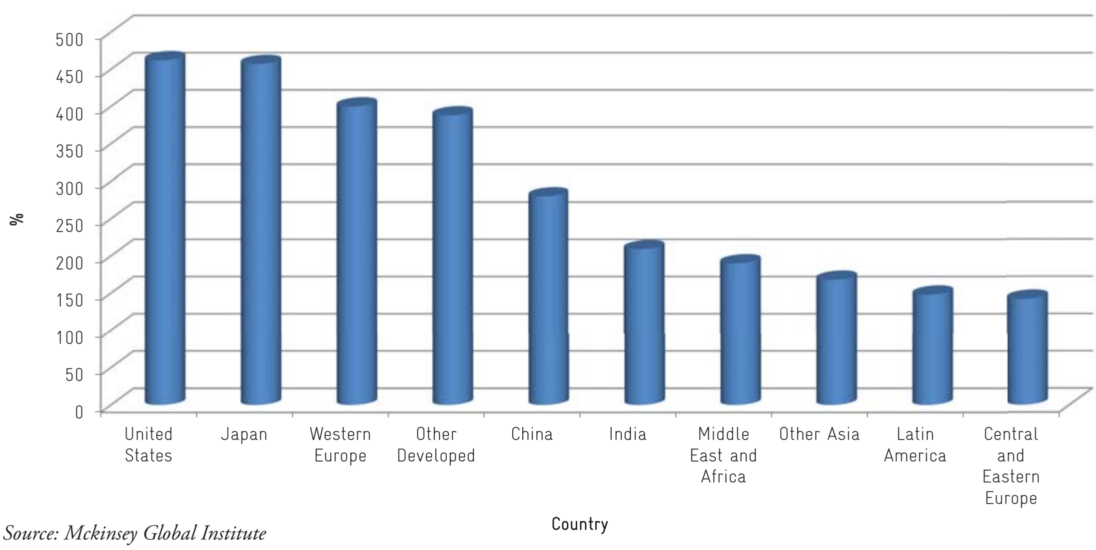
72 See: <http://www.iea.org/techno/etp/iew_paper.pdf>

73 “Mapping Global Capital Markets 2011” – McKinsey Global Institute 2011

fined as total regional debt and equity outstanding divided by regional GDP) of various regions across the globe.

**Subsidy Reforms**- Reforms are needed to eliminate price distortions created by market failures and distortions. Subsidy reforms help reduce,

Figure 4: Financial Depth, 2010




*Source: Mckinsey Global Institute*

Rather than being a problem of capital generation, the key challenge of financing the transition toward a low-emission economy is the redirection of existing and planned capital flows from traditional high-carbon to low-emission, resilient investments.

## III Overview of Existing Investment Vehicles

Following the United Nations Development Programme categorisation, market based instruments can be classified into essentially four categories - fiscal incentives, early market development instruments, debt and equity based instruments and trading instruments (Appendix C1 & C2). These instruments use price, absolute quantities, quantities per unit output or other such variables to provide incentives for polluters to reduce harmful emissions:

### 1. Fiscal Incentives:

**Corrective Taxes**- Numerous unsustainable economic activities enjoy a price advantage because the negative externalities are not fully reflected in market prices so a corrective tax can be imposed.

redesign or eliminate harmful subsidies that promote inefficient use of resources. Conventional energy subsidies are the most important barrier to the growth of clean energy technology today. Fossil fuel consumption subsidies amounted to $312 billion in 2009, down from $558 billion in 2008, mainly due to a fall in international prices[74] (Appendix C3).

**Tax Incentives**- Preferential tax treatments or exemptions function to help develop green technologies, preserve resources and increase climate resilience through direct fiscal incentives. For example, in USA, the Production Tax Credit (PTC) reduces the income taxes of qualified taxpaying owners of renewable energy projects based on the electrical output of renewable energy facilities.[75]

In addition to their price effects, these fiscal instruments have the advantage of raising additional public revenue which can then be used to finance other policy instruments like private equity instruments.

Fossil fuel consumption subsidies amounted to $312 billion in 2009, down from $558 billion in 2008, mainly due to a fall in international prices.

According to the IEA's latest Energy Technology Perspectives report, a low-carbon economy could deliver USD 112 trillion in fuel savings by 2050 for an upfront capital cost of just USD 46 trillion.

74 IEA, "World Energy Outlook 2010"
75 World Resources Institute, 2010 – "The Bottom Line on Climate Bill Compliance", Issue 18.

According to Bloomberg New Energy Finance, during 2004-09, nearly USD **35** billion worth of new clean energy investments were made through private equity and venture capital funds.

## 2. Early Market Development Instruments:

These take the form of procurement requirements or direct grants and support technology development and deployment by securing and boosting market demand. Governments can foster green procurement within commercial companies by requiring them to meet specific energy efficiency targets and to purchase a specific percentage of power from renewable energy sources.

## 3. Sustainable Investment Vehicles:

Asset allocation strategies can fall into four broad areas – public equity, debt markets, real assets and alternative investments.

**Public Equity Products**: Institutional and retail investors can invest in specialised sustainability related sectors including renewable energy, energy efficiency or waste management but also issues more tangentially related such as water and infrastructure investments[76].

**Debt Markets**: In the realm of sustainability investment, climate bonds/green bonds have been especially attractive to sustainability oriented investors who are looking for stable, long term returns. 'Green Bonds' have recently been introduced by the International Finance Corporation (IFC) and European Investment Bank (EIB) as a financial vehicle to invest in sustainability related activities and finance green infrastructure in developing countries. It has supported 21 climate related investments, including energy efficiency improvements in JK Paper (India), installation of biomass power generation in Grupo Calidre (Mexico) and a hydro power plant in La Confluencia (Chile).

**Real Assets**: Real assets refer to those assets that have an intrinsic value and are tangible, like real estate, timber and forestry. Real estate investment involves a variety of products – from private equity placements, debt financing, to publicly traded Real Estate Investment Trusts (REITs) and securitised mortgages – all tied to ownership of existing buildings, rehabilitation of existing buildings and new construction.

Timber and forestry investments are particularly critical for both climate change mitigation and adaptation. Timber investments have a low correlation with other asset classes and are also often seen as an inflation hedge. There are a number of new funds offering exposure to timber and sustainable forestry.

**Alternative Investments**: Private equity/venture capital funds play an important role in providing capital to start up clean technology companies. In emerging markets, private equity investments have focused on more mature segments. They have taken the form of providing expansion capital where access to such markets is limited or making efficiency improvements in operations. According to Bloomberg New Energy Finance, during 2004-09, nearly USD 35 billion worth of new clean energy investments were made through private equity and venture capital funds, led by Europe and Americas. Green hedge funds have the potential to provide investors with substantial returns particularly in negative market environments. They can range in strategies from equities that only invest in "green businesses" to carbon, renewable energy credit, bio-fuels and emissions trading. Appendix C5 provides some examples of private and public funds available today.

## 4. Trading Instruments:

Emission trading instruments create markets for many environmental goods, including emissions phase out, natural habitat conservation and water quality trading. Renewable Energy Certificates (RECs) and Emissions Credits are two specific instruments that have emerged in the carbon trading market.

**Renewable Energy Certificates (RECs)**: The market price for an REC can be seen as a subsidy paid to a renewable energy source per unit of production. The purchase of RECs helps offset carbon emissions and contribute to building a market for renewable energy.

76 "Handbook on Climate Related Investing across Asset Classes" – Institute for Responsible Investing, 2010.

**Emissions Trading**: Emissions trading mechanisms, such as carbon cap-and-trade and baseline-and-credit systems are intended to minimise the cost of a given level of pollution abatement by creating property rights to emit and limiting the supply of permits to ensure that the emissions level target is not exceeded. These permits can then be traded between emitters lacking permits and those who have a surplus. The limit on the total number of permits means that they have a saleable value (Table 1). See Appendix C4 for an overview of the most successful and broad based instruments across such market mechanisms – the EU-ETS.

The voluntary market generally is formed by the companies, individuals, and other entities and activities not subject to mandatory limitations that wish to offset GHG emissions. The market making entities – or exchanges that are prominent players in the voluntary market space are the following:

- Chicago Climate Exchange (CCX): Works on a cap and trade system in North America for the 6 greenhouse gases.
- European Climate Exchange (ECX): Since 2005, it has traded carbon emissions in Europe, uses EU Allowances (EUAs) and CERs.
- Other Exchanges include BlueNext (Paris), Chicago Climate Futures Exchange and Envex (Australia).

## IV The Rationale for "Green" Financial Products for Developing Markets

Diversification of risk is the first and foremost criterion of any well managed financial portfolio. All through this report, the imperative of looking at the world through the sustainability lens has been highlighted. Making investments in long-term, sustainable, businesses and sectors is not only socially responsible; it is financially responsible as well. The correlation between forward looking optimisation behaviour and increased profitability has been observed in many different regions of the world. Companies performing well in the quantifiable parameters within sustainability, especially sustainable energy use patterns tend to outperform companies that do not adapt appropriately with the same long term outlook[77].

The traditional definition of an optimised portfolio flows from Markowitz's portfolio theory (Markowitz 1952). This theory, from which many modern day optimisation models are derive, asserts that investors base their decisions on expected return and risk, as measured by the mean and variance of the returns on various assets. This theory also states that all investors have the same time horizon and are only concerned with the utility of their terminal wealth, and not with the

The correlation between forward looking optimisation behaviour and increased profitability has been observed in many different regions of the world.

**Table 1: Emissions Credits Values 2004-2010**

| Carbon Market Evolution, values ($ billion), 2004-10 | | | | | | |
|---|---|---|---|---|---|---|
| | EU ETS Allowance | Other Allowance | Primary CDM | Secondary CDM | Other offsets | Total |
| 2005 | 7.9 | 0.1 | 2.6 | 0.2 | 0.3 | 11.0 |
| 2006 | 24.4 | 0.3 | 5.8 | 0.4 | 0.3 | 31.2 |
| 2007 | 49.1 | 0.3 | 7.4 | 5.5 | 0.8 | 63.0 |
| 2008 | 100.5 | 1.0 | 6.5 | 26.3 | 0.8 | 135.1 |
| 2009 | 118.5 | 4.3 | 2.7 | 17.5 | 0.7 | 143.7 |
| 2010 | 119.8 | 1.1 | 1.5 | 18.3 | 1.2 | 141.9 |

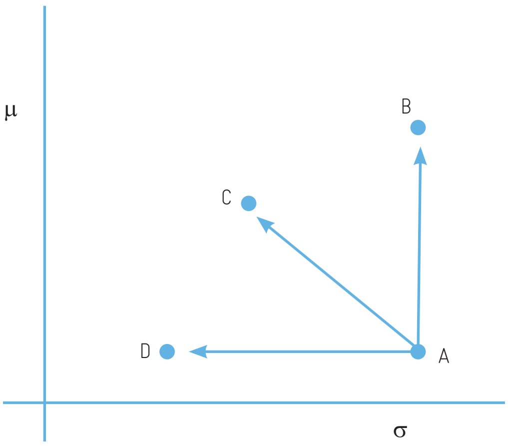
*Source: World Bank, Thomson Reuters Point Carbon, Bloomberg New Energy Finance and Ecosystem Marketplace*

*Note: Numbers may not add up due to rounding.*

77 See: "Motivating Business Leaders To Improve Profitability Through Energy Efficiency", Christopher Russell, New York State Energy Research and Development Authority, 2003
Also See: <http://www.industry.siemens.com/topics/global/en/environmental-care/energy-efficiency/Documents/Brochure_Efficiencygains_E.pdf>

state of their portfolios beforehand[78]. With these given conditions, the basic tenant of the theory is that investor's desire to maximise the expected return (profits) and minimise the standard deviation of the return (the risk). This concept is fairly easy to understand. However, since utility is an unquantifiable concept, the order of preferences from one investor to another may vary considerably. Figure 5 is an illustration of these variations in choices.

Figure 5: An individual will prefer B, C and D to A – but which is the most preferable?

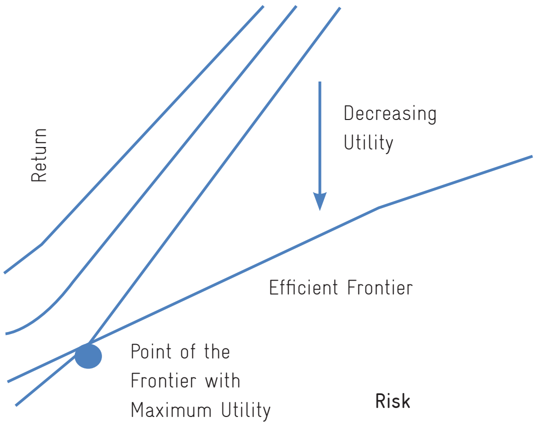



The above figure plots risk on the x axis and returns on the y axis. At point A, the risk is significant without relatively good returns, at point B the returns are high but risk also remains high, at point C there is almost an equal trade-off between profits and risk, and at point D, returns are low, but so is risk. The trade-offs between risk and rewards are significant at points A, B and D. To an investor who is looking to build a suitably diversified yet profitable portfolio, more often than not, point C would be the most attractive.

However, it is not possible to find a suitable portfolio for any given investor in such simplistic terms. This is true since everybody has a different utility curve. People derive different utilities from different combinations of expected risk and reward owing to differences in behavioural preferences. Nevertheless, hypothetically, if a utility function of a sustainable investor is one that resembles the curves in Figure 6, the investor will choose the point marked in the diagram. This point represents the maximum utility derived by the investor at the intersection with the efficient frontier (first defined by Markowitz) – on which all points represent the optimal risk-reward portfolio.

A majority of the indices in question are used as signalling/rating tools meant to incentivise investments in well performing companies/ sectors.

Figure 6: The Efficient Frontier




The risks of increasing carbon emissions and decreasing availability of traditional energy resources are often not accounted for in traditional portfolio optimisation models. However, such risks to financial portfolios can be identified using the following two subcategories of risk[79]:

1. Systemic Risk: This type of risk is associated with macro concerns which include overall economic and market risks. Policies to combat GHG emissions (and climate change) tend to create systemic risk across economies, affecting prices and firm performance. Another characteristic of this type of risk is that it has disproportionate effects on energy production and consumption.
2. Unsystemic Risk: This is a component of investment risk affecting specific securities. With respect to issuer risk for instance, returns on equity investments are determined by a firm's underlying financial performance across various indicators. This in turn is influenced by competitive positioning around themes of concern within the sector. The sector risks affect all firms in a given sector through various

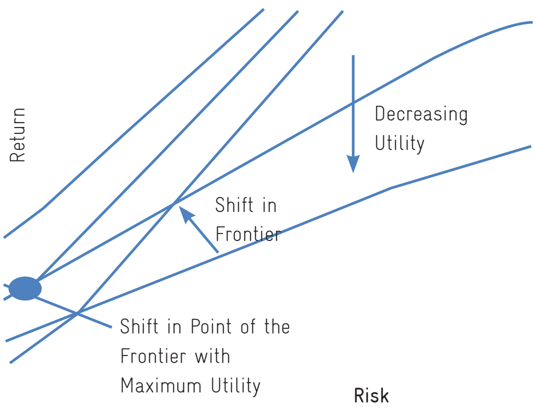
78 Another slightly more involved assumption is that all assets are arbitrarily fungible.

79 "Framing Climate Risk in Portfolio Management", CERES and World Resources Institute, May 2005.

transmission mechanisms including policy, competition and regulation.

While recognising such risks, it becomes immediately necessary for investors to find suitable hedges. This can be done successfully only if the portfolios they hold are suitably diversified to combat such risks. With risk adjustment through a set of portfolios which account for systemic and unsystemic risk, it is possible for investors with the utility curves given in Figure 6 to see an upward shift in their Efficient Frontiers. Therefore, suitably tailored financial products can account for lower risk and greater reward with the same order of preferences for a given investor (Figure 7).

Figure 7: The New Efficient Frontier




The imperatives for diversification against unsystemic and systemic risks in developing countries is greater due to uncertain policy, regulatory environments and dependence on hydrocarbons to fuel economic growth and development. This clearly establishes the rationale for reducing risk through investing in sustainability. The shift in the efficiency frontier of investors, when they invest in instruments that are successfully able to offset such risks, is beneficial even in terms of increased profitability. This undoubtedly will continue to be the single most important barometer of portfolio performance.

Institutional investor awareness on benefits of de-risking in such a way has increased dramatically over the last decade. Having said that, the lack of robust and credible signalling mechanisms (such as indices and ratings), research evidence and analytical tools, especially in emerging/developing economies, has led to disappointing inaction. Furthermore, since the perception of existing market based instruments and mechanisms for investing in carbon related products is inherently complex and opaque the retail investor is more or less completely left out of the market space.

## V Criterion for Creation of a Viable Signalling Mechanism in the Developing Country Context

The proliferation of sustainability related indices and ratings around the world calls for some introspection on behalf of the stakeholders involved. Various stakeholders have jumped on the index bandwagon to provide market signals to different target audiences. A majority of the indices in question are used as signalling/rating tools meant to incentivise investments in well performing companies/sectors (the criterion for performance of course differs in each index as outlined in the previous section).

However, in order to be considered as truly credible tools for allocating risky investments, such indices need to fulfil certain basic criterion. The indices also have to resolve some fundamental issues to be successful/useful in markets in developing countries in particular, where investors (both retail and institutional) tend to be relatively discerning and cautious (partly owing to the relatively nascent nature of the capital markets), whereas the policy environment tends to be disruptive:

a. **Transparency:**

While the companies that the international indices rate are rated based on transparency, it is ironic that within the sustainability domain there is a lot to be desired on very basic levels of transparency itself. It is common for organisations that host and own the indices to not disclose sufficient information for the users of their indices. This can happen in various forms, but most often it is in the case of disclosing basic methodology. Some organisations disclose categories and weightings (for example: energy performance = 15% of total score), but few explain how the

Suitably tailored financial products can account for lower risk and greater reward with the same order of preferences for a given investor.

categories and weightings were originally determined or the genesis and rationale of specific criteria and scaling/weights applied within these categories.

b. **Comparing the Incomparable:**

Many times it is very difficult to objectively evaluate companies across sectors, geographies, currencies with varying revenues and business models. This raises critical questions around the universe of companies, the evaluated parameters and scaling and weightage given to the various performance or disclosure indicators. Furthermore, many ratings insufficiently consider the context of certain companies, industries and issues.

c. **Performance vs. Disclosure:**

Sustainability performance and corporate disclosure are often confused in methodologies. Ultimately, performance and disclosure are inherently linked, and any company improving its performance whether in terms of energy use, governance structures or social indicators, would be willing to take any opportunity to disclose. The converse is also true – companies that perform badly on the various groups of sustainability indicators would not want to voluntary disclose their performance figures in those specific areas. These trends are particularly noticeable when environmental disclosures are voluntary to a large extent as is the case in many developing countries. However, in the case of many indices, it is not sufficiently clear if performance or disclosure (or some combination of the two) is the primary driver. There are important differences in evaluating the carbon efficiency of a company versus evaluating the quality and integrity of reporting.

d. **Financial Performance:**

Many of the indices that exist today within the sustainability universe do not give weightage to financial performance. While sustainability goes beyond financial performance in its overall scope, the foremost basis for sustainable business is good financial performance. Particularly for developing countries, business models are new and constantly adapting to policy shifts and erratic demand cycles. it is necessary to evaluate them on the basis of financial performance, and preferably at the same time with specific sustainability indicators such as energy performance.

e. **Qualitative vs. Quantitative:**

This is perhaps the most significant factor for the discerning investor. Subjective benchmarks are not useful for investments. This is because the scaling/indexing is ultimately left to the judgment of individuals rather than actual performance data. Therefore, even in the case of sustainability indices that outperform the equity indices they are inherently based upon, the outperformance cannot directly be attributed to sustainability performance, but rather to a process of stock picking and signalling. Often, in existing indices, qualitative factors such as management decisions and disclosure practices are scaled quantitatively while at the same time it is mathematically not possible to remove the element of subjectivity from a discrete scaling method.

f. **Benchmark vs. Tradable:**

There is no shortage of benchmark indices and ratings for both the investing community and non-market participants around the world. As a result, there is considerable "noise" in the markets – whereby many options exist but few are credible or accountable. As soon as a benchmark index is tradable, automatic accountability of performance is realised, and the volumes traded become reliable gauges of credibility.

Often in existing indices is qualitative factors such as management decisions and disclosure practices are scaled quantitatively while at the same time it is mathematically not possible to remove the element of subjectivity from a discrete scaling method.

## VI Existing Global Indices/Ratings

There are a number of indices in existence operating within the overall aegis of sustainability and energy performance (Appendix C6). Indices act as visual signalling instruments that incentivise investments in companies which perform well in the components being measured by them. Indices also act as benchmarks for both; passive and active funds and institutional and retail investors. Some indices function as investable indices, which investors can buy into. The performance benchmarks of most indices that are globally within the sustainability domain are the corresponding equity indices for companies in the region, or the MSCI world indices in the case of transnational indexing of firm performance. The most prominent and credible indices according to recent analyst surveys[80] and their characteristics are as follows:

| Index Overview | Parameters/Characteristics |
|---|---|
| Dow Jones Sustainability Indexes (Dow Jones Sustainability World Index)[81]<br><br>"Dow Jones Sustainability Indexes" were amongst the first of global sustainability benchmarks when they were launched back in 1999. The various indices are run in collaboration between SAM Indexes and Dow Jones Indexes, the marketing name and a licensed trademark of CME Group Index Services LLC.<br><br>The Dow Jones Sustainability Indexes (19 in total) comprise global and regional benchmarks including European, Eurozone, Nordic, North American, US, Asia Pacific, and Korean indexes. Subsets of these indexes allow investors to exclude certain sectors from performance measurement.<br><br>Dow Jones Indexes and SAM claim that together they can create customised versions of the indexes to meet investors' specific requirements for their unique investment objectives. This is an investable index. | Type of Index: Benchmark Qualitative<br><br>Stocks Included: The benchmark index for the rest of the 19 indices, the Dow Jones Sustainability World Index (of which the rest are subsets) represents the top 10 percent of the largest 2,500 companies with a total market capitalisation of 9,415 billion USD (as on Oct 31, 2011) in the Dow Jones Global Total Stock Market Index based on long-term economic, environmental and social criteria.<br><br>Weights Used: Float adjusted market capitalisation<br><br>Components: Variable<br><br>Methodology: The SAM "Corporate Sustainability Assessment" along with media and stakeholder analysis is used to review and list companies. The SAM review is broken down into industry specific and general criterion and the assessment is made through a questionnaire.<br><br>Sector Analysis: Yes<br><br>Performance: 7.02 percent returns since inception on December 31st, 1993 |
| Carbon Disclosure Project Leadership Indexes[82]<br><br>The Carbon Disclosure Project (CDP) has facilitated the disclosure of greenhouse gas emissions, water management practices and climate change strategies for over 3,000 organisations across 60 countries.<br><br>CDP has released 2 indices. The older one is called the Carbon Disclosure Leadership Index, which benchmarks the companies within their disclosure resource frameworks, and the Carbon Performance Leadership Index which is a subset of the top scoring companies of the previous index.<br><br>The disclosure scores for the Global 500, Europe, FTSE 350, and S&P 500 companies are used by index provider Markit to create a family of equity indices. | Type of Index: Benchmark, Qualitative<br><br>Stocks included: Voluntary CDP reported/assessed companies only<br><br>Weights Used: None, Percentage units allocated to each company<br><br>Components: Variable<br><br>Methodology: Disclosure and Performance scores are calculated on the basis of voluntary disclosure through questionnaires. Two scales are used – a 2 point scale and a 3 point scale, in order to quantify overall disclosure and disclosure of good performance.<br><br>Sector Analysis: No<br><br>Performance: Not applicable as index components are not weighted by financials. |

80 See: "Rate the Raters, Taking Inventory of the Ratings Universe", SustanAbility Ltd., 2010

81 Information sourced from <http://www.sustainability-index.com/07_htmle/indexes/djsi.html>, The benchmark

82 Information sourced from <https://www.cdproject.net/en-US/Results/Pages/leadership-index.aspx>, The benchmark index for the rest of the 19 indices, the Dow Jones Sustainability World Index has been analysed here as it represents the superset of the other indices.

| | |
|---|---|
| FTSE4GOOD Index Series[83]<br><br>FTSE Group (FTSE) is an independent company jointly owned by The Financial Times and the London Stock Exchange.<br><br>Operational since 2001, the FTSE4Good Index Series has been designed to measure the performance of companies that meet globally recognised corporate responsibility standards. The FTSE4Good Index Series was designed with the support of UNICEF, the United Nations Children's Fund, and uses data provided by EIRIS, the Ethical Investment Research Service. The FTSE4Good criteria is applied to the FTSE Developed Index Series, which covers 23 markets and over 2,000 potential constituents | Type of Index: 4 Tradable (real time) and 5 Benchmark Indices, Qualitative<br>Stocks Included: All indices are subsets of pre-existing composite equity indices operated by the FTSE.<br><br>Weights Used: Market capitalisation variants<br><br>Components: Tradable indices constitute the largest 50 or 100 firms represented in the benchmark indices.<br><br>Methodology: Indexing criteria are developed using a "market consultation process" developed by EIRIS. The questionnaire approach is used.<br><br>Sector Analysis: No<br><br>Performance: The FTSE4Good Global Index has on an average, underperformed the FTSE All World Developed Index (the base index) since 2007. |
| MSCI ESG Indices[84]<br><br>MSCI is a leading provider of investment decision support tools to around 5,800 clients worldwide. These Indices are the continuation of indices developed over the past 20 years by KLD, which became part of MSCI following its acquisition of RiskMetrics in 2010.<br><br>Essentially, there are four categories of MSCI ESG indices:<br><br>MSCI ESG 'Best-in-Class' Indices, ESG 'Values based' Indices, MSCI ESG 'Universal Owner' Indices, MSCI ESG 'Environmental' Indices | Type of Index: Benchmark, Qualitative<br><br>Stocks Included: Constituents of the MSCI Global Investable Market Indices (GIMI)<br><br>Weights Used: Free float-adjusted market capitalisation weighted indices<br><br>Components: Variable, each regional ESG index targets 50 percent of the free float adjusted market capitalisation of each industry classification.<br><br>Methodology: ESG "Rating Framework" is applied using "ESG criterion" on more than 100 indicators, on a 9 point scale (from AAA to C).<br><br>Sector Analysis: Yes (MSCI ESG Research service for clients)<br><br>Performance: Variable |

## VII Brief Evaluation of the Only Existing Signalling Mechanism in India

**S&P ESG India Index:** The S&P ESG India provides investors with exposure to 50 of the best performing stocks in the Indian market as measured by environmental, social, and governance (ESG) parameters. Sponsored by the International Finance Corporation (IFC)and developed by a consortium of Standard & Poor's, CRISIL and KLD, the index is first of its kind in India. Its explicit objective is to measure "environmental, social and corporate governing practices based on quantitative rather than subjective factors with the implementation of a unique and innovative methodology"[85]. The index is an end-of-day index (the data points are not live), and is a benchmark index which is not tradable.

The following table highlights the performance of the ESG index across the various criterion and parameters as established in the previous sections:

83 Information sourced from <http://www.ftse.com/Indices/FTSE4Good_Index_Series/index.jsp>, the parameters/characteristics evaluated are representative of the entire universe of indices, but more specifically on the parent index – the FTSE4Good World Index

84 Information sourced from <http://www.ftse.com/Indices/FTSE4Good_Index_Series/index.jsp>, the parameters/characteristics evaluated are representative of the entire universe of indices, but more specifically on the parent index – the FTSE4Good World Index

85 <http://www.nseindia.com/products/content/equities/indices/thematic_indices.htm>

| Criterion | Parameters | Performance |
|---|---|---|
| Transparency | Methodology: Publically available information made available by the National Stock Exchange and S&P. Each stock is weighted by a "Score Weight Factor (SWF)".<br><br>Maintenance: Rebalancing through the SWF owing to changes in corporate actions and market developments are made at the discretion of the hosts.<br>Subscription: | The overall transparency performance of the index is average. There is a distinct attempt at making the workings of the index transparent – but the actual publically available information is fairly discrete- especially the screening process and basis/patterns of awarding the "score" constituent in the SWF[86]. |
| Comparing the Incomparable | The index is a subset (of 50 stocks) of the top 500 Indian companies (by market capitalisation) listed on the National Stock Exchange of India Ltd regardless of underlying sectors. | A sectoral approach to indexing – in order to signal ESG performance would facilitate comparisons rather than broad based cross-sectoral benchmarking without an explicit sector breakup/analysis. |
| Performance vs. Disclosure | The index measures disclosure performance rather than actual performance. This is clear from the eligibility criterion which states that "in cases where a company discloses a public, well known indicator, it is awarded a score of one and if it did not it is awarded a score of zero". | The question that arises when the focus is on disclosure without the actual quantitative appraisal of sustainability performance, is whether the index is incentivising companies to perform better or disclose better. The objective is not sufficiently clear. |
| Financial Performance | Although the disclosure practices are only evaluated (generally) once a year, and reviewed every quarter for aberrations/changes, the index is dynamic since it tracks price performance. The overall index performance can be found in the Appendix C7. | The index links to the actual performance of companies, and the measures taken to balance events like share splits, rights-offerings etc are well defined. |
| Qualitative vs. Quantitative | The index is described as one that is based "purely on quantitative factors"[87]. The actual indexing of companies is done on the basis of a scoring methodology which converts qualitative data into quantitative data. | The index is not purely quantitative. The fact that the calculation methodology is making use of a scoring system to quantify qualitative criterion with the environment, social and governance themes is indicative of subjectivity. |

## VIII Envisioning Green Instruments for Developing Markets

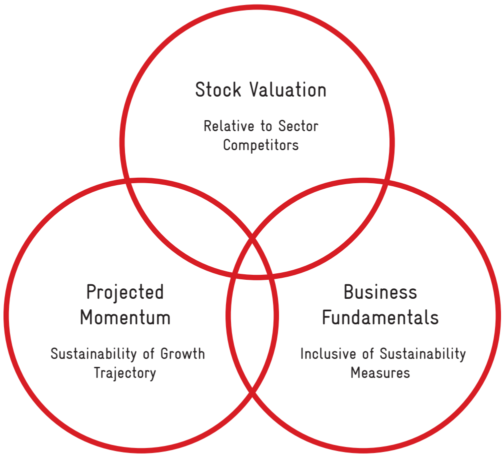
In order to generate sustainability awareness and investments in the developing market context, any market based mechanism needs to inspire a significant amount of confidence. Given that most investment research and analysis within the sustainability domain are based on retrospective study, it is not possible to incentivise forward looking asset allocations. There is a gap between investment instruments and market awareness of how the instruments are calibrated, what they track and how they perform under global economic pressures and volatility brought on by the recent financial crisis.

While non-verified, company disclosed information can be helpful for investors, the actual decision to invest is based upon more concrete quantifiable data; such as that available to financial analysts through the various filings and public information made available by businesses and the industry. To create an optimal financial portfolio based on sustainability data, it is imperative to adhere to the basic principles of investing – companies with strong fundamentals and competitively valued stocks outperform those with weak fundamentals, and stocks with positive business momentum outperform those with negative momentum. These basic tenants are inherently tied into sustainability fundamentals (Figure 8):

86 The "score" constituent is the added up quantitative and qualitative scores, which are arrived at on the basis of a two stage screening process.

87 Complete description available: <www.nseindia.com/products/content/equities/indices/thematic_indices.htm>

Figure 8: The Convergence of Investment Imperatives




For a portfolio to be called suitably diversified, optimised and sustainable, it must lie at the intersection of the three categories identified in the Figure 8. The stock valuation and quantifiable fundamentals need to be accurately reflected in a market based signalling mechanism such as an index or a rating, and the projected momentum be accounted for by way of complete financial and sustainability analysis at the macro and micro level. There are various ways of breaking down optimal portfolio construction given these imperatives. An example of how it is done by Sustainability Asset Management (independent asset management company specialised in sustainability-driven investment vehicles) can be found in Appendix C8. A breakdown of a viable portfolio optimisation strategy in a 3 step process is suggested below:

| Step | Vehicle | Role | Characteristics |
|---|---|---|---|
| 1 | Benchmark Index | Signaling mechanism in the capital markets, helping investors visualise financial and environmental performance across specific quantifiable sustainability themes such as energy efficiency, water management etc, and therefore incentivising ethical and profitable investing. | Publically available index across sectors, with sectoral breakdown of performance, with a fair representation from the relevant sectors within an economy from the standpoint of sustainability. Above all the index should be transparent and quantitative in order to be credible for stimulating investments. |
| 2 | Structured Financial Products | To create a suitably diversified portfolio, the financial product must accurately track the leading performing companies in the benchmark index across both financial and sustainability parameters. Examples of such products could be:<br><br>Index Exchange Traded Fund - funds that follow a specific benchmark index as closely as possible, with the possibility of intraday buying and selling.<br><br>Index Fund: A type of mutual fund with a portfolio constructed to match or track the components of a market index. | Good financial performance, with close tracking of the underlying benchmark.<br>The product must be diversified across sectors, with a variation of large and mid cap companies in the basket of assets.<br>The variation and diversity across sectors in important to hedge against unsystemic risk, meanwhile investment in companies with strong fundamentals and competitive valuations is important for de-risking against systemic macroeconomics risks. |
| 3 | Tradable Composite Index | The last step in a completely optimised sustainability portfolio – a tradable futures and options composite index across sectors and specific to sectors, to make the market financial transmission mechanisms and hedging strategies complete. | Intraday tradable indices, which along with currency indices can be used to hedge portfolio risk further, and generate global market momentum and incentivise better sustainability performance by being directly financially relevant to both listed and unlisted companies. |

## IX Restructuring Asset Allocations through Viable Green Financial Instruments – The Case for Pension Funds

Pension funds around the world are looking to allocate more to alternative asset classes due to the importance of sound asset/liability management in an increasingly volatile economic environment, With the long term investing horizon, and increasing sensitivity to socially responsible and ethical investing principles and policies, pension funds stand much to gain from an efficient and credible market framework for sustainability. Pension funds are required to estimate the probability of their future payments (to pensioners) according to legally binding payout structures based on pre-decided interest rates and maturity. This means that the fund managers employed by them are required to design their portfolios usually based on benchmarks from which analysis on specific securities can be extrapolated in a deterministic manner.

Ideally, the benchmarks used by the fund managers should represent viable investment portfolios – and therefore should represent optimised portfolios with no special characteristics. This is where the problem lies for the existing benchmarks discussed in earlier sections. Due to the fact that they are mostly representative of underlying firm level performance in specific qualitative characteristics (eg. Social screen) they cannot be taken as representation of optimised portfolio universes. Thus, fund managers resort to using traditional benchmarks such as existing equity indices.

Further, investment strategies used by pension funds need to minimise the risk that any given portfolio does not generate the surplus required by the binding commitments that are made by them. This means that the minimisation of the "tracking error" - the deviation in performance of the fund relative to the underlying benchmark(s) - is an absolute priority. If it were indeed possible for funds to track only the leaders within a benchmark, an automatic minimisation of tracking error (or at least on the downside) would be possible. For such active management strategies to work either of the following would be a pre-requirement:

- The existence of a purely quantitative benchmark which outperforms traditional equity indices and has a breakdown of each component, along with an explicit screening strategy based on performance criterion only.
- Structured products that track leaders within specific benchmarks, with a minimum tracking error and maximum possible optimisation through the inherent diversification of underlying assets.

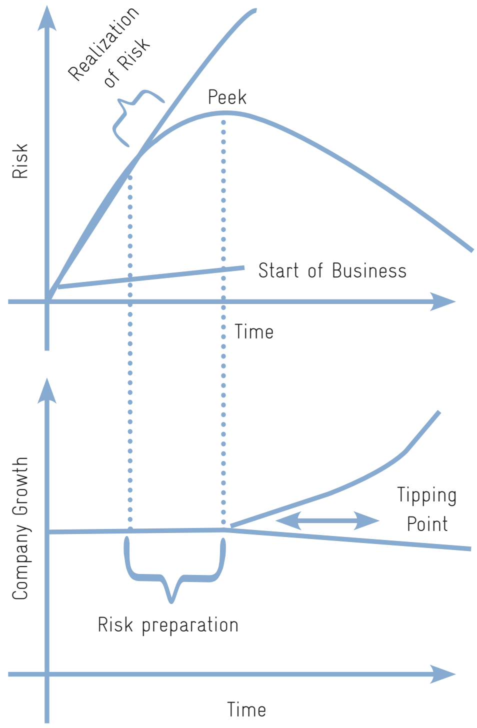
The difference between the two options as outlined above is fairly simple. The first strategy would require huge initial investment in manpower, know-how, databases and information gathering, and would be suitable for large pension funds that are able to invest heavily in managing their funds in-house. The second option would be useful for pension funds that are smaller, and would rather outsource fund management to other entities. Structured products based on alternative investment strategies that minimise risks posed by unsustainable business environments and at the same time deliver an acceptable minimum return on average would fit the bill – especially for pension funds that have a favourable ratio of assets to liabilities, allowing them more room to manoeuvre.

## X Conclusion

Through the course of this report, the focus on sustainability has been constant. The ultimate objective of sustainable economic growth at the firm level has been defined as long term viability and profitability. The question then is; what is the optimal market based mechanism for ensuring that firms and investors have the opportunity to recognise and act upon the various systemic and unsystemic risks?

The adjoining figure helps to illustrate the crux of the matter. In the natural evolution process of a company, cumulative risk factors add up and affect overall growth trajectory. The difference between a company that is successful in the long run and one that is not is represented by the tip-

With the long term investing horizon, and increasing sensitivity to socially responsible and ethical investing principles and policies, pension funds stand much to gain from an efficient and credible market framework for sustainability.




Companies which prepare for risk, are not risk averse, but are risk prepared.

ping point in the figure. The firm which is able to recognise and act upon cumulative risk factors in the time for risk preparation will come out on top at the tipping point when the risk affects the growth profile of the company. Ideal market based mechanisms should ensure that the recognition and actions taken on risk are both facilitated and incentivised as efficiently as possible.

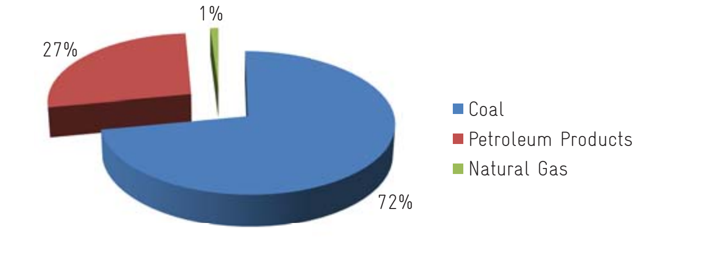
Here it must be highlighted that companies which prepare for risk are not risk averse, but are risk prepared. The difference is subtle but important. Market based mechanisms which incentivise good performance by channelling investments to firms that acknowledge and act upon risk better than their competitors in a given environment, help investors realise this distinction clearly. Therefore, in order for "green" market mechanisms and investment instruments to be viable and effective they must be able to efficiently ensure that the transmission mechanism works and only performance based, credible signals are relayed to the open markets. In the developing country context, this is even more important, due to the nascent capital markets, and urgent need for scaling up sustainability initiatives – both at the firm and policy levels.

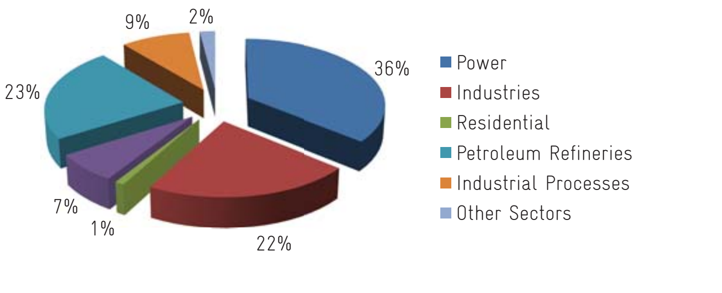
# Appendices

## I Appendix A1 – Fuel share of $CO_2$ emissions in 2005; Sector Distribution of $CO_2$ in 2005

India has one of the largest coal reserves in the world and on average has been consuming over 600 million ton of coal products every year. Non-coking coal is mainly used by the power and cement sectors. Coking coal is mainly used by the iron and steel industry and has a higher Net Calorific Value and therefore a higher emission coefficient - 2.24 ton $CO_2$ per ton of coal consumed. All other types of coal have an average $CO_2$ emission coefficient of 2.03 ton $CO_2$ per ton of coal consumed. $CO_2$ emission from burning biomass in the energy and agriculture sectors has not been considered in this paper since most of the biomass is produced sustainably, in which case the actual net emissions are zero (IPCC, 2006).

Figure A1: (a) Fuel Share of $CO_2$ Emissions in 2005 (b) Sector Distribution of $CO_2$ Emissions in 2005



## II Appendix A2 – Sectoral $CH_4$ Emissions in India During 2005; Methane Emissions Until 2012 in India

Figure A2 (a): Sectoral $CH_4$ Emissions in India During 2005

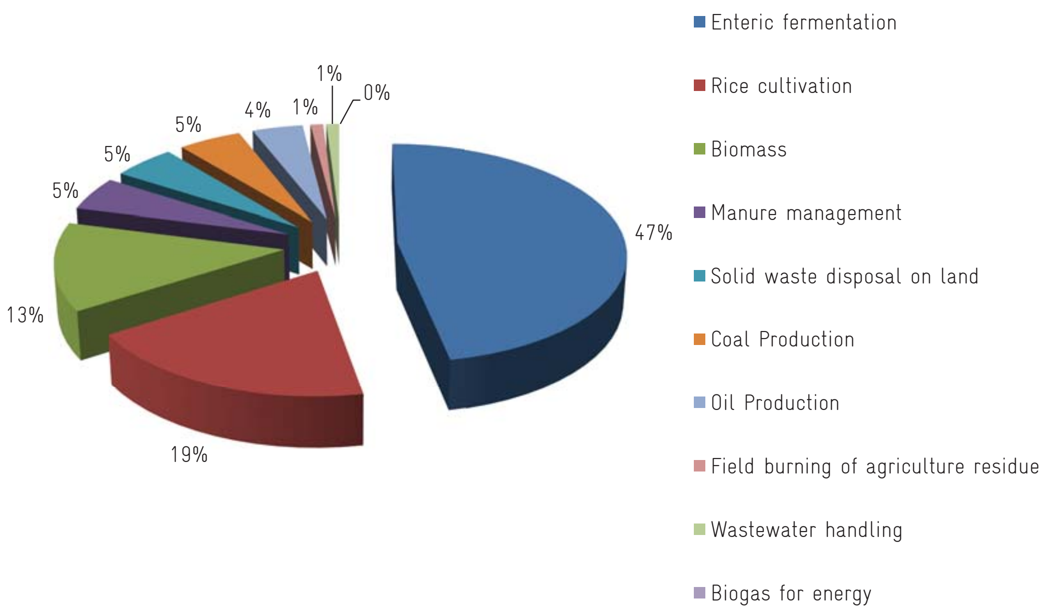
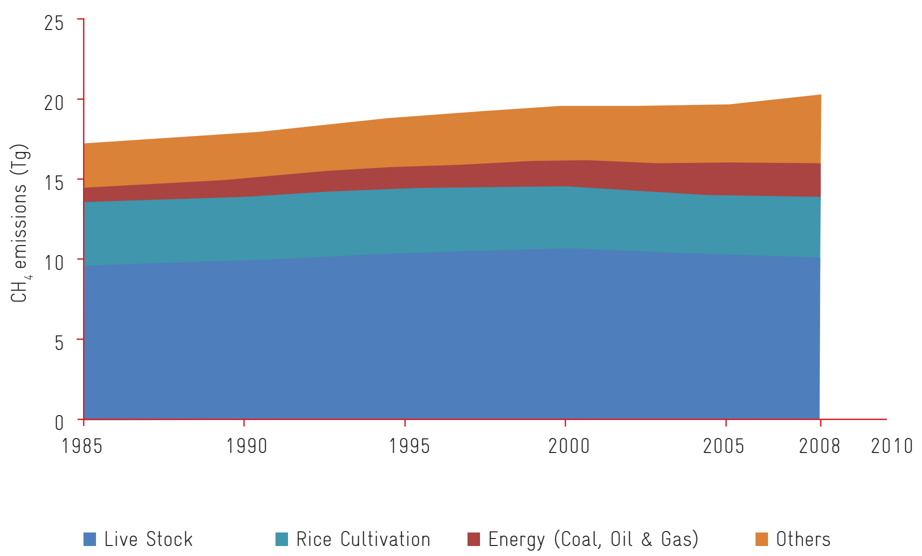



Figure A2 (b): Methane Emissions Over the Years in India



## III Appendix A3 – Sectoral $N_2O$ Emissions in India During 2005; USA, China and India, the 3 Largest Global Contributors of $N_2O$ Emissions

Figure A3 (a): Sectoral $N_2O$ Emissions in India During 2005

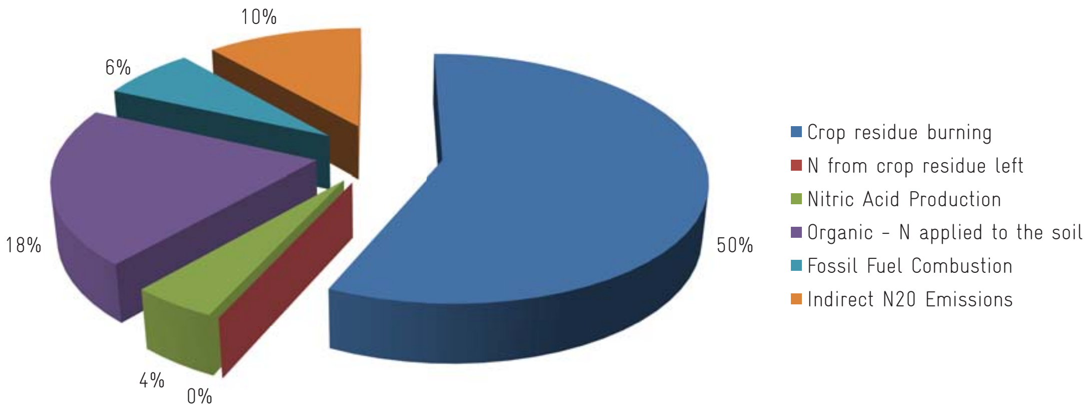
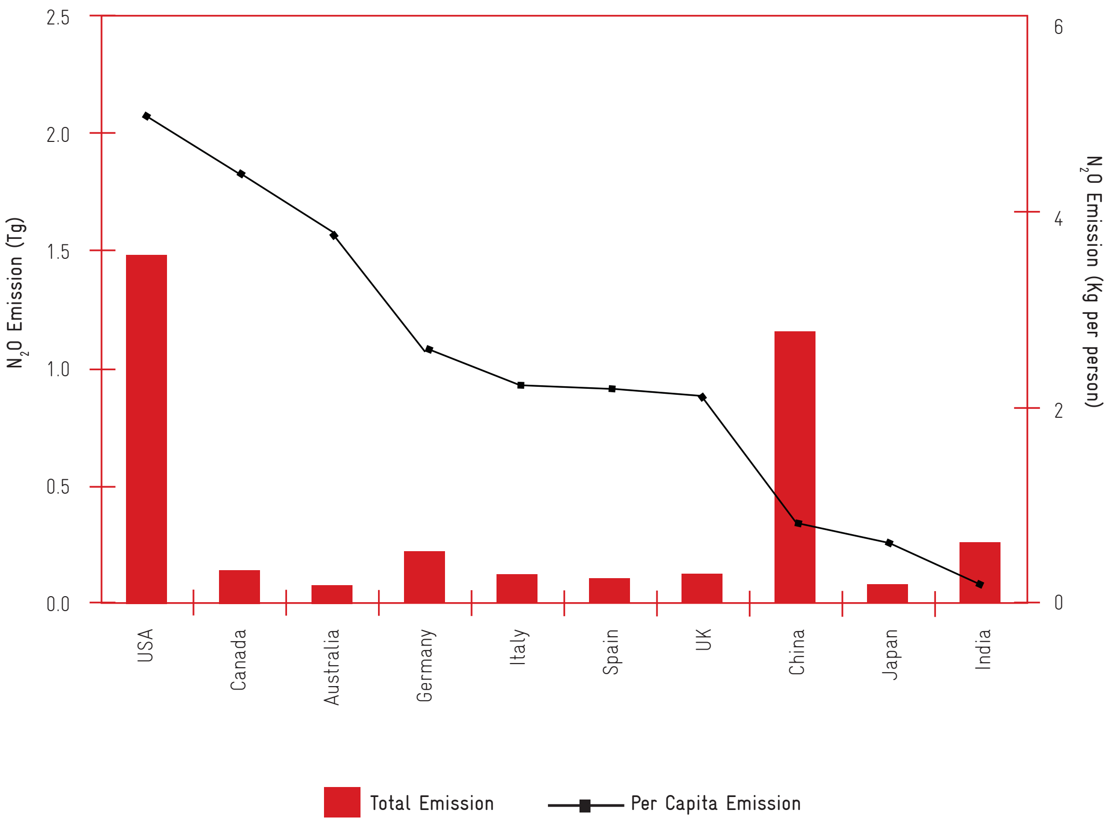


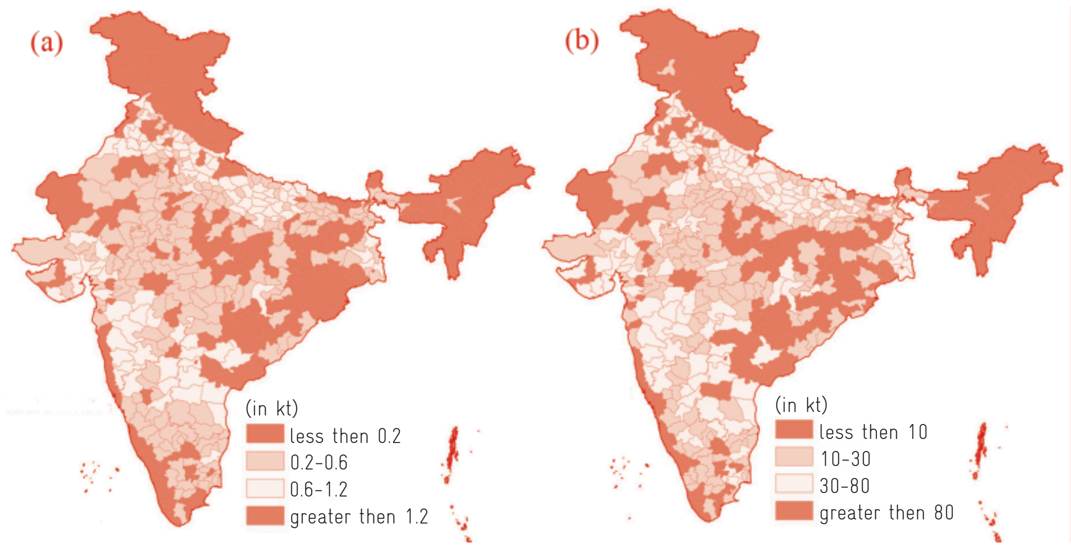

Figure A3 (b): USA, China and India are the 3 Largest Contributors of $N_2O$ Emissions Globally




*Source: UNFCCC (2008), Ecofys (2007), HDR (2007) and author estimates*

## IV Appendix A4 – District Level Absolute $N_2O$ Emissions During 1990, 1995 and 2005 (b) District Level Nitrogenous Fertilizer Applied During 1990, 1995 & 2005

Figure A4: (a) District Level Absolute $N_2O$ Emissions During 1990, 1995 and 2005 (b) District Level Nitrogenous Fertilizer Applied During 1990, 1995 & 2005




The standard deviation of district level $N_2O$ emissions during 2005 has increased 38 percent in respect to the 1990 levels. This indicates an upward shift in annual $N_2O$ emissions from increasingly more districts with time which can be understood by Figure A4 (b). The main reason for such a growth pattern can be noticed from showing almost a similar change in N-fertilizer use across districts.

Table A1: Distribution of Largest $N_2O$ Emissions from Indian Districts

| Rank of largest Emitter Districts | % of Total Emissions | |
|---|---|---|
| | 1995 | 2005 |
| 1 to5 | 5.0 | 6.4 |
| 1 to15 | 13.8 | 12.7 |
| 1 to25 | 21.3 | 17.8 |
| 1 to47 | 34.2 | 27.7 |
| 1 to233 | 86.1 | 77.0 |
| 1 to350 | | 91.3 |
| **Total(1-594)** | **100** | **100** |

## V Appendix B1 – Some Measures Taken by ACL to Reduce Energy Consumption over the Years

**Table B1: Some Measures Taken by ACL to Reduce Energy Consumption over the Years**

| | Options | Electricity Saving | Investment | |
|---|---|---|---|---|
| | | kWh /annum | INR Million (constant price) /annum | INR Million (constant price) |
| 1 | Operation optimisation resulted in improvement in crusher throughput | 158900 | 0.76 | 0.03 |
| 2 | Reduction in mill feed size resulted in improvement in mill throughput | 715050 | 3.63 | 0.17 |
| 3 | Effect of venturi removal from coal mill fan after april '03 onward | 2304050 | 0.99 | 0.09 |
| 4 | DP reduction after refurbishing of PH WHR & installation of sonic horns from April '03 onward | 2335830 | 7.85 | 32.32 |
| 5 | Water optimisation measures resulting in reduction of water consumption | 1287090 | 4.33 | 0.70 |
| 6 | Better monitoring practices on sustainable basis | 556150 | 1.87 | 0.04 |
| 7 | Usage of day light concept in Site Office & MCC rooms | 31780 | 0.11 | 0.00 |
| 8 | Reduction in idle running hours of auxiliaries by incorporated belt conveyor tripping with minimum load (KW) | 63560 | 0.13 | 0.00 |
| 9 | Usage of dry fly ash at mill outlet in place of wet fly ash at mill inlet during PPC grinding after commissioning of dry fly ash system | 5180140 | 9.91 | 89.94 |
| 10 | Replacement of all antenna switches with proximity switch arrangement | 174790 | 0.70 | 0.35 |
| 11 | Improvement in power factor | 95340 | 0.38 | 0.00 |
| 12 | Installation of VVVF with new 150 KW motor & removal of inlet damper (2 nos.) at cooler WHR fresh air fan (R51 FN1) | 554400 | 2.15 | 2.09 |
| 13 | VVVF drive for FD fans (2 nos.) | 655600 | 2.15 | 3.41 |
| 14 | Installation of VVVF for operation of condensate extraction pump | 86400 | 0.29 | 0.52 |
| 15 | 250 CFM refrigerant type air dryer in place of heat less air dryer | 13096.2 | 0.07 | 0.39 |
| 16 | KSB make 100 tph indigenous boiler feed pump – (1 no) in place of existing imported 47 tph x 2 feed pumps | 237600 | 0.98 | 1.97 |
| 17 | Fan-less cooling tower | 138240 | 0.56 | 1.31 |
| 18 | Replacement of fluorescent tubes by energy saving lights | 43000 | 0.14 | 0.18 |

**b. Qualitative Measures:**

In 2009, ACL expanded the initiative for co-processing various industrial wastes in cement kilns. These wastes include TDI tar, shredded tyres, glycerine foot, groundnut husk, agro waste, and FO sludge.

A modern alternative fuel and raw material laboratory was set up in 2010 at Ambujanagar. The laboratory was established with a goal to determine the physical and chemical characteristics of wastes to be used in co-processing.

Extending energy conservation initiatives further, in 2010, paint sludge, a hazardous waste from the automobile industry, is being co-processed at Rabriyawas in Rajasthan.

Waste usage would bring down the cost of energy to the company. However, the carbon footprint may go up as some of these are more intensive in carbon contents than coal or diesel oil currently being used (directly or indirectly) to provide electricity and energy to cement kilns.

## VI Appendix B2 – General and Financial Performance, Technological Change and Energy Intensity of Indian Cement Industry

**Table B2: General and Financial Performance, Technological Change and Energy Intensity of Indian Cement Industry**

| | % Share of Cement MakingTtechnology[a,b,c] | | |
|---|---|---|---|
| | Wet Process | Semi Dry Process | Dry Process |
| 1992-93 | 21 | 3 | 76 |
| 1993-94 | 18 | 3 | 80 |
| 1994-95 | 15 | 3 | 84 |
| 1995-96 | 12 | 2 | 86 |
| 1996-97 | 10 | 2 | 86 |
| 1997-98 | 9 | 2 | 87 |
| 1998-99 | 9 | 2 | 89 |
| 1999-00 | 8 | 2 | 91 |
| 2000-01 | 7 | 2 | 92 |
| 2001-02 | 5 | 2 | 93 |
| 2002-03 | 5 | 2 | 93 |
| 2003-04 | 4 | 2 | 94 |
| 2004-05 | 3 | 1 | 95 |
| 2005-06 | 3 | 1 | 96 |
| 2006-07 | 1 | 2 | 96 |
| 2007-08 | 1 | 2 | 96 |
| 2008-09 | 0 | 2 | 98 |

*Source: [a] Cement Statistics 2006, CMA; [b] Cement Statistics 2009, CMA; [c] Indian Cement Industry, IRDA < http://www.ccap.org/docs/fck/file/New%20Delhi%203-19-09%20-%20Indian%20Cement%20Industry.pdf>; the shares of wet, semi wet/dry and dry processes at all India level have been extrapolated for the years 1993-95, 1996-2001, 2002-05 based on data for the other years;*

## VII Appendix B3 – Carbon Emissions and Revenue Generation (at current prices) of Major Indian Cement Companies During 2009-10

Table B3: Carbon Emissions and Revenue Generation (at current prices) of Major Indian Cement Companies During 2009-10

| | Cement companies | Installed capacity[a] (Mt) | Clinker production[a] (Mt) | Cement production[a] (Mt) | $CO_2$e emissions[b] (Mt) | | | Revenue[a] (INR billion) |
|---|---|---|---|---|---|---|---|---|
| | | | | | Clinker making | Cement making | Total | |
| 1 | A C C Ltd. (Dec closing) | 26.16 | 14.64* | 21.37 | 11.82 | 3.63 | 15.45 | 91.71 |
| 2 | Ambuja Cements Ltd. (Dec closing) | 22.00 | 11.40 | 18.83 | 10.99 | 2.75 | 13.74 | 70.76 |
| 3 | Binani Cement Ltd. | 6.25 | 4.40 | 5.28 | 3.57 | 0.30 | 3.87 | 22.92 |
| 4 | Birla Corporation Ltd. | 5.78 | 3.88 | 5.7 | 3.97 | 0.89 | 4.86 | 22.95 |
| 5 | Century Textiles | 7.8 | 5.63 | 7.58 | 5.72 | 0.96 | 6.68 | 26.94 |
| 6 | Dalmia Cement (Bharat) Ltd. | 8.58 | 3.37 | 4.10 | 2.89 | 0.35 | 3.24 | 14.75 |
| 7 | Grasim Industries Ltd. | 25.65 | 14.36 | 19.38 | 9.28 | 2.45 | 11.73 | 68.14 |
| 8 | Heidelberg Cement (Dec closing) | 3.07 | 1.35 | 2.66 | 1.26 | 0.21 | 1.47 | 9.85 |
| 9 | India Cement | 14.05 | 8.68 | 10.49 | 7.13 | 0.81 | 7.94 | 40.09 |
| 10 | J K Cement Ltd. | 7.87 | 3.48* | 4.59 | 3.02 | 0.77 | 3.79 | 18.46 |
| 11 | J K Lakshmi Cement Ltd. | 4.75 | 3.52 | 4.57 | 2.74 | 0.53 | 3.27 | 15.02 |
| 12 | Jaiprakash Associates Ltd. | 19.10 | 8.62 | 10.52 | 6.72 | 2.31 | 9.03 | 39.21 |
| 13 | Madras Cements Ltd. | 10.49 | 6.12 | 8.02 | 4.66 | 0.74 | 5.40 | 26.66 |
| 14 | Orient Paper & Inds. Ltd. | 5.00 | 2.35 | 3.05 | 2.31 | 0.54 | 2.85 | 9.98 |
| 15 | Prism Cement | 2.0 | 2.31 | 2.56 | 1.92 | 0.17 | 2.09 | 10.2 |
| 16 | Shree Cement Ltd. | 12.0 | 8.05 | 9.37 | 6.62 | 1.82 | 8.44 | 40.14 |
| 17 | Ultratech Cement Ltd. | 23.10 | 15.55 | 17.64 | 14.57 | 2.54 | 17.12 | 66.66 |

*Source:* [a]*Annual report 2009-10 of respective company; Cement Statistics 2011, CMA and CMIE 2011*
[b]*Own estimates*

*Note:* *( ) indicates rank of respective company in respective column*
**Clinker production for ACC Ltd and JK Cement Ltd has been extrapolated for the year 2009-10*

## VIII Appendix B4 – Emission Factor for Purchased Electricity

Table B4: Emission Factor for Purchased Electricity

| Source category | Emission factor $CO_2$e (kt/GWh) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| Purchased electricity | 0.82 | 0.83 | 0.85 | 0.85 | 0.84 | 0.82 | 0.80 | 0.80 | 0.82 | 0.81 | 0.81 |

*Source: Central Electricity Authority, Ministry of Power, Government of India*

## IX Appendix B5 – General Performance Details of ACL

Table B5: General Performance Details of ACL

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Installed capacity (Mt) | 7 | 9 | 9 | 12.86 | 13.3 | 16.3 | 16.3 | 18.5 | 22 | 22 | 25 |
| Clinker production (Mt) | 5.38 | 6.02 | 8.48 | 8.86 | 10.76 | 11.80 | 11.7 | 11.6 | 11.5 | 11.4 | 14.1 |
| Cement production (Mt) | 6.1 | 7.2 | 9.8 | 10.4 | 12.8 | 14.6 | 16.3 | 16.9 | 17.8 | 18.9 | 20.1 |
| Capacity utilisation (%) | 87 | 80 | 109 | 81 | 96 | 90 | 100 | 91 | 81 | 86 | 80 |
| Clinker to cement ratio (%) | 89 | 86 | 88 | 87 | 85 | 81 | 73 | 72 | 69 | 70 | 70 |

*Source: Annual reports of ACL*

## X Appendix B6 – Fuel and Raw Material Consumption Details of ACL

Table B6: Fuel and Raw Material Consumption Details of ACL

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fly ash (Mt)* | 0.04 | 0.15 | 0.35 | 0.73 | 1.31 | 1.37 | 2.73 | 4.07 | 4.48 | 4.71 | 4.96 |
| Limestone (Mt) | 5.12 | 6.16 | 8.15 | 8.34 | 10.09 | 5.25 | 10.50 | 10.84 | 10.75 | 11.22 | 13.42 |
| Coal for clinker making (Tcal) | 3947 | 4541 | 6267 | 6464 | 7697 | 7697 | 8236 | 8631 | 8575 | 8609 | 10534 |
| Diesel for clinker making (Tcal) | 17 | 16 | 11 | 13 | 7 | 7 | 11 | 13 | 14 | 14 | 29.77 |
| Electricity purchased (GWh) | 191 | 206 | 240 | 246 | 257 | 257 | 259 | 309 | 358 | 318 | 402 |
| Coal for electricity generation (Tcal) | NA | 472 | 6740 | 1054 | 1210 | 1872 | 4441 | 4046 | 4662 | 5415 | 6734 |
| Diesel for electricity generation (Tcal) | 674 | 758 | 788 | 784 | 898 | 898 | 982 | 813 | 443 | 489 | 402.49 |

*Source: Annual reports of ACL*
*Note: * Fly ash consumption has been extrapolated for the years 2002 and 2003 based on data for the other years*

## XI Appendix B7 – Graph for Index Performance of NSE CNX Finance & Infrastructure Index

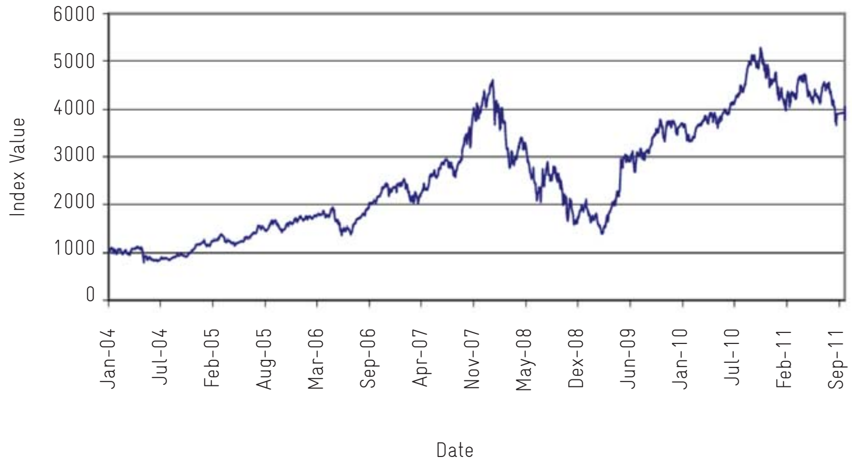
Growth in Cement vs. Financial Sector:

We compared the growth of the cement industry with the financial services industry (FSI) for the last five years between 2007 and 2011. FSI is one of the fastest growing industries in India. Cement revenues in India grew at a CAGR of 19.4 percent for the period. On the other hand, revenues in FSI for the five year period grew at CAGR of 24.3 percent[88].

As stock market is a leading indicator of core business activities and sentiment, this analysis can further be substantiated with the growth in market capital for companies in FSI as compared to cement. We compared the returns of the CNX Finance Index of National Stock Exchange (NSE) with the CNX Infrastructure Index of NSE. Since cement doesn't have a dedicated index on the NSE, infrastructure was the best proxy available for cement.

88 CMIE Data

Figures B7 (a) & (b): Graph for Index Performance of NSE CNX Finance & Infrastructure Index





In the figures above, it can be observed that the CNX Finance Index from Jan 2007 to 2011 had approximately doubled in value. On the other hand, the CNX Infrastructure Index was actually trading below its opening value for the same period, thereby eroding investors' wealth.

*As on Sept. 30, 2011

| CNX Finance Index | | CNX Infrastructure Index | |
|---|---|---|---|
| Period | Returns (%) | Period | Returns (%) |
| 1 year | -23.38 | 1 year | -30.39 |
| 3 year | 57.41 | 3 year | -18.67 |
| 5 year | 88.39 | 5 year | -2.60 |

# XII Appendix C1 – Examples of Green Instruments Available Globally

| Examples of Green Instruments Available Globally | |
|---|---|
| Fiscal incentives | Carbon Tax<br>Energy Emission Taxes<br>Environmental Levies on polyethylene bags, old refrigerators etc.<br>Clean Energy Production Tax Breaks<br>Water Consumption Charge |
| Early Market Development Mechanisms | Microfinance for sustainable practices<br>Crop certification<br>Seed grants<br>Net metering<br>Development grants |
| Debt and Equity based Instruments | Technology transfer funds<br>Catastrophe bonds<br>Weather indices<br>Agricultural insurance<br>Public Equity Funds (PEFs)<br>Export trade credit<br>Policy risk insurance |
| Trading Instruments | Tradable biodiversity credits<br>Voluntary biodiversity offsets<br>Habitat banking<br>Tradable wetland mitigation credits<br>Fishing quotas<br>Water trading (nutrient and salinity trading)<br>Project based carbon credits<br>Carbon cap and trade markets |

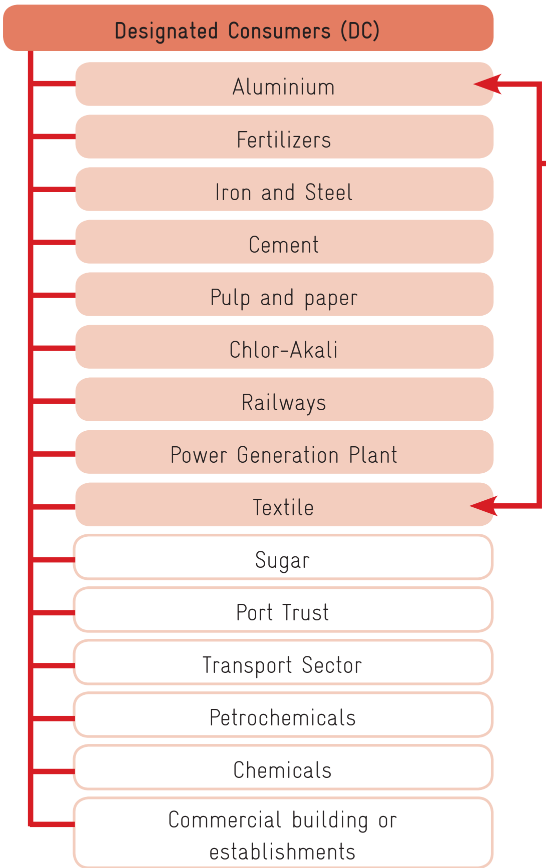
*Source: UNDP, 2011<http://www.beta.undp.org/undp/en/home/librarypage/environment-energy/low_emission_climateresilientdevelopment/in_focus/catalyzing-climate-finance.html>*

# XIII Appendix C2 – Green Instruments Available in the Indian Market

| Green Instruments Available in the Indian Market | |
|---|---|
| Perform, Achieve and Trade (PAT) | Nationally, the Ministry of Power has notified 563 designated consumers (industries) across eight industrial sectors such as thermal power plants, fertilizer, cement, pulp and paper, textiles, chlor-alkali, iron and steel and aluminum, where consumption is very high (Figure A1). Industries of these eight sectors account for about 231 million metric tonnes of oil equivalent of energy conservation annually according to 2007-08 data. The PAT mechanism will enable designated consumers who use less energy than the norm set for them to earn Energy Saving Certificates (ESCerts) for the excess savings. These ESCerts can be used by other designated consumers (who may find it expensive to meet their norms) for compliance. They will be denominated in tones of oil-equivalent (ToE) and exchanged on special trading platforms.<br><br>By adopting the market based mechanism, they would be saving about 10 MT oil equivalents in the next three years along with expected capacity addition of over 19,000 Mw. Also, the carbon-dioxide emission reduction is estimated to be 98.6 MT annually. A time frame of three years, beginning April 2011, has been set out by the BEE for driving energy-intensive manufacturing companies to adhere to energy conservation norms; however, even specific energy consumption targets have not been allocated or decided upon as of November 2011. |
| Renewable Energy Certificates (RECs) | According to the Indian Electricity Act (2003), the State Electricity Regulatory Commission (SERC) sets targets for utility companies to purchase some percentage of their total power from renewable energy sources called Renewable Purchase Obligations (RPOs). The renewable energy that is generated can be divided into two parts: the physical commodity electricity and a tradable certificate (REC). The commodity electricity is sold to the utility and the REC can be traded in the exchange (Figure A2). Utilities can make up for their shortfall in meeting RPOs by buying RECs from the exchange. |
| Carbon Tax | To prevent over use of high carbon intensive fuels, in 2010, the Government of India set up a carbon tax of INR 50 for each metric tonne of coal used in India which was expected to raise USD 535 million in 2010 itself. It should be kept in mind that the carbon tax coexists alongside a fossil fuel subsidy. In 2009, India was the $4^{th}$ largest subsidiser in the world at USD 21 billion. So in essence, unless there is a phase out of fossil fuel subsidies in India, the carbon tax would essentially go towards neutralising the subsidy. |
| Clean Development Mechanism (CDM) | India does not have any emission reduction target but it is able to sell Certified Emission Reduction (CER) units to large emitters covered by the European Union Emissions Trading Scheme, countries that have emission reduction targets under the Kyoto Protocol, or any other entity that wishes to purchase such CERs for compliance purposes. India ranks second in the world by number of CDM projects at 1914 and by number of issued CERs at approximately 120 million as of November, 2011. |
| Nationally Appropriate Mitigation Action (NAMAs) | These policies are part of the Copenhagen Accord (COP15) and commit to reduce greenhouse gas emissions. Different countries may take different nationally appropriate action on the basis of equity but in accordance to a common goal, along with financial transfers from developed to developing countries. India is of the view that mitigation actions are voluntary in nature and are guided by the national priorities of social and economic development. On $30^{th}$ January, 2010, the Ministry of Environment and Forests announced that it would endeavour to reduce the emissions intensity of GDP by 20-25% by 2020 in comparison to the 2005 level in reference to India's Nationally Appropriate Mitigation Action. |

*Source: Ministry of New and Renewable Energy, Renewable Energy and Energy Efficiency Partnership, 2010*
*The Guardian, UK- 10th July, 2011, Ministry of Environment and Forests, Ministry of External Affairs, <http://cdmpipeline.org/cers.htm>*

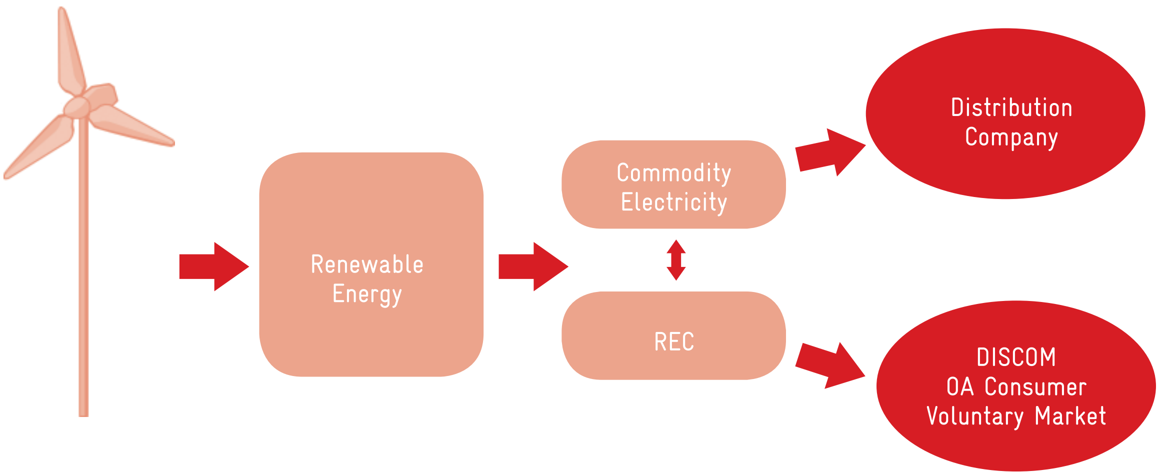
## Figure C2: (a) & (b): (a) Layout of PAT Scheme, (b) REC Mechanism Schematic Diagram




Reference: The EC Act, 2001 has identified 15 large Energy Intensive Industries

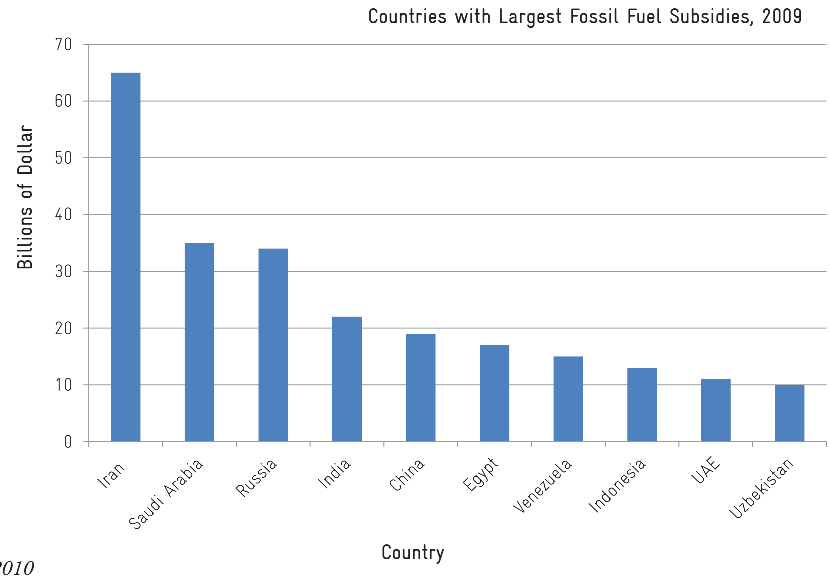
| Sector | Minimum annual energy consumption for the DC (MTOE) | No. of probable DCs |
|---|---|---|
| Aluminium | 7500 | 11 |
| Fertilizers | 30000 | 22 |
| Iron and Steel | 30000 | 110 |
| Cement | 30000 | 92 |
| Pulp and paper | 30000 | 70 |
| Chlor-Akali | 12000 | 23 |
| Railways | 30000 | 8 |
| Power Generation Plant | 30000 | 154 |
| Textile | 3000 | 197 |

Sector covered under the PAT mechanism



## XIV Appendix C3 – The Top 10 Countries with the Highest Fossil Fuel Subsidies

Figure C3: The Top 10 Countries with the Highest Subsidies




*Source: IEA 2010*

## XV Appendix C4 – The European Union Emissions Trading Scheme

The European Union Emissions Trading Scheme:

The EU-ETS is the largest carbon trading scheme established. It currently covers more than 10,000 installations in the energy and industrial sector. The scheme covers nearly half of the EU's $CO_2$ emissions and 40% of the EU's total GHG emissions.

It works on the "cap and trade" principle. This means there is a "cap", on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. Within this cap, companies receive emission allowances which they can sell to or buy from one another as needed. The limit on the total number of allowances means that they have a saleable value.

The rights granted under EU-ETS are called EU Allowances (EUAs). In order to track exchanges of EUA's and meet the requirements of the Kyoto Protocol, it is mandatory for each member state to have a national registry. These registries ensure the accurate accounting for all units under the Kyoto Protocol plus the accurate accounting for allowances under the EU-ETS.

At the end of each year all companies must surrender enough allowances to cover all its emissions, otherwise heavy fines are imposed. If a company reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another company that is short of allowances. If a company does not surrender a sufficient number of allowances, a fine of EUR 40/ tonne of $CO_2$ was charged during 2005-07. As of 2008, the penalty is EUR 100/ $tCO_2$. The flexibility that trading brings ensures that emissions are cut where it costs least to do so.[89]

The number of allowances is reduced over time so that total emissions fall. In 2020 emissions will be 21% lower than in 2005.[90] While the EU-ETS has been the primary driver of the carbon markets globally, the prices and volumes of EUAs traded have been falling steadily over the past years since the financial crisis. This is detailed in Figure c3:

89 "Carbon Markets: An International Business Guide" -2009

90 European Commission on Climate Action, 2010

Figure C4: The EUA Futures Chart from the ICE Exchange in Europe


*Source: www.Barchart.com*

# XVI Appendix C5 – Examples of Public and Private Funds for Sustainable Investing

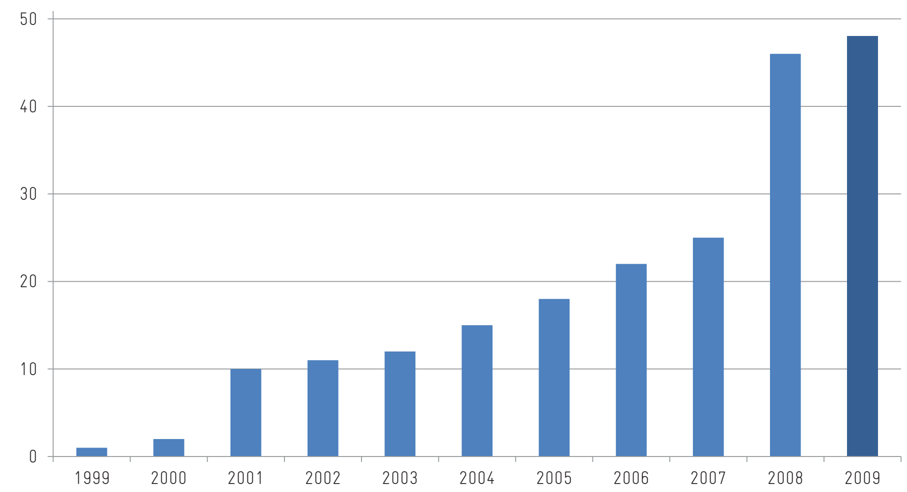
Table C5: Examples of Public and Private Funds for Sustainable Investing

| Type of Fund | Fund | Entity | Portfolio Size USD (mil) |
|---|---|---|---|
| Multilateral | Clean Technology Fund (CTF) | The World Bank | 4339 |
| | GEF Trust Fund – Climate Change focal area (GEF 4th replenishment round) | The Global Environment Facility (GEF) | 3130 |
| | GEF Trust Fund – Climate Change focal area (GEF 5th replenishment round) | The Global Environment Facility (GEF) | 3540 |
| | Pilot Program on Climate Resilience (PPCR) | The World Bank | 986 |
| | Strategic Climate Fund (SCF) -- umbrella fund, including SREP, PPCR, FIP | The World Bank | 1891 |
| | UN-REDD Programme | United Nations Development Programme | 151 |
| Bilateral | Carbon Fund for Europe (CFE) | European Investment Bank (EIB) | 65 |
| | Post 2012 Carbon Credit Fund (CCF) | European Investment Bank (EIB), German Development Bank (KfW) | 175 |
| | KfW Carbon Fund | German Development Bank (KfW) | 117.6 |
| | NEFCO Carbon Fund (NeCF) | Nordic Environment Finance Corporation (NEFCO) | 140 |
| | EIB-KfW Carbon Programme I and II | European Investment Bank (EIB), German Development Bank (KfW) | 263 |

| | | | |
|---|---|---|---|
| | Cool Earth Partnership (CEP) | Asian Development Bank (ADB) | 2000 |
| | Enhanced Sustainable Development of Asia (ESDA) | Asian Development Bank (ADB) | 250 |
| | International Climate Fund (ICF) | Government of the United Kingdom | 1000 |
| | International Climate Initiative (ICI) | Government of Germany | 500 |
| | Japan's Fast Start Finance | Government of Japan | 15000 |
| National Funds | Bangladesh Climate Change Resilience Fund | Government of Bangladesh | 110 |
| | Brazil National Fund on Climate Change | Government of Brazil | 143 |
| | China CDM Fund | Government of China | 129 |
| | Ecuador Yassuni ITT Trust Fund | Government of Ecuador | 3600 |
| Private Funds | Access Capital Community Investment Fund | Royal Bank of Canada | 1000 |
| | Appleseed Fund | United Financial Securities | 2000 |
| | Calvert Global Alternative Energy Fund | Calvert | 300 |
| | Calvert Global Water Fund | Calvert | 100 |
| | Gabelli SRI Green Fund | Gabelli | 160 |
| | Sentinel Sustainable Core Opportunities Fund | Sentinel Asset Management | 540 |
| | Winslow Green Growth Fund | Winslow Management Company | 380 |
| | Global Trend Clean Technology Fund | Vontobel Asset Management | 30 million USD |
| | Schroder Global Climate Change Fund | Schroders | 40 million USD |
| | Pictet Environmental Megatrend | Pictet Asset Management | 20 mil USD |
| | SAM Sustainable Climate Fund | SAM Sustainable Asset Management | 20 million USD |
| | Global Climate Opportunities Fund | F&C Asset Management | 40 million USD |

## XVII Appendix C6 – Existing Signalling Instruments

Figure C6: Existing Signalling Instruments




*Source: WFE <http://www.world-exchanges.org/sustainability/m-4-0.php>*

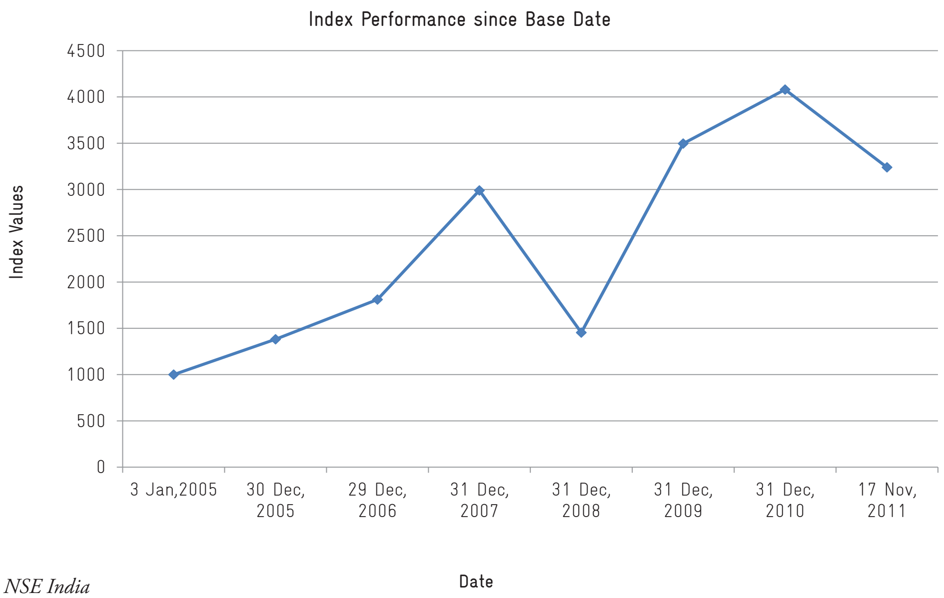
The table below lists the full range of sustainability related investment indices provided by World Federation of Exchanges (http://www.world-exchanges.org) members, either directly or through subsidiaries:

| Exchange | Index | Launch year |
|---|---|---|
| BME | FTSE4Good IBEX Index | 2008 |
| BM&FBOVESPA | Corporate Sustainability Index (ISE) | 2005 |
| Deutsche Börse | DAXglobal® Alternative Energy Index | 2006 |
| | DAXglobal® Sarasin Sustainability Germany Index | 2007 |
| | DAXglobal® Sarasin Sustainability Switzerland Index | 2007 |
| The Egyptian Exchange | ESG index in development with S&P | 2010(a) |
| Indonesia Stock Exchange | SRI-KEHATI Index | 2009 |
| International Securities | ISE Water Index | 2000 |
| Exchange | ISE-CCM Green Energy Index | 2001 |
| | ISE Global Wind Energy Index | 2005 |
| Johannesburg Stock Exchange | JSE Socially Responsible Investment (SRI) Index | 2004 |
| Korea Exchange | Korean SRI Index (in development) | 2009(b) |
| London Stock Exchange Group (via joint ownership of FTSE) | FTSE4Good Global Index | 2001 |
| | FTSE4Good US Index | 2001 |
| | FTSE4Good Europe Index | 2001 |
| | FTSE4Good UK Index | 2001 |
| | FTSE4Good Global Index 100 | 2001 |
| | FTSE4Good US 100 Index | 2001 |
| | FTSE4Good Europe 50 Index | 2001 |
| | FTSE4 Good UK 50 Index | 2001 |
| | FTSE4Good Japan Index | 2004 |
| | FTSE4Good Environmental Leaders Europe 40 Index | 2007 |
| | FTSE4Good Australia 30 Index | 2008 |
| | FTSE4Good IBEX Index | 2008 |
| | FTSE KLD Global Sustainability (GSI) Index Series | 2008 |
| | FTSE KLD Global Climate 100 Index | 2008 |
| | FTSE Environmental Technology Index Series | 2008 |
| | The FTSE Environmental Opportunities Index Series | 2008 |
| NASDAQ OMX | NASDAQ Clean Edge US Index | 2006 |
| | NASDAQ OMX Clean Edge Global Wind Energy Index | 2008 |
| | Wilder NASDAQ OMX Global Energy Efficient Transport Index | 2008 |
| | OMX GES Sustainability Nordic Index | 2008 |
| | OMX GES Ethical Nordic Index | 2008 |
| | OMX GES Ethical Denmark Index | 2008 |
| | OMX GES Ethical Finland Index | 2008 |
| | OMX GES Ethical Norway Index | 2008 |
| | OMX GES Ethical Sweden Index | 2008 |
| | OMX GES OMXS30 Ethical Index | 2008 |
| | OMX GES Sustainability Sweden Ethical Index | 2008 |
| | OMX GES Sustainability Sweden Index | 2008 |
| National Stock Exchange of India | S&P ESG India Index | 2008 |

| | | |
|---|---|---|
| NYSE Euronext | NYSE Arca Cleantech Index | 1999 |
| | NYSE Arca Environmental Services Index | 2003 |
| | NYSE Arca WilderHill Clean Energy Index | 2004 |
| | NYSE Arca WilderHill Progressive Energy Index | 2006 |
| | Euronext FAS IAS Index | 2006 |
| | Low Carbon 100 Europe Index | 2008 |
| Shanghai Stock Exchange | SSE Social Responsibility Index | 2009 |
| Tel-Aviv Stock Exchange | Maala SRI (Socially Responsible Investing) Index | 2005 |
| Wiener Börse | VÖNIX Sustainability Index | 2008 |
| | CEE Responsible Investment Universe Index (CEERIUS®) | 2009 |
| | | (a) Launch planned for Q1 2010<br>(b) Launch planned for Q3 2009 |

## XVIII Appendix C7– ESG Index Performance

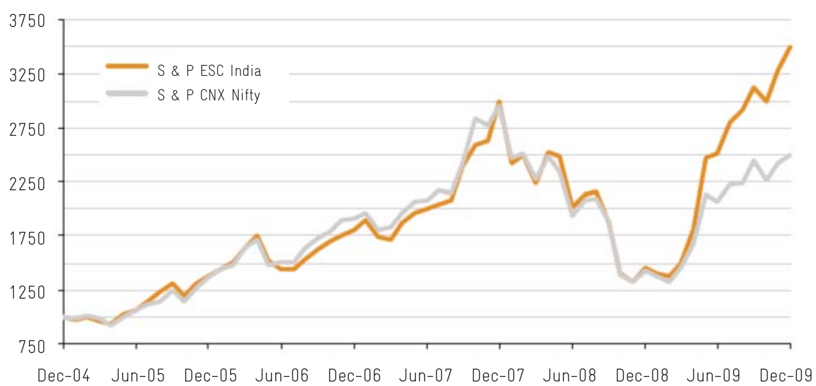
### Figure C7 (a): S&P ESG Index Performance




*Source: NSE India*

Performance: Approximately 224% returns on 17th November, 2011 since 03 January, 2005.

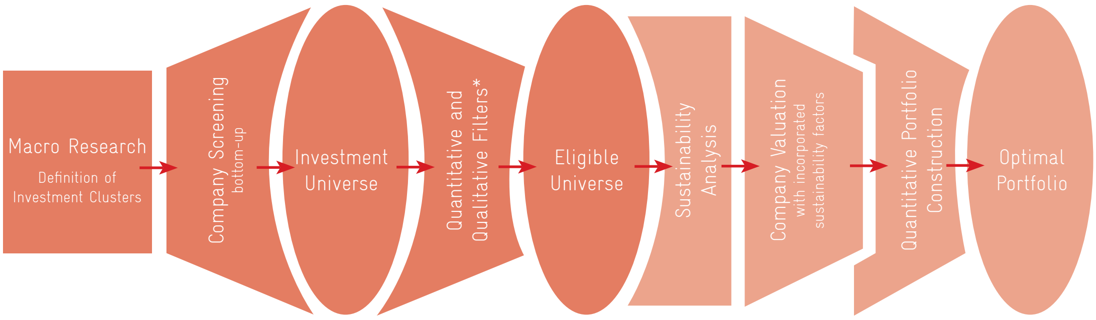
### Figure C7 (b): Index Performance vs. S&P CNX Nifty




*Source: S&P Index Services.*

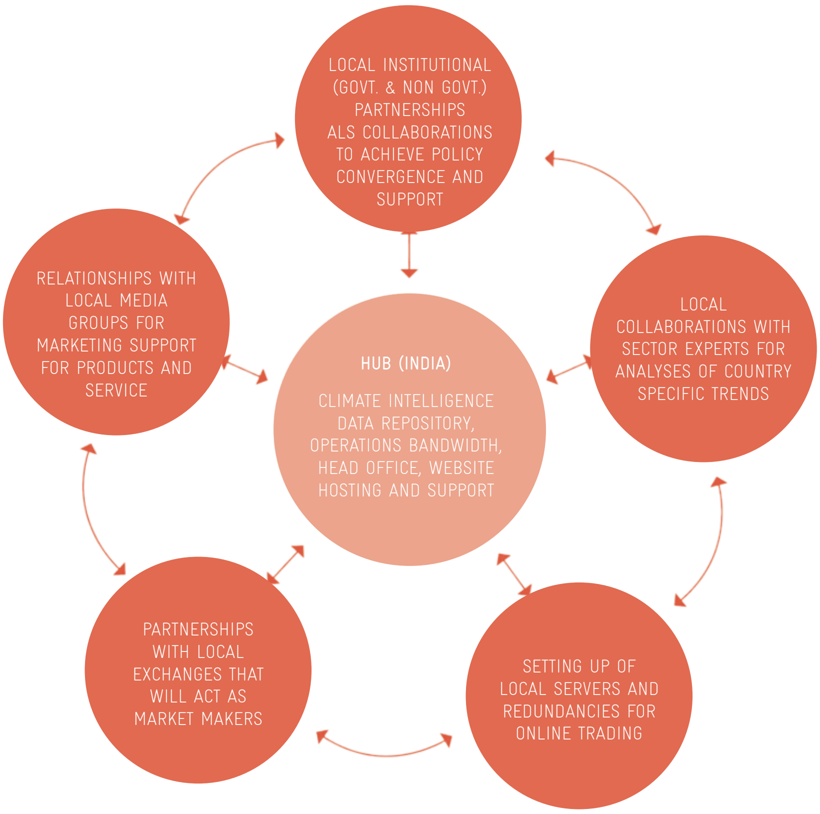
## XIX Appendix C8 – SAM's Portfolio Creation Strategy

**Figure C8: SAM's Portfolio Creation Strategy**




*Source: Sustainability Asset Management, 2011*

## XX Appendix C9 – Value Chain- Framework Illustration



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