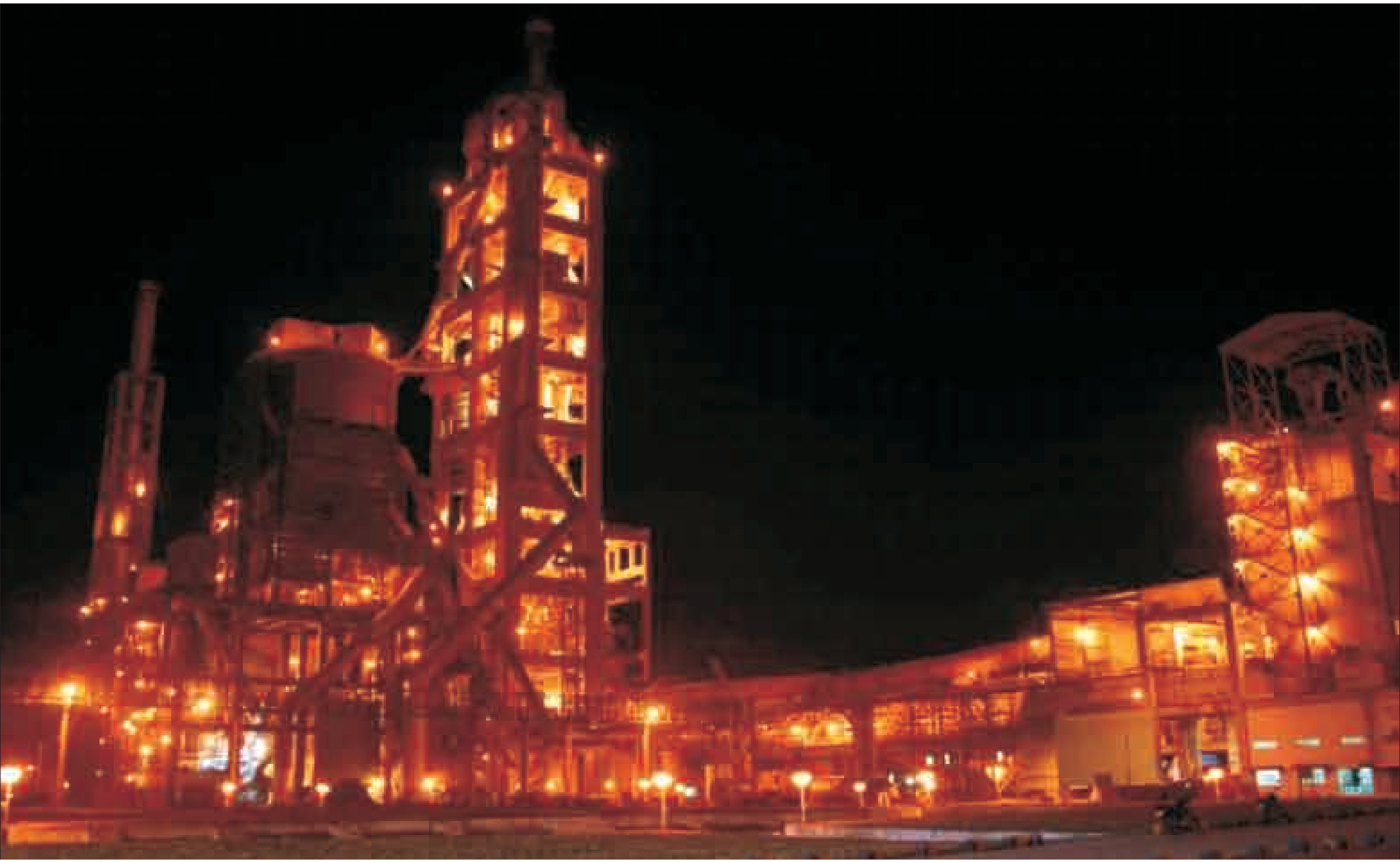
Confederation of Indian Industry
CII-Sohrabji Godrej Green Business Centre

Low Carbon Roadmap for Indian Cement Industry



May 2010

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Foreword

The impact of climate change is proven beyond doubt by various scientific studies and physical observations world over. The climate across the globe is changing very fast. It is established with overwhelming scientific consensus that the fragile ecological system is disturbed, the increasing extremities in climatic patterns are experienced and climate change is largely caused by human interventions.

Government of India (GOI) favours a multilateral response to the issue of climate change; based on the principle of 'common but differentiated responsibility'. GOI maintains that greenhouse gas emission mitigation and adaptation strategies should be designed to allow developing countries to achieve rapid economic growth and meet millennium development goals with sufficient resources to support adaptation efforts.

The Government of India has recently announced its voluntary emission intensity reduction target. India has committed to reduce its greenhouse gas emission intensity by 20-25% of 2005 levels by 2020. To meet the targets set by the Govt of India, it becomes imperative for all segments of the economy to independently strive to reduce their emissions and help the nation meet its commitments.

Cement industry in India, being a responsible and a mature industry, would certainly have to play its part in helping the country meet its obligations. This report is an effort to create a roadmap for Indian cement industry to achieve its target of 20% reduction in its Greenhouse gas emission intensity.

This report is meant for due contemplation, reflection and necessary action from the Indian cement industry in its roadmap towards a low carbon growth. This report would also serve to be a reference point for initiating a series of steadfast efforts towards achieving the end objective.

I am very eager to see the Indian cement industry achieve much greater results than what is contemplated in this report through its steady & continuous improvement, something this industry is renowned for over several decades.

G Jayaraman
Chairman, Green Cementech 2010, CII – Godrej GBC &
Executive President, Birla Corporation Limited

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Executive summary

Indian economy is on a high growth path and is anticipated to grow further considering the increased infrastructure plans and rapid economic development. India is currently ranked fourth in terms of Gross domestic product based on Purchasing Power Parity[1], ranked only next to the United States, China & Japan.

While India's GDP presents a sanguine figure of 7.2%[2], several economic sectors have been growing at a much rapid pace. These growth estimates are certainly an encouraging and elevating, but would also create an increased strain on the ecology. As per the 2006 Integrated Energy Policy report submitted to the Planning Commission, India needs to sustain an 8 to 10% economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. Consequently, the country needed at the very least to increase its primary energy supply three or four -fold over the 2003-04 level. This accelerated pace of economic growth will certainly result in increased energy and water consumption, higher greenhouse gas emission levels and increased waste generation.

The pertinent need of the hour therefore, is to *'Promote and champion conservation of natural resources in industry, without compromising on high and accelerated growth'*. Towards this objective, CII – Sohrabji Godrej Green Business Centre (CII – Godrej GBC) has been promoting ecologically sustainable business growth in Indian industry by implementing an initiative titled the "Mission on Sustainable Growth" (MSG).

To facilitate the Indian Industry adopt ecologically sustainable growth, CII in 2008 developed a report on 'Building a low carbon Indian economy'. This report outlines the technologies, practices and policies required for Indias leapfrog to a low carbon economy.

Cement industry is one of the major industries releasing appreciable quantity of Green House Gases with one of major source being the process emission (calcination) itself .The present contribution of GHG emissions from the industry is approximately 8 % of the total national emissions. CII's estimate of average greenhouse gas emissions based on the public available data and in-depth studies of emissions in Indian cement industry presents an average emission of 697 kg CO_2/Ton of Cement[3]

The Government of India has recently announced its voluntary target of reducing its greenhouse gas emission intensity reduction by 20-25% of 2005 levels by 2020. To meet the targets set by the Government of India, it becomes imperative for all segments of the economy to independently strive to reduce their emissions and help the nation meet its commitments. Cement industry in India, being a responsible and a mature industry, would certainly have to play its part in helping the country meet its obligations.

This report is an effort to create a roadmap for Indian cement industry to achieve its target of 20% reduction in its Greenhouse gas emission intensity, from the present average levels of 697 kg CO_2 / ton of cement to 560 kg CO_2 / ton of cement.

[1] World Bank Economy Database

[2] State of the Economy & Prospects, Ministry of Finance, GoI

[3] Weighted average of emissions of about 60% of India's cement manufacturing capacity for the year 2008-09

Some of the major areas which could offer significant GHG emission reduction opportunities are:

1. Generation and Utilization of Power from Waste heat Recovery
2. Use of alternate fuels & Bio mass
3. Improving energy efficiency & Increasing blended cement portion
    a) Increasing the Blended Cement portion further
    b) Increasing the Percentage of Additives in Blended Cement
    c) Further improvements in Electrical energy consumption
    d) Further improvements in Thermal energy consumption
    e) Producing Composite cement
4. Producing limestone based Cement / Low grade cement
5. Transport logistics

Indian cement industry has historically been a pioneer in the Indian industrial segment, leading the way in energy efficiency, productivity and technological avenues. This industry has the technical capability & mental maturity to achieve greater levels and lead the way for all other industrial sectors to follow.

Such large emission reduction targets need enabling ambience for Indian cement industry to operate. This target, though looks ambitious on paper, would be possible with greater stakeholder engagement, with clear and specific actions needed from various agencies.

A combination of these efforts can make a significant impact in the GHG emissions of the overall cement industry and guide the Indian cement industry in its low carbon growth pursuit.

Introduction

This report is intended to serve as a reference document for all further developments in the industry. This report would also help in determining the areas of competence of Indian cement industry and identify avenues for improvement across the sector.

Methodology adopted

The data used in this document has been predominantly sourced from the published reports of Cement Manufacturers Association (CMA), the individual company's public documents (websites, annual reports, etc) and the GHG inventorisation activity carried out by CII- Godrej GBC. The data has been collated and inferred by CII – Godrej GBC for meeting the objectives of this report.

Companies reviewed

The data used in this document has been predominantly sourced from the published reports of Cement Manufacturers Association (CMA), the individual company's public documents (websites, annual reports, etc) and the GHG Emission Inventorization activity carried out by CII- Godrej GBC. The data has been collated and inferred by CII – Godrej GBC for meeting the objectives of this report.

The study included three major players - The ACC Ltd, Gujarat Ambuja Cements Limited & Grasim Industries (including Grasim cements + Ultra tech cements) which have produced 12%, 10% & 18% respectively in the country's overall cement production for the year 2008-09; and 17 other plants wherein GHG emission Inventorization was carried out by CII- Godrej GBC under this project.

The 17 plants were grouped under three categories as follows :

Details of plants covered under CII GHG Emission Inventorization activity					
Sl no	Group	Plant capacity	No of cement plants	Group Cement production, Mn MTPA	Share of Country's production
1	A	< 1.5 Mn MTPA	6	6.04	3.3
2	B	1.5-3.0 Mn MTPA	6	10.25	5.6
3	C	>3.0 Mn MTPA	5	17.05	9.4
Total			**17**	**33.34**	**18.4**

The combined market share of these three major groups (ACC, Ambuja & Grasim) and 17 plants exceeds 58 % of the total cement market in India. The performance of the other players has also been reviewed to analyze the present operating practices and to estimate the overall GHG emission reduction potential in this sector.

The analysis of the data has been carried out in view of the technological, regulatory and 'business as usual' scenario of the Indian cement industry.

The report is structured to present an overview of the Indian cement industry, brief on the major players in the market, present operating practices, present levels of GHG emission (approximated based on production levels, overall mix of cement, present energy efficiency levels, technology adopted, etc), potential available for further reduction and steps needed to achieve the same.

Background of Indian cement industry

History

The history of Indian Cement industry started with a manufacturing capacity of mere 0.85 MMT (Million Metric Ton) in 1914-16 when a Cement plant was set-up at Porbandar, has attained phenomenal growth to the current level of around 260 MMT[4] as on 31st March 2010.

The Indian Cement industry, the second largest in the world, is regarded as one of the best in the world in terms of technology, quality, efficiency and productivity parameters.

Plant Location - Cluster details

Limestone Reserves

In India, Limestone is found in abundance. The total limestone reserves in India are estimated to be approximately 95,623.07 MMT, of which about 32% of total reserves are found in state of Andhra Pradesh itself. Cement industry is the largest consumer of limestone in India, accounting for over 75-80% of total limestone that is mined out. Limestone is the basic raw material needed for the manufacture of cement.

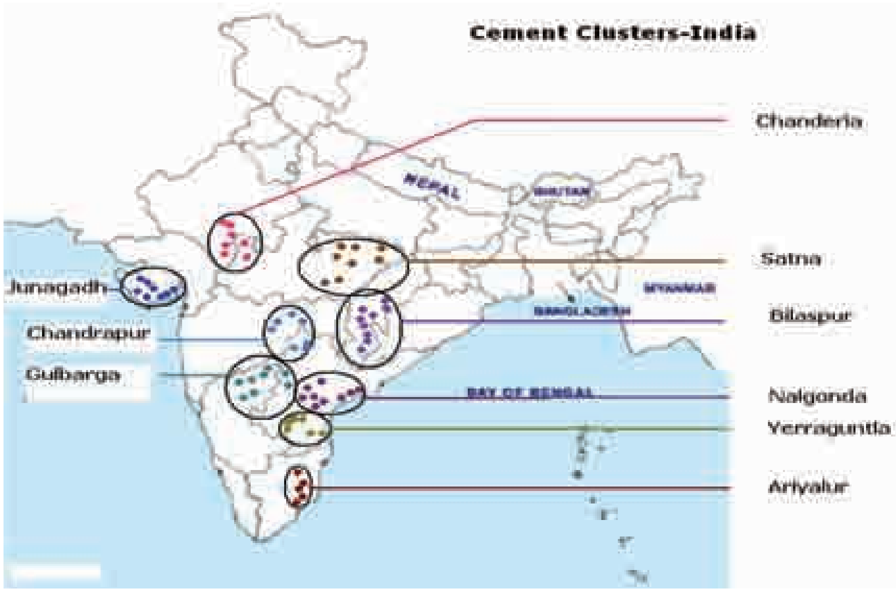
For making cement, limestone with a minimum CaO content of 44% is necessary. Typically, 1.4-1.5 MT (Metric Tonne) of Limestone is required for producing 1 MT of clinker. Thus, for a 1.0 Million MT cement plant, assured availability of cement grade limestone reserves of the order of 50-60 MMT in the close vicinity is vital.

Limestone Clusters

The location of limestone reserves in particular States has resulted, the Indian cement Industry to evolve in the form of clusters. A significant portion of the plants are located in these clusters.

Concentration of Cement plants in India

The figure below shows the Concentration of Cement plants in India[5]



[4] Business Standard News, April 10, 2010
[5] Basic data 2009, Cement Manufacturer's Association

Place of Concentration of Large Cement Plants & their capacity[6]

The table below gives the Concentrated Places and their capacity as on 31.03 2009:

State	Plants	No. of plants	Installed Capacity (MMT)
Andhra-Pradesh	India Cements - Chilamkur, Tandur, Wadapally & Yerraguntla, Ultratech-APCW, Zuari cements – Krishna nagar & Sitapuram, Penna Tadipatri, Rain Industries Ltd Ramapuram,Racherla, Dalmia cement – Kadapa, Panyam cements,Andhra Cements Vijayawada & Nadikude, Kistna, KCP Ltd, Rain Industries Ltd Ramapuram & Racherla, Penna- Ganeshabad & Boyareddypalli, Tadipatri, My Home Industries,Madras cements Jayanthipuram, Kesoram, Orient, CCI-Adilabad,CCI Tandur	24	37.52
Rajasthan	ACC – Lakheri, Birla – Chittorgarh, Neer shree cement,Aditya cement, Vikram cement, JK Nimbahera, Gotan & Mangrol, JK Lakshmi cement, JK Udaipur Udyog ltd, Ambuja cement – Rabriyawas,Shree cement Beawar, Binani cement – Sirohi & Neem ka thana, Shriram cements - Kota	14	34.82
Tamil Nadu	ACC – Madukarai, Grasim-Reddipalayam, Tamilnadu cements – Ariyalur & Alangulam, India cements Sankar nagar, sankari durg, dalavoi & valliyur, Madras cements-Alathiyur, Chettinad – Ariyalur,Karur & Karikali, Dalmia Cements- Dalmiapuram Ultratech - Arakonam	16	24.43
Madhya-Pradesh	ACC Kymore, Birla vikas, Satna cement, Maihar cement, Grasim - Rawad, Mysore – Damoh, CCI -Neemuch Jaypee Rewa & Bela, Diamond cement, Prism cement	10	19.37
Gujarat	Shree Digvijay cement,, Saurashtra, Gujarat Ambuja Cements Ltd- I & II Kodinar, Gujarat Sidhee Cement Ltd, Veraval, HMP Ltd, Ultratech Pipavav, Jafrabad & Magdalla, Sanghi, JK Lakshmi - Kalol	12	19.28
Karnataka	ACC Wadi CCI- Kurkunta, Grasim - Malkhed, HMP-Shahabad, Bagalkot udyog limited, Vasavadatta cement, Mysore cements – Ammasandra, Ultratech - Ginigera	9	15.33
Maharashtra	ACC Chanda, Manikgarh cement, Grasim - Hotgi Ultratech – Chadrapur & Ratnagiri, Mysore – Raigad, Orient – Jalgaon, Ambuja cements - Chandrapur	8	13.10
Chattisgarh	ACC Jamul, CCI-Akaltara, CCI-Mandhar, Century cement, Grasim-Raipur, Ambuja Eastern-CTG, Lafarge - Arasmeta cement, Lafarge-Sonadih, Ultratech-HCW	9	12.01
Others		46	43.31
Grand total (Large Plants)		148	219.17

[6] Cement Manufacturer's Association of India website: www.cmaindia.org

Capacity

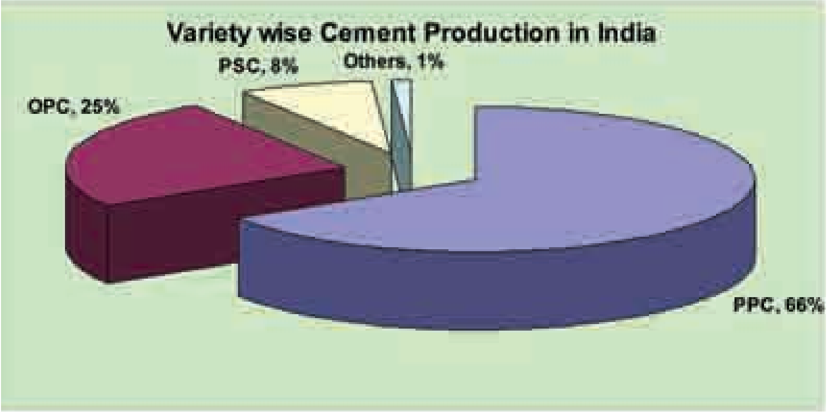
Production capacity

India is the 2nd largest producer of cement in the world. The total installed capacity is about 260 Million MT as on March 2010. The industry added over 40 Million MT to its installed capacity in just one year during previous fiscal (April 2009–March 2010). The capacity utilization in the Indian Cement Industry is close to 100%.

India has presently about 52 companies involved in cement manufacturing business. The cement industry comprises 148 large cement plants and more than 365 mini cement plants. The large plants account for more than 96% of the total production. Even though private and public sector are indulged in cement production, the private sector alone contributes about 97 % of total production. As high as 150,000 of manpower are directly involved in the production process. The present per capita consumption of cement in India is about 186 kg, which is still way below compared to several other countries in the world.

Industry has a domestic demand of 97 % and the rest is exported. Exports of Cement and Clinker are not only made for neighbouring countries but also to countries in West Asia and Africa. The industry produces cement varieties such as Ordinary Portland, Pozzalano Portland (Fly-ash based), Pozzalano blast furnace slag, Sulphate resistance, IRST 40, Oil well, Low heat, silicate, GPC and Special Cement.

The Chart below shows the product mix of Cement Production in India[7]:



Technological Advancements

At present, the quality of cement and standard of cement produced in India is par to any cement produced else-where and can compete in international markets.

The productivity parameters are now nearing the theoretical bests and the Indian cement industry is now looking beyond for alternate means. Substantial technological improvements have been brought through out its growth.

The industry can legitimately be proud of its state-of-the-art technology and processes incorporated in most of its cement plants. For example 96 % of the cement production happens in the latest dry process technology. This technology up gradation has resulted in increasing the capacity and reducing the cost of production.

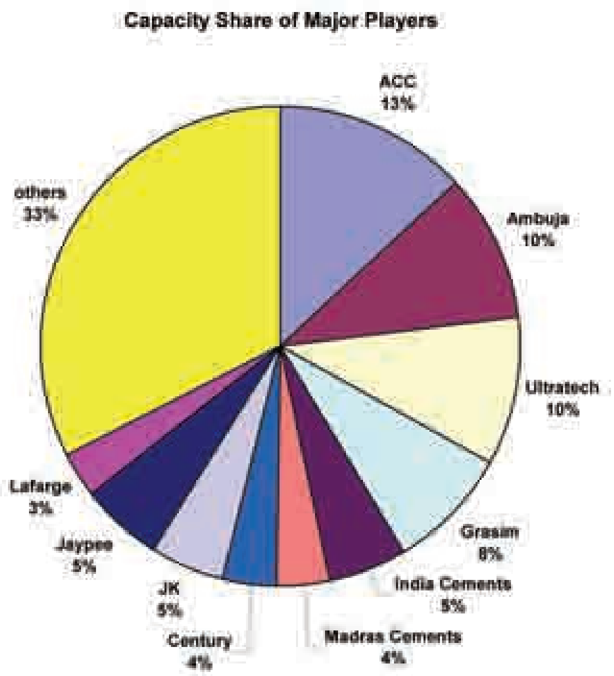
[7] Cement Manufacturer's Association, Basic data, 2009

Major players

Some of the Major players of the Indian cement industry are

1. ACC Ltd.
2. Gujarat Ambuja groups
3. Ultra-tech Cement Ltd.
4. Grasim Industries
5. India Cements
6. Madras cements
7. Century Cements
8. JK Groups
9. Jaypee Group
10. Lafarge

The following chart illustrates the Capacity share of the major players in India[8]



[8] Cement Manufacturer's Association, Basic data, 2009

Major Cement Manufacturers in India

Associated Cement Companies Ltd (www.acclimited.com)

ACC Limited is the leading cement producer in the country. It is regarded as the oldest company in India. It has a total consolidated capacity of 22.4 MMT in the region and commands nearly 13 percent industry capacity share. With 12 integrated plants and 4 grinding units, ACC is one of the few companies to have a pan-India presence. Holcim - world's premier cement producer has a major stake in this company.

Ambuja Cements Ltd (www.gujaratambuja.com)

Gujarat Ambuja Cements Ltd. is the third largest cement producer in the country. It commenced its operation in 1986.The group it has upgraded its capacity to 18.5 MMT. The group has 5 integrated and 3 grinding units well placed in the states of Himachal Pradesh, Gujarat, Maharashtra, Chhattisgarh, Punjab and Rajasthan. It has a strong foothold in the northern and western markets. It is the India's largest Cement exporter and one of the most cost efficient firms in the country. Holcim has a major stake in this company.

Ultra-tech Cement Limited (www.ultratechcement.com)

Ultratech Cement, an Aditya Birla Group Company and a 51 percent subsidiary of Grasim, has a consolidated capacity of 23.1 MMT. In fact, it is the second largest cement producer in the country. The company has its presence in western, eastern and southern regions. It has 5 integrated plants, 6 grinding units, and 3 terminals – two in India and one in Sri Lanka. Ultratech cement is the country's largest exporter of Cement and Clinker.

Grasim Industries (www.grasim.com)

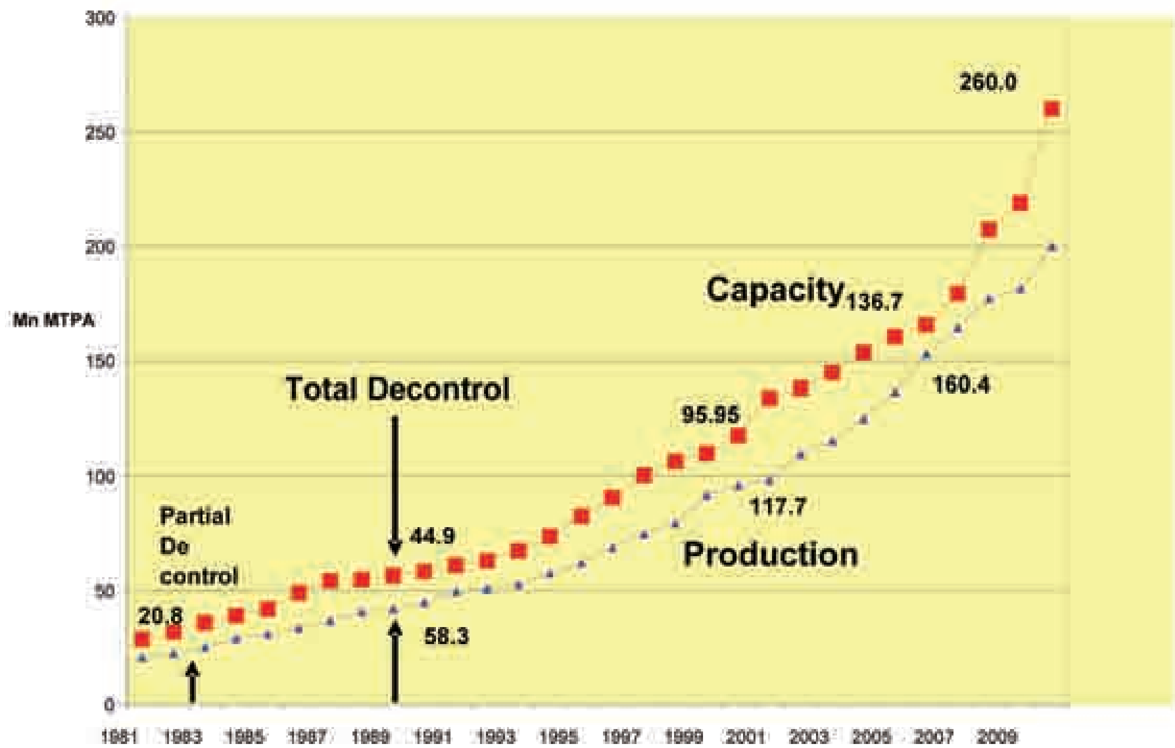
Grasim Cements ranks 4th in the country have a combined capacity of 22.5 MMT. It has 6 integrated and 2 grinding units which spread across Madhya Pradesh, Chhattisgarh, Punjab, Rajasthan, Tamil Nadu and Gujarat. Grasim cement is a part of Aditya Birla Group, a diverse industry conglomerate having business interests in Textiles, Aluminum, Chemicals & Staple Fibre apart from Cement.

Growth

Growing Demand

The Indian cement industry is growing rapidly at an annual rate of 9 – 10%. In order to meet the expanding demand, cement companies are fast developing new plants. The cement industry is poised to add 40 MMT of annual capacity by the end of 2010–11 (FY 2011), riding on the back of approximately 30 outstanding cement projects. The installed capacity is expected to increase to 300 MTPA by the end of FY 2011.

The graph below illustrates the growth of the Cement industry during the last 2 decades[9]



[9] Cement Manufacturer's Association

Entry of Foreign players

The booming demand for Cement in India has attracted global cement players to enter Indian Market. In 2005-06, four of the top-5 cement companies in the world have entered India through mergers, acquisitions, joint ventures etc. These include France's Lafarge, Switzerland's Holcim, Italy's Italcementi and Germany's Heidelberg Cements.

Holcim

Swiss based Holcim is the leading cement producer in the world. It has units in excess of 70 countries all over the world. It made its in-road in India by picking up 14.8% of the promoters' stake in Gujarat Ambuja Cements (GACL). Moreover, they made a strategic alliance with GACL, and acquired a 67 percent controlling stake in Ambuja Cement India. Through this, Holcim acquired a majority in Ambuja Cement Eastern and a substantial stake in ACC.

Italcementi Group

Italy based Italcementi group is one of the largest producers and distributors of cement. It has 60 cement plants, 547 concrete batching units and 155 quarries spread across 19 countries in Europe, Asia, Africa and North America. Italcementi entered into the Indian markets through a 50:50 joint venture company with Zuari Cements.

Lafarge

Lafarge group is the foremost Cement producer in France. It made its presence in India with the acquisition of the Tisco and the Raymond cement plants. Lafarge Cement presently has three cement manufacturing units in India. It has a large network of distributors in the eastern part of India. The Lafarge Cement Company is presently producing nearly 5 million tons of cement.

Heidelberg

Heidelberg Cement Company is the leading German cement manufacturing company. Through an equal joint-venture agreement with SP Lohia Group, it took control of Indo-Rama Cement and entered Indian market. Recently, it took over Mysore Cement of S K Birla group.

Mergers and Acquisitions

The Indian cement industry is also witnessing a flurry of mergers and acquisitions. It has brought smaller players under the umbrella of larger companies, and larger companies coming under the umbrella of global players like Holcim and Heidelberg. The following table gives the Mergers & Acquisitions carried out by the Global players in India.

[10] Care Research

Global players[10]		
Company	**Companies Acquired (Stake)**	**Year of acquisition**
Holcim (Holland)	a. ACC (34%) b. Ambuja Group (23%)	2005 2006
Lafarge (France)	a. Tisco's cement b. Raymond's cement	1999 2001
Italcementi (Italy)	a. Zuari cement (50:50 JV)	2001
Heidelberg Cement (Germany)	a. Indorama (50:50) b. Mysore Cement (51%)	2005 2006
CRH PLC (Ireland)	a. My Home Cements	2008
Vicat (France)	a. Sagar Cement b. Bharati cement	2010

The following table gives the Mergers & Acquisitions undergone by the Indian players in India

Indian players[11]		
Company	**Co. Acquired/Stake**	**Year of acquisition**
Gujarat Ambuja	a. DLF Cement b. Modi Cement	2000 1998
Grasim	a. Indian Rayon b. Shri Digvijay c. Dharani cement	1999 1999 1998
Ultratech	a. Narmada cement	1999
India Cements	a. Raasi Cement b. Shree Vishnu Cement c. Vishaka cement d. Yerraguntla Cement	1999 1999 1998 1998
Ultratech cement	a. Star Cement	2010

Energy consumption

Cement industry is an energy intensive industry with about 35-45% of the total manufacturing cost. It needs both Electrical as well as thermal energy for its operation. Cement industry accounts for around 10 % of the coal and 6 % of the electricity consumed by the Indian industrial sector.

Electrical Energy

The Indian cement plants on an average consume about 82 kWh of Electrical energy for producing one ton of cement.

Cement plant requires electrical energy to run its Mill drives, Pumps, Fans, Conveyors, Packers and for Lighting systems. Kiln and cement mill sections are major electrical power consuming areas of the cement plant. In fact, they consume about 60 % of total electrical energy requirement.

The following table gives the energy consumption levels of cement plants covered under this study in the Indian cement industry during the financial year 2008-09.

[11] Care Research

Electrical Energy Consumption Levels of cement plants covered under the study for the year 2008-09							
Group	ACC	Grasim & Ultra tech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	Average
Power consumption kW/MT Cement	85.0	81.1	86.4	90.7	85.7	73.8	82.7

Thermal Energy

On an average, the Indian cement plants require 743 kCal of thermal energy for making one kg of clinker. The major use of thermal energy is in the kiln and pre-calciner systems. Thermal energy is needed for the raw meal processing specifically for converting the raw mix to Clinker. Clinker production is the most energy-concentrated stage in cement production. The number of stages in the pre-heater system has a major bearing on the thermal energy consumption in Kiln system.

Table below gives the Thermal Energy consumption levels of cement plants covered under this study in the Indian cement industry during the financial year 2008-09.

Thermal Energy Consumption Levels of cement plants covered under the study for the year 2008-09							
Group	ACC	Grasim & Ultra tech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	Average
Thermal Energy consumption kcal / kg clinker	746.0	716.0	755.0	795.0	795.8	728.0	742.9

Energy reduction in Indian Cement Industry

Indian cement industry has been a fore-runner as far as energy efficiency in the cement manufacturing process is concerned. Some of the Indian cement plants are operating with the lowest specific energy consumption numbers in the world.

All Indian cement plants are taking several initiatives to reduce their energy consumption and minimize their variable costs. Their efforts are quite evident from the fact that the specific energy consumption has come down significantly for last 2 decades from 110 units to 82 units per MT of cement.

The best thermal and electrical energy consumption presently achieved in India is 663 kcal/kg clinker and 59 kWh/t cement which are comparable to the best figures of 650 kcal/kg clinker and 65 kWh/t cement in a developed country like Japan.

The cost of energy, competition & self drive thrust for achieving excellence in energy efficiency had been the predominant driving factor for such advancements in energy efficiency

The following initiatives are taken by the industry in its continued efforts on achieving energy efficiency:

- Adopting latest technology
  - 96 % of the cement is produced in modern dry process plants with calciner technology
  - Latest Generation grinding systems & classifiers are utilized
  - Advance automation and energy monitoring systems installed in all major plants
  - Skilled man power and continuous training of personnel in latest technology being followed
  - Participation in national and international seminars / conferences sharing the best practices,

discussing the challenges and future and further improvements organized by agencies like CII, CMA , NCCBM and others.

- Participation in mandatory energy conservation programs like conducting energy audit once in two years and implementing the energy conservation projects identified therein (The complete list of energy conservation projects that can be implemented in the cement process are enclosed in the Annexure for ready reference).

- Rigorous Benchmarking exercise by Cement Manufacturers Association (CMA), India and internal benchmarking exercises by several cement manufacturing groups
- Participation in Voluntary energy conservation activities like, Achieving World Class Energy efficiency status in cement industry - an initiative promoted by CII. (Complete details of this activity is enclosed in the annexure 2 for ready reference)
- Active participation in National level Energy award competitions organized by CII, BEE (Bureau of Energy Efficiency), Ministry of Power (Govt. of India).
- In house identification and implementation of energy conservation activities through employees participation in management tools like TPM (Total Productivity Management) & TQM (Total Quality Management) , Six Sigma etc.,

Future Targets

The Industry is considering the following aspiration numbers in Electrical as well as in Thermal energy consumption as a future targets.

Table below shows the break up Target of electrical energy consumption in a typical Cement plant[12]

Area of activity	Electrical consumption (kWh / Ton of OPC Cement)
Crushing	1.5
Raw mill	12-18
Kiln and Cooler	18
Coal mill	2.5
Cement mill	18
Packing	1
Miscellaneous	3.5
Total	56-62

Table below gives the break-up Target of Thermal energy consumption in Kiln & Cooler system

Parameter	Specific Fuel Consumption (kcal / kg Clinker)
Theoretical heat consumption	410
Pre-heater loss	105
Cooler loss (Clinker & Cooler vent gases)	90
Radiation loss	75
Heat Input	-30
Total	**650**

[12] Confederation of Indian Industry, CII, Godrej GBC

Climate Change

Growth of Indian economy

Indian economy is on a high growth path and is anticipated to grow further considering the increased infrastructure plans and rapid economic development. India is currently ranked fourth in terms of Gross domestic product based on Purchasing Power Parity, ranked only next to the United States, China & Japan[13]. While India's GDP (at factor cost of 2004-05) presents a sanguine figure of 7.2%, several economic sectors have been growing at a much rapid pace.

Rate of growth at factor cost at 2004-2005 prices (per cent)[14]					
	2005-06	2006-07	2007-08	2008-09	2009-10
Agriculture, Forestry & Fishing	5.2	3.7	4.7	1.6	-0.2
Mining & Quarrying	1.3	8.7	3.9	1.6	8.7
Manufacturing	9.6	14.9	10.3	3.2	8.9
Electricity, Gas & Water Supply	6.6	10	8.5	3.9	8.2
Construction	12.4	10.6	10	5.9	6.5
Trade, Hotels & Restaurants	12.4	11.2	9.5	5.3	8.3
Transport, Storage & Communication*	11.5	12.6	13	11.6	
Financing, Insurance, Real Estate & Services	12.8	14.5	13.2	10.1	9.9
Community, Social & Personal Services	7.6	2.6	6.7	13.9	8.2
GDP at Factor Cost	9.5	9.7	9.2	6.7	7.2
* Transport & communication included for 2009-10 in trade, hotels and restaurants.					

These growth estimates are certainly a encouraging and elevating, but would also create an increased strain on the ecology. As per the 2006 Integrated Energy Policy report submitted to the Planning Commission, India needs to sustain an 8 to 10% economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. Consequently, the country needed at the very least to increase its primary energy supply three or four -fold over the 2003-04 level.

This accelerated pace of economic growth will certainly result in increased energy and water consumption, higher greenhouse gas emission levels and increased waste generation.

CII – Sohrabji Godrej Green Business Centre (CII – Godrej GBC) has been promoting ecological sustainable business growth in Indian industry by implementing an initiative titled the "Mission on Sustainable Growth" (MSG). The core purpose of this mission is to *"Promote and champion conservation of natural resources in industry, without compromising on high and accelerated growth"*.

As part of the mission, a "CII Code for Ecologically Sustainable Business Growth" has been developed, which aims to involve the top management of companies to seek voluntary commitments to reduce resource consumption and emissions intensity.

Climate Change

The impact of climate change is proven beyond doubt by various scientific studies and physical observations world over. The climate change across the globe is very fast. It is established with overwhelming scientific consensus that the fragile ecological system is disturbed, the increasing

[13]World Bank Economy Database

[14]State of the Economy & Prospects, Ministry of Finance, GOI

extremities in climatic patterns are experienced and climate change is largely caused by human interventions.

In fact, several countries have agreed that Climate change may be one of the greatest threats facing the planet today.

Intergovernmental Panel on Climate Change's (IPCC) Assessment Report 2007[15] shows unequivocal evidence of warming of climate systems:

- CO_2 atmospheric concentration up from 280 ppm (pre-industrial) to 379 ppm (2005)
- GHG emissions up by 70% between 1970-2004
- Global mean temp. rise 0.74°C from 1906-2005
- The previous 11 years (1995-2006), among the 12 warmest years since 1850
- Global sea level rise 1.8 mm/yr during 1961-2003, faster during 1993-2003 (@3.1 mm/yr)

Impact of Climate Change on India

Developing countries such as India are already baffling with several societal transformations such as increasing urbanization, rapid industrialization and fast pace of economic development. The additional impact due to Climate Change, either on the health, ecosystem, and agriculture or on industrial activities could add significant strain on the administration and Governments.

Greenhouse Gas Emissions – India's Stand

India presently stands as the fourth largest emitter of greenhouse gases, ranking next to China, United States of America and Russia. However, the per capita emission of India is far below world average levels. Moreover, India in the recent years has managed an 8% growth rate with only 3.7% increase in energy consumption.

Some of the key highlights of India's stand on Climate Change negotiations are as under[16]:

- Prime Minister of India has stated that India's per capita emission levels will never exceed that of the per capita emission levels of developed countries
- India cannot and will not take on emission reduction targets because:
    - Poverty eradication and social and economic development are the first and over-riding priorities
    - Each human being has equal right to global atmospheric resources (i.e., Principle of Equity)
    - "Common but differentiated responsibility" is the basis for all climate change actions
- India will continue to be a low-carbon economy (World Bank study)
- India's primary focus is on "adaptation", with specific niches for "mitigation"
- India has already unveiled a comprehensive National Action Plan on Climate Change whose activities are in the public domain. Work on the Action Plan has been initiated
- Only those Nationally Appropriate Mitigation Actions (NAMAs) can be subject to international monitoring, reporting and verification that are enabled and supported by international finance and technology transfer

[15]IPCC www.ipcc.ch

[16]Ministry of Environment & Forest, Govt of India, www.moef.nic.in

National Action Plan on Climate Change (NAPCC)[17]

On June 30, 2008, Prime Minister Dr Manmohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation. The plan identifies eight core "National Missions" running through 2017 and directs relevant ministries to chalk out detailed implementation plans.

Emphasizing the overriding priority of maintaining high economic growth rates to raise living standards, the plan "identifies measures that promote our development objectives while also yielding co-benefits for addressing climate change effectively." It says these national measures would be more successful with assistance from developed countries, and pledges that India's per capita greenhouse gas emissions "will at no point exceed that of developed countries even as we pursue our development objectives." The following are the salient highlights of the 8 National Missions:

1. National Solar Mission: The NAPCC aims to promote the development and use of solar energy for power generation and other uses with the ultimate objective of making solar competitive with fossil-based energy options. The plan includes:
   - Specific goals for increasing use of solar thermal technologies in urban areas, industry, and commercial establishments;
   - A goal of increasing production of photovoltaic to 1000 MW/year; and
   - A goal of deploying at least 1000 MW of solar thermal power generation.

   Other objectives include the establishment of a solar research center, increased international collaboration on technology development, strengthening of domestic manufacturing capacity, and increased government funding and international support.

2. National Mission for Enhanced Energy Efficiency: Current initiatives are expected to yield savings of 10,000 MW by 2012. Building on the Energy Conservation Act 2001, the plan recommends:
   - Mandating specific energy consumption decreases in large energy-consuming industries, with a system for companies to trade energy-savings certificates;
   - Energy incentives, including reduced taxes on energy-efficient appliances; and
   - Financing for public-private partnerships to reduce energy consumption through demand-side management programs in the municipal, buildings and agricultural sectors.

3. National Mission on Sustainable Habitat: To promote energy efficiency as a core component of urban planning, the plan calls for:
   - Extending the existing Energy Conservation Building Code;
   - A greater emphasis on urban waste management and recycling, including power production from waste;
   - Strengthening the enforcement of automotive fuel economy standards and using pricing measures to encourage the purchase of efficient vehicles; and
   - Incentives for the use of public transportation.

4. National Water Mission: With water scarcity projected to worsen as a result of climate change, the plan sets a goal of a 20% improvement in water use efficiency through pricing and other measures.

[17] http//pmindia.nic.in/climate-change.htm

5. National Mission for Sustaining the Himalayan Ecosystem: The plan aims to conserve biodiversity, forest cover, and other ecological values in the Himalayan region, where glaciers that are a major source of India's water supply are projected to recede as a result of global warming.

6. National Mission for a "Green India": Goals include the afforestation of 6 million hectares of degraded forest lands and expanding forest cover from 23% to 33% of India's territory.

7. National Mission for Sustainable Agriculture: The plan aims to support climate adaptation in agriculture through the development of climate-resilient crops, expansion of weather insurance mechanisms, and agricultural practices.

8. National Mission on Strategic Knowledge for Climate Change: To gain a better understanding of climate science, impacts and challenges, the plan envisions a new Climate Science Research Fund, improved climate modeling, and increased international collaboration. It also encourages private sector initiatives to develop adaptation and mitigation technologies through venture capital funds.

India Greenhouse Gas Emissions modeling studies[18]

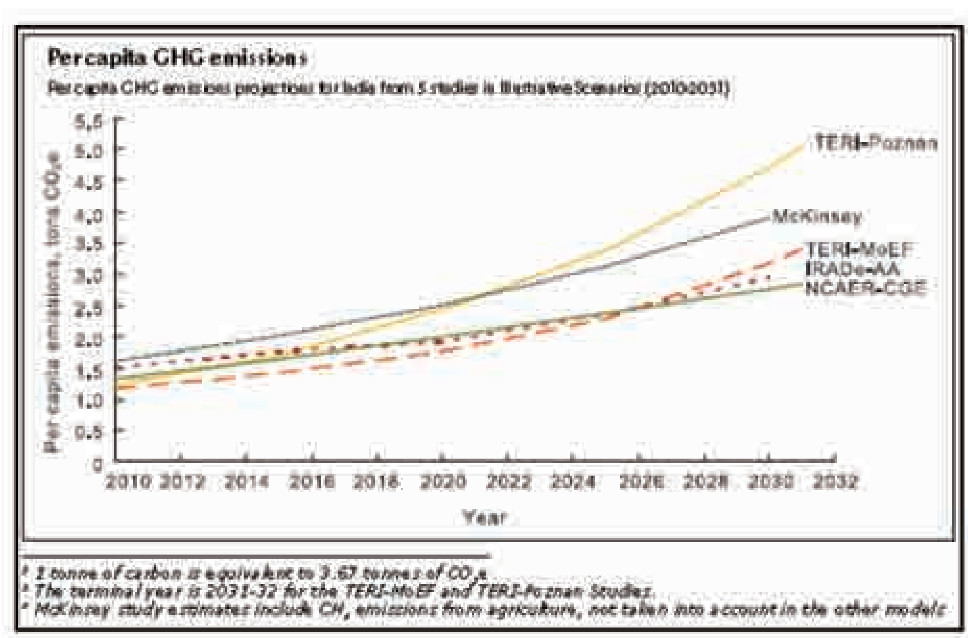
In late 2009, Ministry of Environment & Forests (MoEF) released a report "India's GHG Emissions Profile: Results of Five Climate Modeling Studies" as a synthesized consolidation of Five independent India's climate modeling studies. One of the key finding of the report was that India's per capita emission of Greenhouse Gases (GHG) will continue to be low until the year 2030-31. In fact, it is estimated that India's per capita emissions in the year 2031 will be lower than the per capita global emission of GHG in the year 2005.

As per the estimates of the five different studies, India's per capita GHG emissions in 2030-31 would be between 2.77 MT and 5.00 MT of CO_2e (Carbon Dioxide equivalent). Four of the five studies estimated that even in 2031, India's per capita GHG emissions would stay under 4.0 MT of CO2e, which is lower than the global per capita emissions of 4.22 MT of CO_2e in 2005. This would mean that even two decades from now, India's per capita GHG emissions would be well below the global average of 25 years earlier.

In absolute terms, estimates of India's GHG emissions in 2031 vary from 4.0 billion MT to 7.3 billion MT of CO_2e, with four of the five studies estimating that even two decades from now, India's GHG emissions will remain under 6 billion MT. The key drivers of the range of these estimates are the assumptions on GDP growth rates, penetration of clean energy, energy efficiency improvements etc.

All the five studies also show evidence of a substantial and continuous improvement in India's energy efficiency of GDP. India's energy use efficiency has been steadily improving over the years which is reflected in the decline of its energy intensity of GDP from 0.30 kgoe (kilogram of oil equivalent) per $ of GDP in 1980 to 0.16 kgoe per $ GDP in PPP (purchasing power parity) terms. This is comparable to Germany and only Japan, UK, Brazil and Denmark have lower energy intensities in the world.

Graph 1



[18]Ministry of Environment & Forest, Govt of India, www.moef.nic.in/downloads/home/GHG-report.pdf

Graph 2

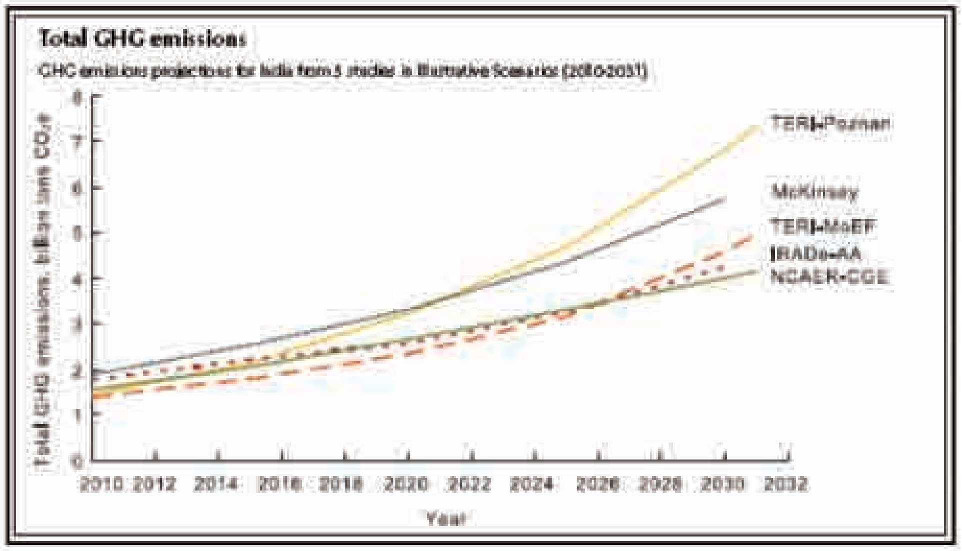

Total GHG emissions
GHG emissions projections for India from 5 studies in Illustrative Scenarios (2010-2031)
Total GHG emissions, billion tons CO2e
0
1
2
3
4
5
6
7
8
2010
2012
2014
2016
2018
2020
2022
2024
2026
2028
2030
2032
Year
TERI-Poznan
McKinsey
TERI-MoEF
IRADe-AA
NCAER-CGE

Table 3: Results of Illustrative Scenarios

	NCAER CGE Model	TERI MoEF Model	IRADe AA Model	TERI Poznan Mode	McKinsey India Model
GHG emissions in 2030-31 (CO_2 or CO_2e) (billion tons)	4.00 billion tons of CO_2e	4.9 billion tons (in 2031-32)	4.23 billion tons	7.3 billion tons in 2031-32	5.7 billion tons (including methane emissions from agriculture); ranges from 5.0 to 6.5 billion tons if GDP growth rate ranges from 6 to 9 per cent
Per capita GHG emissions in 2030-31 (CO_2 or CO_2e)	2.77 tons CO_2e per capita	3.4 tons CO_2e per capita (in 2031-32)	2.9 tons CO_2e per capita	5.0 tons CO_2e per capita (in 2031-32)	3.9 tons CO_2e per capita (2030), all GHGs
CAGR of GDP till 2030-31, %	8.84%	8.84% (Exogenous - taken from CGE)	7.66% (Endogenous, 2010-11 to 2030-31)	8.2% 2001-2031 (Exogenous)	Exogenous - 7.51% (2005-2030) from MCI Oxford Econometric model
Commercial energy use in 2030-31, mtoe	1087 (Total commercial primary energy forms)	1567 (Total commercial energy including secondary forms) in 2031-32	1042 (Total commercial primary energy)	2149 (Total commercial energy including secondary forms) in 2031-32	NA
Fall in energy intensity	3.85% per annum *(compound annual decline rate)*	From 0.11 in 2001-02 to 0.06 in 2031-32 kgoe per $ GDP at PPP	From 0.1 to 0.04 kgoe per $ GDP at PPP	From 0.11 in 2001-02 to 0.08 in 2031-32 kgoe per $ GDP at PPP	Approximately 2.3% per annum between 2005 and 2030 (at PPP GDP, constant USD 2005 prices)
Fall in CO_2 (or CO_2e) intensity	From 0.37Kg CO_2e to 0.15 Kg CO_2e per $ GDP at PPP from 2003-04 to 2030-31	From 0.37 to 0.18 kg CO_2 per $ GDP at PPP from 2001-02 to 2031-32	From 0.37 to 0.18 Kg CO_2 per $ GDP at PPP from 2003-04 to 2030-31	From 0.37 to 0.28 kg CO_2 per $ GDP at PPP from 2001-02 to 2031-32	Approximately 2% per annum between 2005 and 2030 (at PPP GDP, constant USD 2005 prices)

IEA Cement Technology Roadmap[19]

Recognising the urgency of identifying technology to reduce the CO_2 intensity of cement production, the IEA has worked together with the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI) to develop a technology roadmap for cement. This is currently the only industry-specific roadmap; others focus on specific technologies. This joint effort shows willingness to build on progress already made, as well as the industry's understanding that further progress lies ahead.

CO_2 emissions from cement production currently represent about 5% of anthropogenic global CO_2 emissions. The cement roadmap outlines a possible transition path for the industry to make continued contributions towards a halving of global CO_2 emissions by 2050. As part of this contribution, this roadmap estimates that the cement industry could reduce their emissions 18% from current levels by 2050. A reduction of global emissions does not imply a linear reduction by the same percentage in all industries. This roadmap should be understood as a deep analysis of potentials and challenges in one industry.

The vision for such reductions is ambitious, yet the changes required must be practical, realistic and achievable. This roadmap is a first step. It is only attainable with a supportive policy framework, and appropriate financial resources invested over the long term. The roadmap outlines these policies, estimates financial requirements, and describes technical changes, along with recommendations to support research and development (R&D) and future investment decision-making.

Key Points

- Cement is a key material. Demand reduction / substitution is not an option
- Options today best available technology (BAT), alternative fuels and clinker substitutes) are not sufficient to reduce future emissions in the sector
- New technology is needed – CCS and new cement types
- Urgent action is needed to develop and demonstration carbon capture technology for the cement sector
- Step increase in RD&D needed, a very long term solution is required
- Deep emission cuts are costly (USD 50-100/t CO_2) and capital intensive
- Policy should address economic implications
- Cement will become twice as expensive – a challenge and an opportunity

[19]International Energy Agency http:www.iea.org/roadmaps/cement.asp

Table 1:

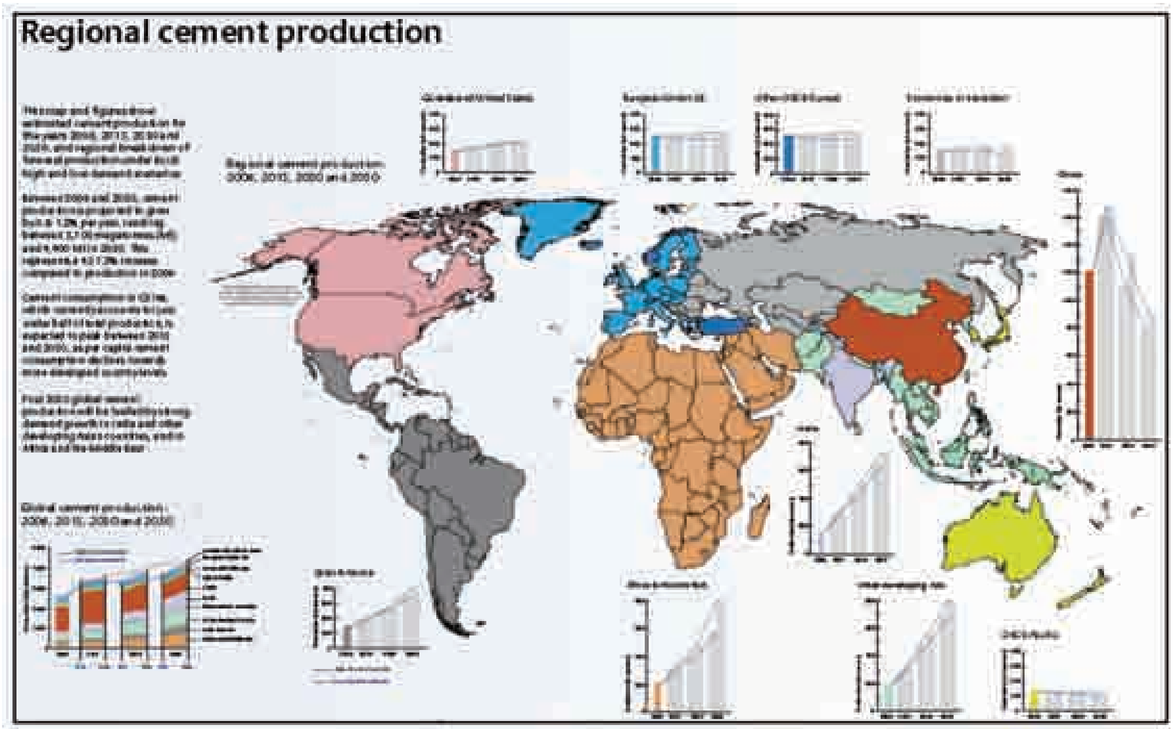
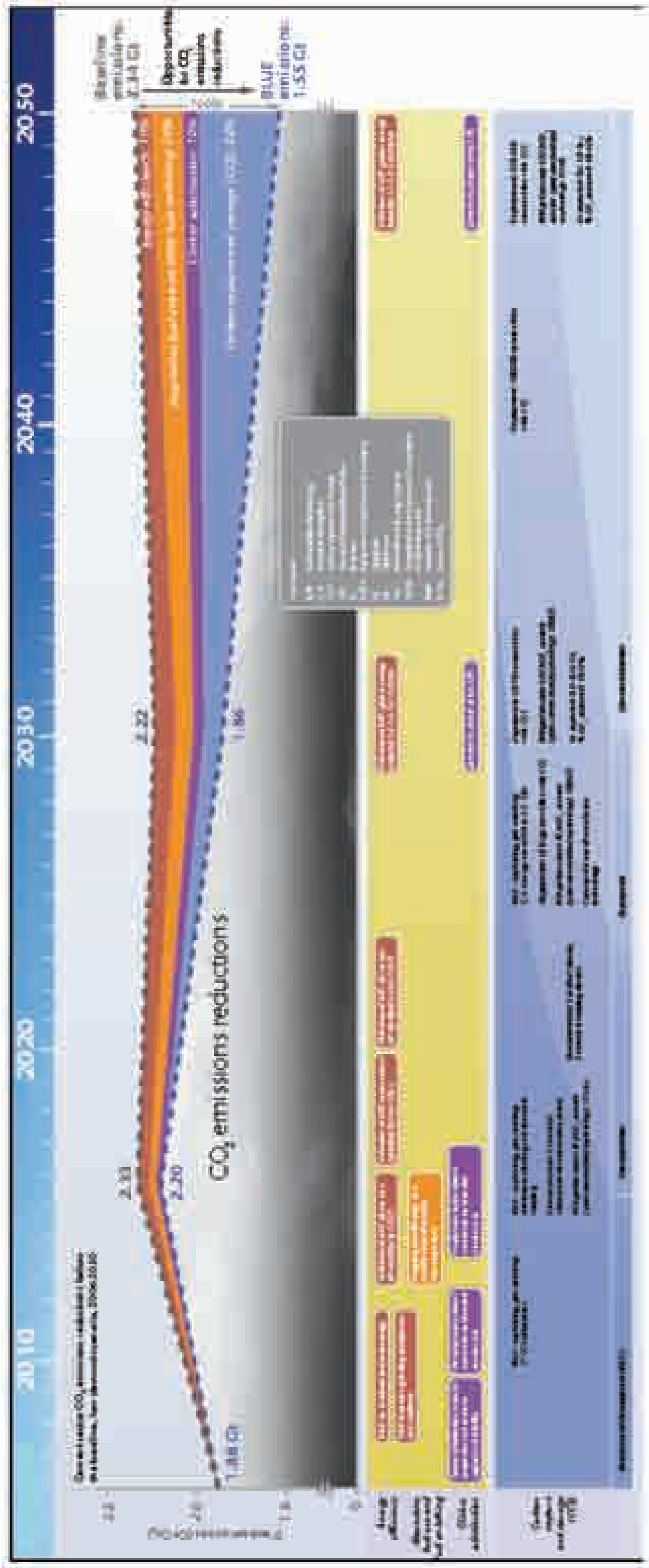


Table 2:


2010
2020
2030
2040
2050
CO2 emissions reductions
1.88 Gt
2.33
2.20
2.22
1.86
Baseline emissions: 2.34 Gt
BLUE emissions: 1.55 Gt

Greenhouse Gas Emissions - Indian Cement Industry

Cement Industry Cement industry is one of the major industries releasing appreciable quantity of Green House Gases with one of major source being the process emission (calcination) itself. The present contribution of GHG emissions from the industry is approximately 8 % of the total national emissions.

Indian cement industry has been one of the forerunners as far as energy efficiency in the Indian industry is concerned. Several initiatives taken by Indian cement industry over the two decades has reduced the GHG emission levels to the current level.

These steps include:

- Increasing the share of blended cement from a mere 28 % in 1989 to present level of 74 % resulting in
  - ❑ Utilization of large quantities of Industrial wastes like fly ash & slag from thermal power plant and steel industry resulting environmental protection and conservation of key resources
  - ❑ Conservation of Limestone & coal
  - ❑ Reduction of Absolute GHG emissions from calcinations
  - ❑ Reducing the power demand for the industry bridging the gap between the supply and demand
- Conversion of inefficient semi dry and wet process kiln into modern dry calciner kilns with latest technology
- Several Energy conservation initiative reducing the specific power consumption from 120 kWh to 82 kWh per MT of cement and thermal energy consumption from over 800 kcal / kg clinker to 743 kcal / kg clinker.

Greenhouse Gas Emission Inventorization in Indian Cement Industry

Greenhouse Gas Emission Inventorization study at a cement manufacturing facility / company involves the following procedure:

1. Identification of Emission sources
2. Classification of Emission sources as per the Scope 1,2 &3
3. Identification & collection of various inputs / data(s) required for calculation of Emission sources
4. Utilizing GHG tool for arriving at the emission level using the above data

Identification of Emission sources & classification

The various sources / activities that result in the emission of GHG's are:

a. Calcination (Conversion of $CaCO_3$ in the limestone to CaO and CO_2 (Scope 1)

b. Burning of fossil fuel in the kiln and calciner (Scope 1)

c. Burning of fuel in the captive power plant (Thermal or Diesel Generator sets) (Scope 1)

d. Consumption of electricity produced externally for manufacturing cement (Scope 2)

e. Transportation of raw material / finished products (Scope 1 if the vehicles are owned by the company / Scope 3 if they belong to contractor

An exhaustive list of all possible sources of GHG's in the cement manufacturing process with classification of scope is given in Annexure.

Identification & Collection of data

The various inputs / data required for estimating the Green House Gases that are released from the sources identified above are given in the annexure

For example, to calculate the emission due to calcination, the following data is needed:

a. Quantity of Clinker produced in Metric Tonnes per Annum

b. CaO content in the clinker in %

c. Quantity of Non Carbonate materials added to clinker (like fly ash , Ash from coal etc.,) in Metric Tonnes per Annum

d. CaO content in the non carbonate raw materials in %

Most of the data required is readily available from the Indian cement industry , as the majority of the plants have Quality Management systems like ISO 9001 /ISO 14001 and keep track of these data is all forms (soft / hard). However data like Employee commute, Business travel require some standardization as they are less monitored as on date / are available in segregated manner.

Current Emission Level

A detailed and procedural methodology was adopted for establishing the average greenhouse gas emission levels in the Indian cement industry. Basic data like Production level, Energy consumption (both thermal and electrical) of major cement producers in the country were collected from their annual reports. A sample emission estimation procedure is enclosed as Annexure 3 to calculate the existing emission level and to identify the reduction potential.

This greenhouse gas emission level assessment study included three major players - The ACC Ltd, Gujarat Ambuja Cements Limited & Grasim Industries (including Grasim cements + Ultra tech cements) which have produced 12%, 10% & 18% respectively in the country's overall cement production for the year 2008-09; and 17 other plants wherein GHG emission Inventorization was carried out by CII-Godrej GBC.

The 17 cement manufacturing facilities covered as part of CII studies are grouped under three categories as follows:

Details of plants covered under CII GHG Emission Inventorization activity

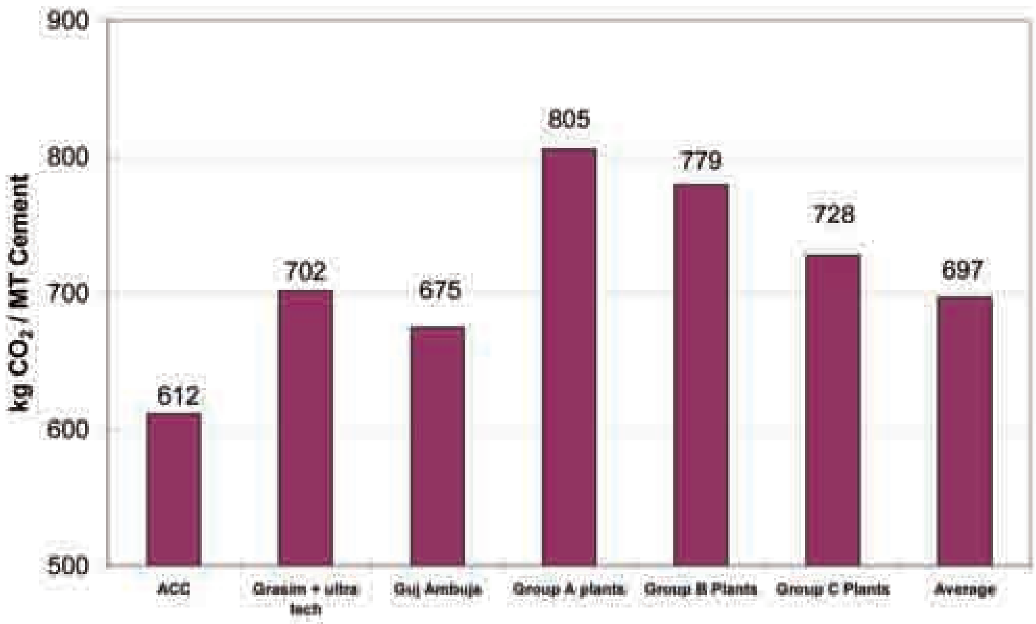
Details of plants covered under CII GHG Emission Inventorization activity					
Sl no	Group	Plant capacity	No of cement plants	Group Cement production, Mn MTPA	Share of Country's production
1	A	< 1.5 Mn MTPA	6	6.04	3.3
2	B	1.5-3.0 Mn MTPA	6	10.25	5.6
3	C	>3.0 Mn MTPA	5	17.05	9.4
Total			**17**	**33.34**	**18.4**

The combined market share of these three major groups (ACC, Ambuja & Grasim) and 17 plants exceeds 58 % of the total cement market in India. The performance of the other players has also been reviewed to analyze the present operating practices and to estimate the overall GHG emission reduction potential in this sector.

The estimated average specific emission factor (for Scope 1 & 2) for all the cement manufacturing facilities under study for the year 2008-09 is about 934 kg CO_2 per MT of clinker and 697 kg CO_2 per MT cement.

Specific Emission factors of various major players are given in the following table:

Specific Emission Factors for Cement Plants covered under study in India in 2008-09							
Group	ACC	Grasim & Ultra tech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	Average
Specific Emission factor, kg CO_2 /MT Cement	612	702	675	805	779	728	697



The variation in the emission ranging from 612 kg CO_2 to 964 kg CO_2 (plant to plant basis) is about 58 % with respect to minimum level.

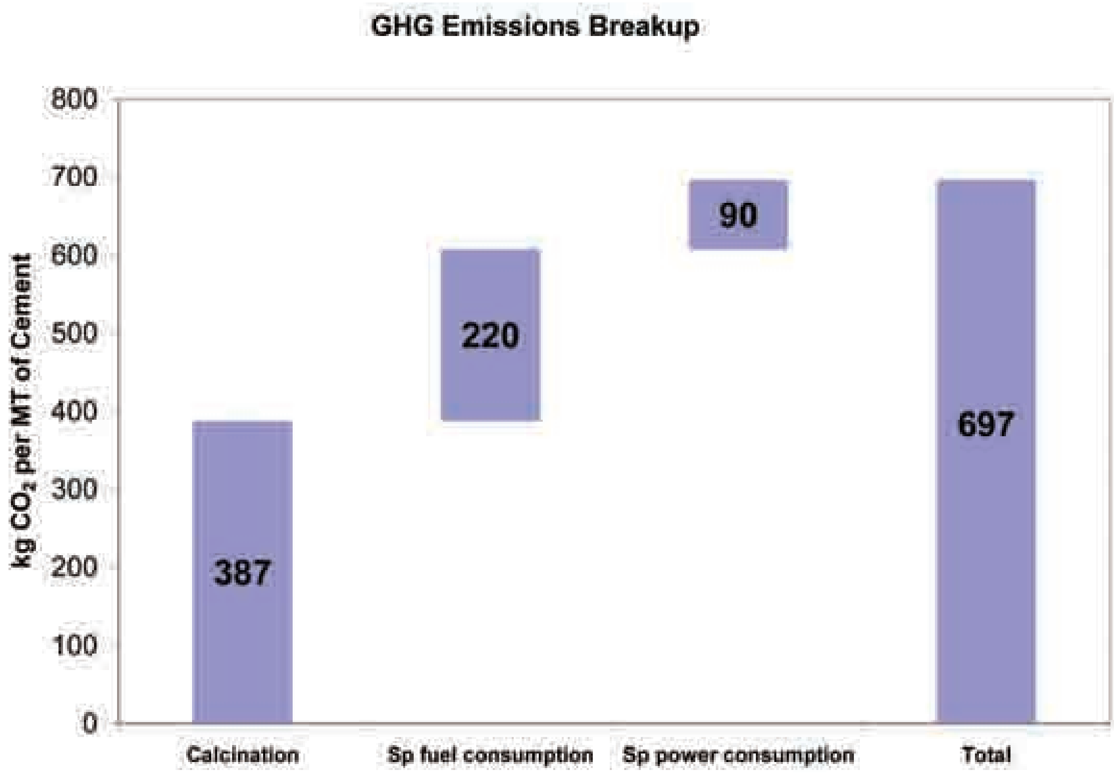
The variation can be attributed to the following factors

1. Difference in levels of Blended cement production where in clinker is partly substituted by fly ash / slag - one of the group produces 9% blended cement whereas one another group produces as high as 100 % blended cement in their overall cement production.
2. Differences in additive percentages in blended cements ranging from 15 % of fly ash addition in fly ash based Portland Pozzolona Cement (PPC) to 60 % blast furnace slag in Portland Slag Cement (PSC)
3. Specific electrical and thermal energy consumption levels depending on the type of technology adopted, operating efficiency and the share of blended cements over total cement production.
4. The variation in between major and minor consumer in electrical energy varying from 67 kWh /MT cement to 130 kWh /MT cement and thermal energy from 711 kcal / kg clinker to 864 kcal / kg clinker

Scope 1 & 2 emissions can be further divided according to the source as

- Emissions from the process (Calcination) accounts for 387 kg CO_2 per MT of cement (56%)
- Emissions from fuel consumption (thermal energy consumption) accounts for 220 kg CO_2 per MT of cement (31%)
- Emissions from power consumption accounts for 90 kg CO_2 per MT of cement (13%)

It can be seen that the major source of GHG emission is by calcination 56% of total 697 kg CO_2 / MT Cement, followed by 31 % contribution from fuel used for meeting the thermal energy requirement of the process followed by 13% contribution from electrical energy requirement of the process.


GHG Emissions Breakup
kg CO_2 per MT of Cement
800
700
600
500
400
300
200
100
0
387
220
90
697
Calcination
Sp fuel consumption
Sp power consumption
Total

Low Carbon Growth in Indian Cement Industry

The Government of India has recently announced its voluntary emission intensity reduction target. India has ommitted to reduce its greenhouse gas emission intensity by 20-25% of 2005 levels by 2020.

Some of the other fast growing economies such as China (40% reduction in emission intensity of 2005 levels by 2020), Brazil (15-18% reduction over 2005 levels by 2020) and South Africa (34% emission reduction over 2005 levels by 2020) have also announced their emission reduction targets.

To meet the targets set by the Govt of India, it becomes imperative for all segments of the economy to independently strive to reduce their emissions and help the nation meet its commitments. Cement industry in India, being a responsible and a mature industry, would certainly have to play its part in helping the country meet its obligations.

Indian Cement industry, in spite of being advanced as far as energy efficiency and productivity measures are concerned, still has avenues for reducing its GHG emissions. Some of the major areas which could offer significant GHG emission reduction opportunities are:

1. Generation and Utilization of Power from Waste heat Recovery
2. Use of alternate fuels & Bio mass
3. Improving energy efficiency & Increasing blended cement portion
   a. Increasing the Blended Cement portion further
   b. Increasing the Percentage of Additives in Blended Cement
   c. Further improvements in Electrical energy consumption
   d. Further improvements in Thermal energy consumption
   e. Producing Composite cement
4. Producing limestone based Cement / Low grade cement
5. Transport logistics

Generation and Utilization of Power from Waste heat Recovery

Out of 400 - 500 MW[20] potential available from Waste Heat Recovery, only about 30 MW in 5 installations has been tapped as of now. This indicates the huge opportunity for adoption of waste heat recovery in Indian cement industry. While the technology of waste heat recovery systems are accepted by the Indian cement manufacturers, the predominant reason for such low adoption has been the cost of technology and lack of attractive financial mechanisms.

Almost all the cement manufacturers in the country have captive power plants to meet their power demand. The reason for captive power generation is to lower the cost of power generation. Installing

[20] Manual on Waste Heat Recovery in Indian Cement Industry, CII, 2009

captive power plants would cost the cement manufacturers about Rs 40 Million per MW. On the other hand, installing WHR systems is costing the manufacturers about Rs 70 Million to Rs 80 Million per MW depending on the type of technology adopted and the WHR potential. This high initial investment is deterring manufacturers from adopting waste heat recovery systems.

However, with increasing number of installations, higher energy costs, supplemental income through Clean Development Mechanism (CDM) and reducing equipment cost, the number of WHR installations in India is on an increasing trend. 90 MW of WHR plants are coming up shortly in the Indian cement industry and it is anticipated that the entire WHR potential will be tapped over the next 8 – 10 years.

The generation of 300 MW of electricity through WHR I the Indian cement industry will result in annual greenhouse gas emission reduction of about 14.5 kg CO_2 /MT cement. Every unit of power generated through Waste heat recovery technology will result in 0.8 – 1.3 kg CO_2 reduction in emissions.

Use of alternate fuels & Bio mass

Exchange of industrial wastes like waste carbon from pharmaceutical industries, paint sludge from Automobile industries, utilization of used tires and municipal waste in cement industry for producing clinker replacing coal is another high potential area of interest in the Indian Cement industry.

Currently thermal energy consumption accounts for 31 % of the GHG emissions. Even if efforts are taken to replace the conventional fossil fuel with any of the wastes or alternate fuel by at least 10 %, this will result in reducing the emissions by about 22 kg CO_2 /MT cement

Improper collection and segregation systems, absence of any credits / enabling policies for using wastes / lternate uels in cement kiln and lack of awareness are some of the areas of concern the Indian cement industry is facing today in widespread adoption of alternate fuels in cement manufacturing.

Alternate Fuels / Biomass utilization for thermal substitution could be a major area where Indian cement industry is far behind its European / Japanese counterparts. Some of the European countries have a thermal substitution rate as high as about 40%[21] in their cement manufacturing facilities. Japanese cement industry, for example, utilizes about 450 kg of waste / ton of cement produced.

CII's estimates indicate that the Thermal substitution in Indian cement industry is about 2%. India still has a long way to go in ensuring greater thermal substitution, resulting in fossil fuel and GHG emission reduction.

Improving energy efficiency & Increasing blended cement portion

Increasing the Blended Cement portion further

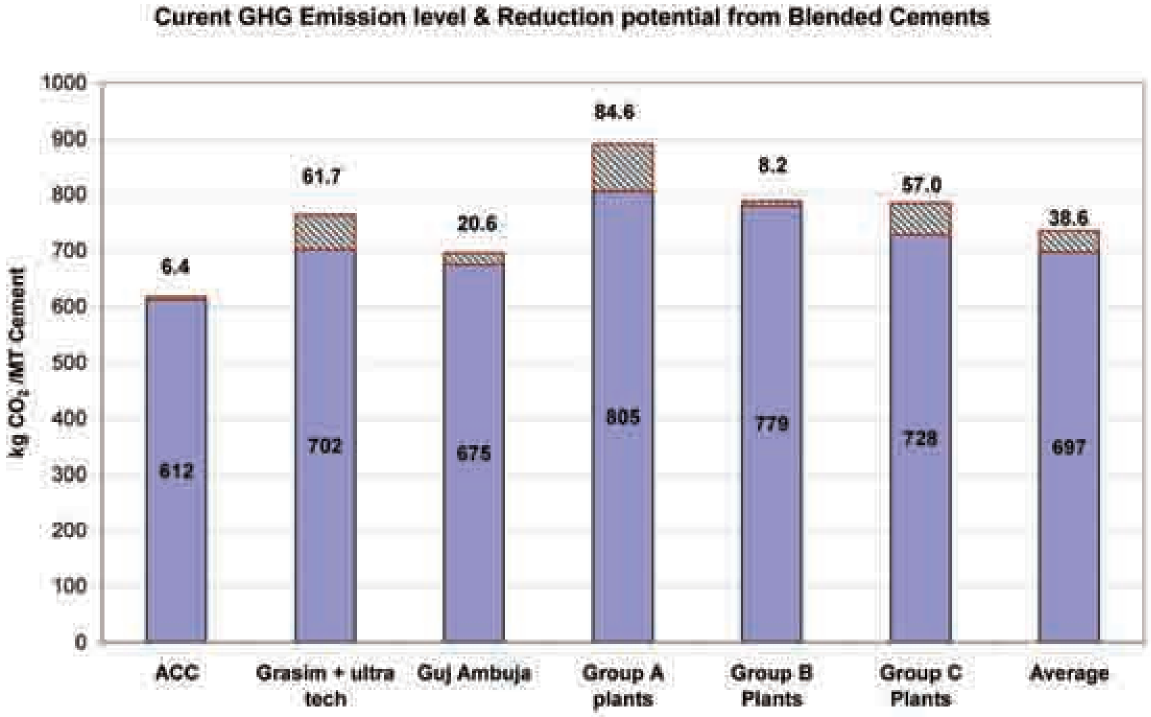
Replacing the clinker with additive materials like fly ash / blast furnace slag not only reduces the power consumption, protects the environment, conserve the limestone and coal but also reduces the amount of GHG emission to a larger extent.

Indian Cement Industry, having realized these multiple benefits associated with the production of blended cement, has increased the blended cement portion by 40% over the past two decades. The present manufacture of blended cement in India is about 74%. This offers significant potential for increasing the share of blended cement in the overall cement manufacture in the country. Availability of blending material would not be a major area of concern presently, considering huge quantities of fly ash already accumulated over last several years, present generation from the existing power plants and expected addition of newer power plants.

[21] Perspectives and limits for cement kilns as a destination for RDF, Elsvier

The following table gives the extent to which the cement industries under study produce blended cement in their production levels. It also provides the GHG emission reduction potential that exists if the blended cements levels are increased to 90% from the existing levels.

Blended Cement Production Percentage in Cement plants for the year 2008-09							
Group	ACC	Grasim & Ultratech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	average
% Blended Cement production	89.6	64.3	83.0	51.4	86.5	66.3	74.5
Current emission levels, kg CO_2 /MT Cement	612	702	675	805	779	728	697
GHG reduction potential in kg CO_2/ MT Cement by increasing Blended cement to 90 %	8.2	61.7	20.6	84.6	8.2	57.0	38.9



The graph displayed above gives the current emission level of the major companies out of their total cement production and further CO_2 reduction potential in kg CO_2 /MT cement that exists in these groups by further increasing the blended cement portion alone keeping other parameters like Electrical Energy Consumption, Thermal energy consumption, Percentage addition of additives like fly ash, slag in blended cement as constant.

For every 1% of increase in Blended cement production, CO_2 emission will be reduced by approximately 2.2 – 6.0 kg per MT of cement keeping all other parameters constant.

Educating the customers, clear policy from the Government, clear and complete understanding of the advantages of blended cement over Ordinary Portland cement are required for achieving this level.

Increasing the Percentage of Additives in Blended Cement

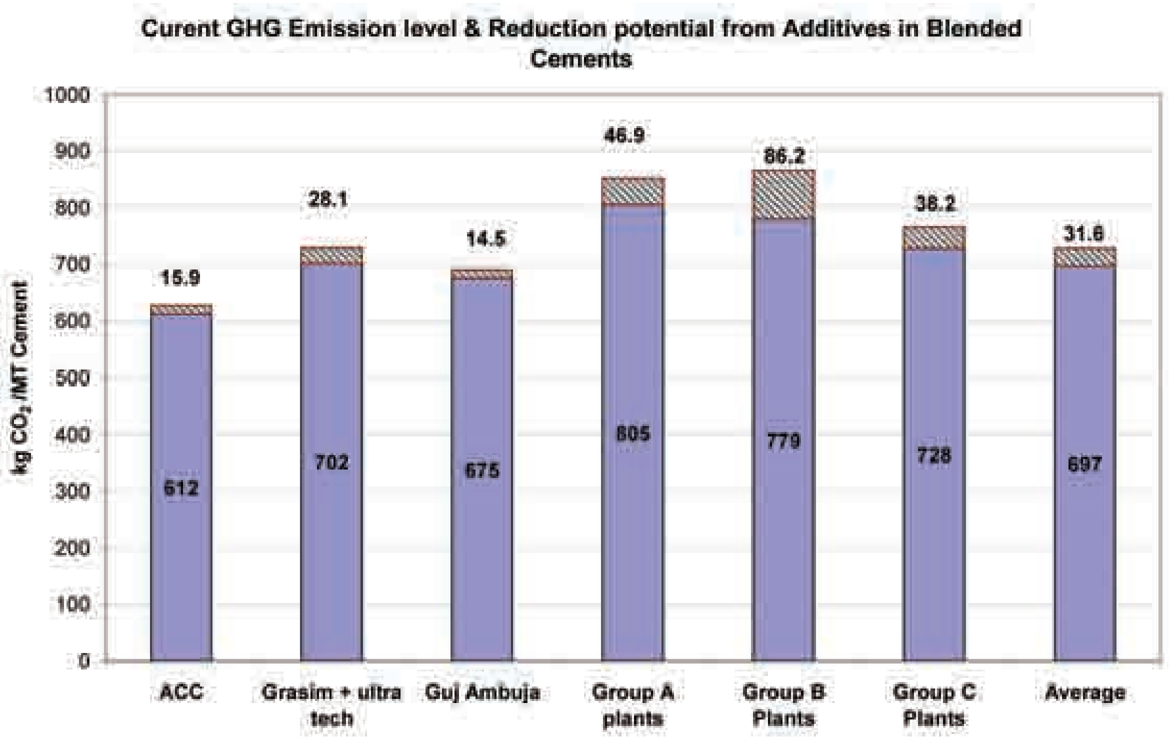
Bureau of Indian Standards (BIS), as per the latest types of specifications of blended cements allows addition of maximum 35 % of fly ash in PPC (Portland Pozzolona Cement) and blast furnace slag to a maximum of 65% in (PSC) Portland Slag Cement subject to meeting other quality requirements such as setting time, compressive strength etc.,

Currently the fly ash addition in PPC varies between 15% and 32% with an average of 28% (for the plants considered for the study) as against the maximum allowed norm of 35%.

With complete consumption of slag produced in the country for the manufacture of slag cement, non utilization of fly ash generated in the thermal power plants the potential exists at least in PPC by increasing the levels of fly ash addition there by reducing the GHG emissions.

The following table and graph presents the data on levels of fly ash addition in PPC by cement companies and reduction potential of CO_2 emissions of 33.0 kg CO_2 /MT cement that can be achieved by increasing the fly ash in PPC to 32%.

Percentage Fly ash addition in PPC (Portland Pozzolona Cement) Production for the year 2008-09							
Group	ACC	Grasim & Ultratech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	average
% fly ash in Blended Cement(PPC) production	29.6	26.8	30.2	22.4	22.9	25.8	27.3
Current emission levels, kg CO_2 /MT Cement	612	702	675	805	779	728	697
GHG reduction potential in kg / MT Cement by increasing fly ash % to 32%	15.9	28.1	14.5	46.9	86.2	38.2	31.6



The graph displayed above gives the current emission level of the major companies and CO_2 reduction potential in kg CO_2 /MT cement that exists in these groups by further increasing the additives in the blended cement portion alone keeping other parameters like Electrical Energy Consumption, Thermal energy consumption , Percentage addition of additives like fly ash , slag in blended cement as constant.

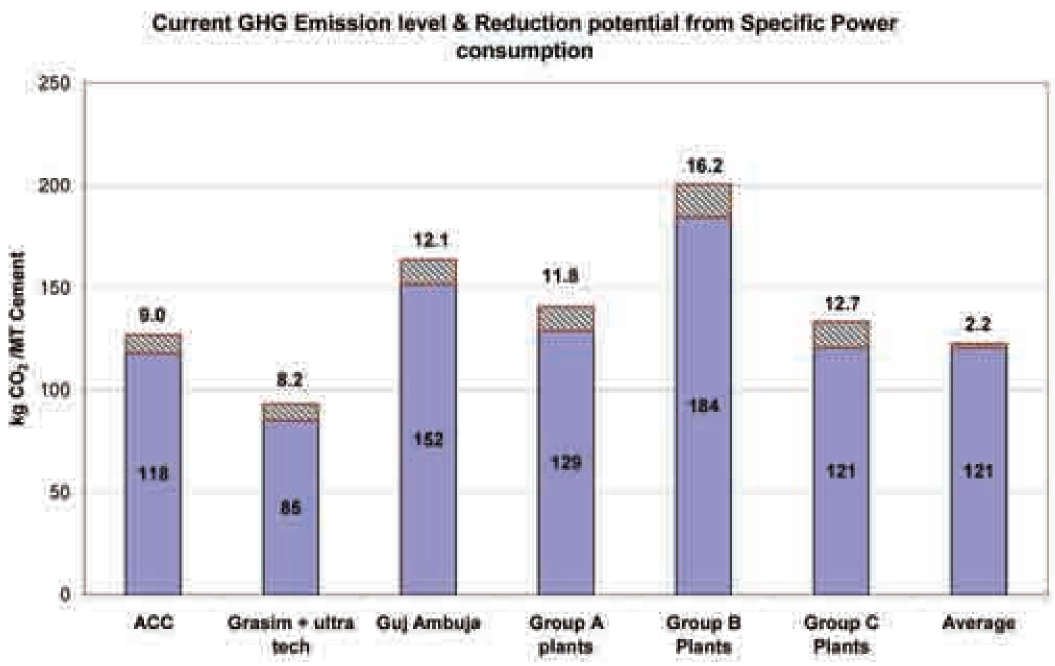
For every 1% of increase in additives in Blended cement production, CO_2 emission will be reduced by approximately 4.0 – 6.5 kg per MT of cement keeping all other parameters constant.

3 c) Further improvements in Electrical & Thermal energy consumption

Adopting the latest technologies, actively participating in the energy conservation activities and implementing the projects will result in further reduction of specific power and thermal energy consumption of Indian cement industry.

Reducing the electrical energy consumption level by 10 kW /MT of cement and 5 kcal / kg clinker from the existing level provides scope for further reduction in GHG emissions to the tune of 3.7 kg CO_2 / MT cement.

Electrical Energy Consumption Levels & GHG Reduction potential 2008-09							
Group	ACC	Grasim & Ultratech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	Average
Power consumption kW/MT Cement	85.0	81.1	86.4	90.7	85.7	73.8	82.7
Power component of current GHG emissions kg CO_2/MT cement	118	85	152	129	184	121	121
GHG reduction potential in kg CO_2 / MT Cement by reducing 10 kW /MT cement	9.0	8.2	12.1	11.8	16.2	12.7	2.2

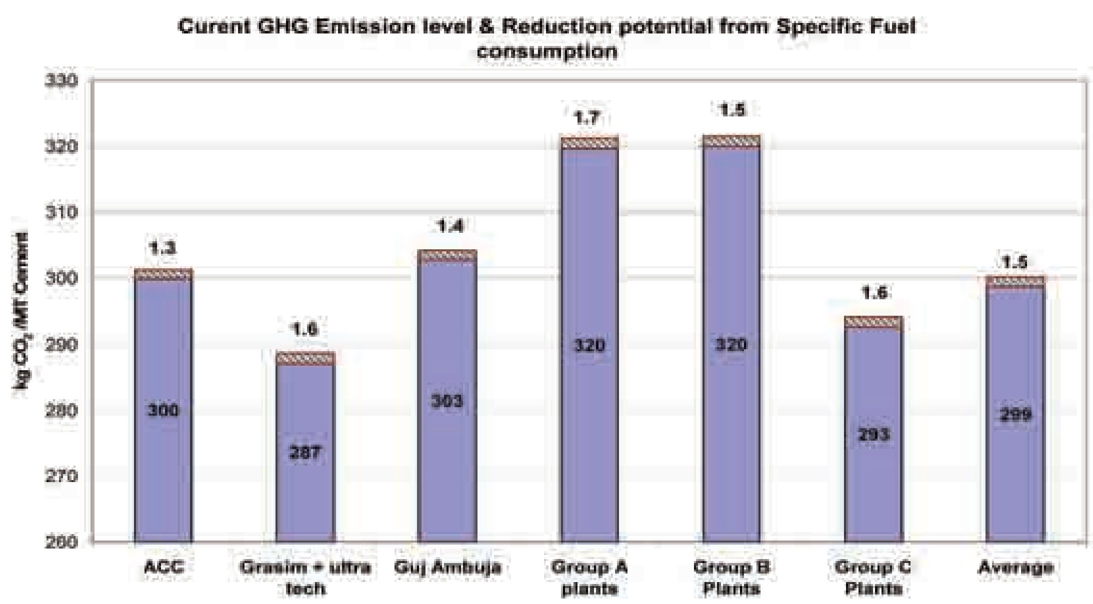


The graph shown above gives the GHG emissions due to specific power consumption / Electrical energy requirement to produce one MT of cement in each of the major cement producers in the country.

It also gives the CO_2 reduction potential in kg CO_2 /MT cement by reducing this electrical energy consumption from current value by 10 kW / MT cement keeping all other parameters like thermal energy consumption, portion of blended cement in overall cement and additives in blended cement.

For every 1 kW /MT of cement reduction in specific power consumption, CO_2 emission will be reduced by approximately 0.9 – 1.6 kg CO_2 per MT of cement.

Thermal Energy Consumption Levels & GHG Reduction potential 2008-09							
Group	ACC	Grasim & Ultratech	Gujarat Ambuja	Group A Plants	Group B Plants	Group C Plants	average
Thermal Energy consumption kcal / kg clinker	746	716	755	795	796	728	743
Fuel component of current GHG emissions kg CO_2/MT cement	300	287	303	320	320	293	299
GHG reduction potential in kg CO_2 / MT Cement by reducing 5 kcal / kg clinker	1.3	1.6	1.4	1.7	1.5	1.6	1.5



The graph shown above gives the current GHG emissions due to specific fuel consumption / thermal energy requirement to produce one kilogram of clinker in each of the major cement producers in the country.

It also gives the CO_2 reduction potential in kg CO_2 /MT cement by reducing this thermal energy consumption from current value by 5 kcal / kg clinker keeping all other parameters like thermal energy consumption, portion of blended cement in overall cement and additives in blended cement.

For every 10 kcal / kg clinker reduction in specific heat consumption, CO_2 emission will be Reduced by approximately 2.6 – 3.6 kg per MT cement.

3 d) Producing Composite cement

One of the latest trend & recent development in the cement industry is to produce composite cement where in clinker is replaced with both blast furnace slag and pozzolonic material like fly ash.

Composite cement will have the best properties of cement like low heat of hydration, resistance against chemical attack with the equivalent strength portion. Producing composite cement ensures reduction in specific energy consumption, complete utilization of waste and conservation of limestone and hence green house gas emission reduction. Composite cement can have the highest cement to clinker ratio as high as 3.33 as the cement can be made from 30 % clinker. Currently there is no quality standard for producing such type of cement in India.

EN 197 - 1: 2000 cement type V has two composite cements with the following cement composition comprising higher percentages of blast furnace slag and pozzolana or fly ash[22]

Composition of composite cements under EN 197 - 1 : 2000[22]					
Cement	Cement notation	Clinker content %	Blast furnace slag %	Pozzolana / Fly ash %	Gypsum %
Composite cement	CEM VA	40-64	18-30	18-30	0-5
Composite cement	CEM VB	20-39	31-50	31-50	0-5

4. Producing limestone based Cement / Low grade cement

Bureau of Indian Standards (BIS) which controls the standards for various types of cements produced in the country, has allowed up to 5 % of limestone / slag / similar material addition in cement as on date.

Presently many of the cement plants are not adding the filler due to more focus higher one day strength requirements to maintain competition. Concentrating on one day strength does not improve quality of construction as a whole and results in higher specific power consumption and reduces the additives.

General awareness is to be created among the all stake holders for better and durable cement quality instead of concentrating only on initial strength.

Considering the fact that normal house hold constructions do not require high grade cement, Existence of similar products in other countries, greater potential in reducing the power demand, fuel consumption and GHG emissions, consumption of low grade limestone and conservation of high grade limestone promoting limestone based Cement (up to addition of 20 %) will result in huge potential in GHG emissions.

Increasing the addition of limestone in OPC as filler from the existing level by 10% will result in GHG reduction of 25.0 kg CO_2 /MT cement

[22] http://www.cnci.org.za/inf/publication_pdf/cement.pdf

5. Transport logistics

Reducing transport emissions by locating the grinding plant nearer to the fly ash / slag source, bulk packing instead of retail packing, bulk transport through bulk tankers and rail instead of smaller size lorries and back haulage for cement dispatch and raw material receipt are some other smaller initiatives that can be adopted to reduce the GHG emissions by 0.5 kg CO_2 /MT cement

It can be noted that Road transport releases 2.5 times the GHG emission than rail per MT of material transported for the same distance because of the bulk transport, better

CO_2 emissions reduction targets by various cement manufacturing groups:

By 2010

- Holcim: 20% reduction in specific CO_2 emissions*
- Lafarge: 20% reduction in specific CO_2 emissions*
- Heidelberg Cement: 15% reduction in specific CO_2 emissions*
- Titan: 15% reduction in specific CO_2 emissions*
- Taiheiyo: 3% reduction in specific CO_2 emissions from 2000 baseline
- Siam Cement Group: reduction to 670 kg/ton cementitious product

By 2012

- Votorantim: 10% reduction in specific CO_2 emissions*
- Italcementi: reduction to 690 kg/ton cementitious product

By 2015

- CEMEX: 25% reduction in specific CO_2 emissions*
- CRH: 15% reduction in specific CO_2 emissions*

*from 1990 baseline

Overall reduction potential

In line with the Government of India's voluntary commitment to reduce the country's emissions by 20-25% of 2005 levels by 2020, it is necessary for cement industry to take proactive measures and reduce its emission intensity by at least 20% to help the nation meet its obligations.

Based on the present average greenhouse gas emissions of the cement manufacturing facilities under study, the industry should reduce its emissions from the present average of 697 kg CO_2/Ton of cement to about 560 kg CO_2/Ton of Cement for achieving a 20% reducing in emission intensity. This calls for about 137 kg CO_2 reduction / ton of cement across the sector.

Some of the major areas which could offer significant GHG emission reduction opportunities are:

1. Generation and Utilization of Power from Waste heat Recovery
2. Use of alternate fuels & Bio mass
3. Improving energy efficiency & Increasing blended cement portion
    a. Increasing the Blended Cement portion further
    b. Increasing the Percentage of Additives in Blended Cement
    c. Further improvements in Electrical energy consumption
    d. Further improvements in Thermal energy consumption
    e. Producing Composite cement
4. Producing limestone based Cement / Low grade cement
5. Transport logistics

The summary of the benefits achieved by adopting the above mentioned opportunities would result in overall GHG emission reduction of 141.3 kg CO_2 / MT cement

Identified GHG Emission Reduction Potentials in the Cement plants covered under study based on 2008-09 data to meet emission intensity reduction target of 20-25 % by 2020		
Sl no	Emission reduction potential	Reduction potential, kg CO_2 per MT of cement
1	Generating power by installing Waste Heat Recovery system up to the tune of 300 MW by 2020 across cement plants in the country	14.5
2	Replacing fossil fuels with alternate fuel (Industrial waste, MSW, etc) by at least 10% on thermal basis	22.0
3	Improving Energy Efficiency & Increasing Blended Cement	79.3
3(a)	Increasing the blended cement production to 90 % from the existing level of 74% – 38.9 kg CO_2 /MT cement	
3(b)	Increasing the additives (pozzulona) in blended cement production by 32% from the existing average of 27% – 33.0 kg CO_2 /MT cement	
3(c)	Reducing the electrical energy consumption by 10 kW /MT cement from the existing level – 2.2 kg CO_2 /MT cement	
3(d)	Reducing the thermal energy consumption by 5 kcal / kg clinker from the existing level – 1.5 kg CO_2 /MT cement	
3(e)	Producing composite cement with slag and fly ash - 1.6 kg CO_2 /MT cement	
7	Increasing the addition of limestone in OPC by 10%	25.0
8	Applying logistics like bulk packing, transport	0.5
	Overall reduction potential (kg CO_2 /MT Cement)	**141.3**

Stakeholder Engagement

Such large emission reduction targets need enabling ambience for Indian cement industry to operate. This target, though looks ambitious on paper, would be possible with greater stakeholder engagement, with clear and specific actions needed from various sources:

Government of India

Government of India, being one of the largest consumers of cement in its infrastructure projects, and in its support & guiding role has a major role to play:

Ministry of Power

The forthcoming Perform, Achieve & Trade (PAT) scheme of Bureau of Energy Efficiency (BEE), Ministry of Power (MoP) would serve as an excellent mechanism for Indian cement industry to reduce its energy intensity on a steady and consistent basis.

Some of the other areas for Ministry of Power to play a pivotal role:

- Creating enabling policies for increased adoption of WHR in Indian cement industry. The highlighted potential of 400-500 MW could serve as an excellent leverage in MoP's endeavour to reduce the fossil fuel based energy consumption in India

Ministry of Environment & Forest (MoEF)

MoEF has a major role to play in helping the Indian cement industry achieve its low carbon growth targets. Some of the areas of imminent importance are:

- Creating enabling policies for increased waste utilization in the Indian cement industry by prompting 'Polluter Pays' concept.
- Facilitating increased use of urban & municipal solid waste in the cement industry with synergy at state, city & municipality levels, Central & State Pollution Control Boards with the cement industry
- Creating suitable mechanism & policies for increased manufacture and use of blended cement

Government of India, as a major user of cement

Government of India, as a major user of cement has a very responsible role in enabling low carbon growth of Indian cement industry. Some of the initiatives which could create a significant impact in this endeavour are:

- Increased use of blended cement in infrastructure projects
- Creating awareness among key consumers within the Government of India such as Central Public Works Department (CPWD), several state Public Works Departments (PWD), Ministry of Housing, etc on increased use of blended cement and its advantages to the construction / infrastructure and the benefits to the Indian cement industry and country at large.

Other Key Stakeholders

Industry Associations

Industry associations such as Cement Manufacturers Association (CMA) and Confederation of Indian Industry (CII), etc have a major role in creating awareness among the consumer, government and the industry for right selection of appropriate cement for the each application based on the demands (for example low grade, low fineness & blended cement for house hold construction and special cements only for required applications)

Research & Development Organizations

R & D organizations such as National Council for Cement & Building Materials (NCCBM) should strive to develop and encourage wide adoption of newer types of cement such as Composite Cement, Masonry Cement etc which could play a major role in Indian cement industry's low carbon growth. Close association and working between NCCBM, CMA & Bureau of Indian Standards (BIS) could go a long way in this direction.

Other major area of work for R & D Institutions and Industry associations is to help promote carbon sequestration technologies such as Algae or Calera technologies in India. These technologies, though looks futuristic today, are soon becoming a reality at commercial scale in other countries and would be a certain area of interest for Indian cement industry.

Summary

Indian economy is on a high growth path and will grow further considering the increased infrastructure plans and rapid economic development. India is currently ranked fourth in terms of Gross domestic product based on Purchasing Power Parity, ranked only next to the United States, China & Japan.

While India's GDP presents a sanguine figure of 7.2%, several economic sectors have been growing at a much rapid pace. These growth estimates are certainly a encouraging and elevating, but would also create an increased strain on the ecology. As per the 2006 Integrated Energy Policy report submitted to the Planning Commission, India needs to sustain an 8 to 10% economic growth rate, over the next 25 years, if it is to eradicate poverty and meet its human development goals. Consequently, the country needed at the very least to increase its primary energy supply three or four -fold over the 2003-04 level. This accelerated pace of economic growth will certainly result in increased energy and water consumption, higher greenhouse gas emission levels and increased waste generation.

The pertinent need of the hour therefore, is to 'Promote and champion conservation of natural resources in industry, without compromising on high and accelerated growth'. Towards this objective, CII – Sohrabji Godrej Green Business Centre (CII – Godrej GBC) has been promoting ecologically sustainable business growth in Indian industry by implementing an initiative titled the "Mission on Sustainable Growth" (MSG).

To facilitate the Indian Industry adopt ecologically sustainable growth, CII in 2008 developed a report on 'Building a low carbon Indian economy'. This report outlines the technologies, practices and policies required for Indias leapfrog to a low carbon economy.

Cement industry is one of the major industries releasing appreciable quantity of Green House Gases with one of major source being the process emission (calcination) itself .The present contribution of GHG emissions from the industry is approximately 8 % of the total national emissions.

The Government of India has recently announced its voluntary target of reducing its greenhouse gas emission intensity reduction by 20-25% of 2005 levels by 2020. To meet the targets set by the Govt of India, it becomes imperative for all segments of the economy to independently strive to reduce their emissions and help the nation meet its commitments. Cement industry in India, being a responsible and a mature industry, would certainly have to play its part in helping the country meet its obligations.

This report is an effort to create a roadmap for Indian cement industry to achieve its target of 20% reduction in its Greenhouse gas emission intensity, from the present average levels of 697 kg CO_2 / ton of cement to 560 kg CO_2 / ton of cement.

Some of the major areas which could offer significant GHG emission reduction opportunities are:

1. Generation and Utilization of Power from Waste heat Recovery
2. Use of alternate fuels & Bio mass
3. Improving energy efficiency & Increasing blended cement portion
    a) Increasing the Blended Cement portion further
    b) Increasing the Percentage of Additives in Blended Cement
    c) Further improvements in Electrical energy consumption

d) Further improvements in Thermal energy consumption

e) Producing Composite cement

4. Producing limestone based Cement / Low grade cement

5. Transport logistics

The summary of the emission reduction oppritunities are as under:

Identified GHG Emission Reduction Potentials in the Cement plants covered under study based on 2008-09 data to meet emission intensity reduction target of 20-25 % by 2020		
Sl no	Emission reduction potential	Reduction potential, kg CO_2 per MT of cement
1	Generating power by installing Waste Heat Recovery system up to the tune of 300 MW by 2020 across cement plants in the country	14.5
2	Replacing fossil fuels with alternate fuel (Industrial waste, MSW, etc) by at least 10% on thermal basis	22.0
3	Improving Energy Efficiency & Increasing Blended Cement	79.3
3(a)	Increasing the blended cement production to 90 % from the existing level of 74% – 38.9 kg CO_2 /MT cement	
3(b)	Increasing the additives (pozzulona) in blended cement production by 32% from the existing average of 27% – 33.0 kg CO_2 /MT cement	
3(c)	Reducing the electrical energy consumption by 10 kW /MT cement from the existing level – 2.2 kg CO_2 /MT cement	
3(d)	Reducing the thermal energy consumption by 5 kcal / kg clinker from the existing level – 1.5 kg CO_2 /MT cement	
3(e)	Producing composite cement with slag and fly ash - 1.6 kg CO_2 /MT cement	
7	Increasing the addition of limestone in OPC by 10%	25.0
8	Applying logistics like bulk packing, transport	0.5
	Overall reduction potential (kg CO_2 /MT Cement)	**141.3**

Indian cement industry has historically been a pioneer in the Indian industrial segment, leading the way in energy efficiency, productivity and technological avenues. This industry has the technical capability & mental maturity to achieve greater levels and lead the way for all other industrial sectors to follow.

Such large emission reduction targets need enabling ambience for Indian cement industry to operate. This target, though looks ambitious on paper, would be possible with greater stakeholder engagement, with clear and specific actions needed from various agencies

A combination of these efforts can make a significant impact in the GHG emissions of the overall cement industry and guide the Indian cement industry in its low carbon growth pursuit.

To conclude, this study thus indicates excellent potential for the Indian cement industry to reduce its GHG emissions by adopting both present and futuristic initiatives. As intended to be an objective of this report, this document would serve to be a reference point for initiating a series of steadfast efforts towards achieving the end objective.

Annexure

Annexure-1: GHG Emission Sources

The various emission sources are listed in the table below

Sl no	Source / Activity	Data required	Emission factor	Classification of source
1	Calcination	% CaO, MgO in clinker & ash, Clinker production,	kg CO_2 / MT clinker	Scope 1
2	Fuel burnt in kiln Coal, FO for light up, alternate fuel	Quantity of fuel, Net Calorific Value of fuel	kg CO_2 / GJ	Scope 1
3	Fuel burnt in power plant Coal, Diesel for light up, alternate fuel	Quantity of fuel, Net Calorific Value of fuel	kg CO_2 / GJ	Scope 1
4	Fuel used for blasting in mines, FO	Quantity of fuel used with Ammonium Nitrate	kg CO_2 / litre	Scope 1
5	Fuel used by company owned vehicles Diesel,Petrol	Quantity of fuel used	kg CO_2 / litre	Scope 1
6	Fuel used in canteen	Quantity of fuel used	kg CO_2 / litre	Scope 1
7	Fire extinguisher usage	Quantity of CO2 type fire extinguisher used	kg CO_2	Scope 1
8	Refrigeration and Air Conditioning	Quantity of refrigerant used for refill /makeup	GWP	Scope 1
9	Fuel used for emergency DG sets	Quantity of fuel used	kg CO_2 / litre	Scope 1
10	Fabrication	Quantity of acetylene cylinder used	kg CO_2 / kg acetylene	Scope 1
11	Electricity used from Grid	Quantity of units consumed	kg CO_2 / MW	Scope 2
12	Fuel used for transport of raw material through rail	Quantity of fuel, Type of fuel	kg CO_2 / litre	Scope 3
13	Fuel used for transport of raw material by contractors through road	Quantity of fuel	kg CO_2 / litre	Scope 3
14	Fuel used for transport of finished product through rail	Quantity of fuel, Type of fuel	kg CO_2 / litre	Scope 3
15	Fuel used for transport of finished product by contractors through road	Quantity of fuel	kg CO_2 / litre	Scope 3
16	Fuel used for employees for their transportation	Quantity of fuel		Scope 3
17	Fuel used for employees for business travel	Quantity of fuel	kg CO_2 / litre	Scope 3

Annexure-2: List of Energy Saving Projects

The list of energy saving projects, which can be implemented in different sections of a cement plant are listed below:

Mines and Crusher

Short-term

- Increase operating capacity of primary & secondary crusher
- Reduce idle run of crushers and belts
- Reduce idle operation of dust collection equipment

Long-term

- Install bulk analyser for crushed limestone

Raw mill grinding & storage

Short-term

- Avoid idle running of raw mill conveyor system (Auxillaries)
- Avoid idle operation of raw mill lubrication system
- Optimise starting & stopping sequence of raw mill (to minimise idle running of fans)
- Minimise false air entry in raw mill system

Medium-term

- Install variable louvre system for roller mill
- Install high efficiency dynamic separator for roller mills

Long-term

- Use vertical roller mill instead of ball mill
- Control raw meal feed size by installation of tertiary crusher
- Install belt and bucket elevator in place of pneumatic conveying
- Installation of efficient mill intervals – diaphragm and liners
- Install online X-Ray analyser for raw meal
- Install slip power recovery system / VFD for raw mill fan / ESP fan
- Install external mechanical recirculation system for roller mills and optimise air flow

Kiln, Pre-heater & cooler

Short-term

- Install CO and O2 analyser at kiln inlet and preheating outlet
- Maintain proper kiln seal (inlet and outlet) to avoid false air infiltration
- Reduce leakages in the preheater system
- Minimise primary air to kiln
- Utilise the cooler waste heat for flyash / slag / coal
- Install soft starters for clinker breaker

Medium-term

- Install VFD for cooler fans and cooler ID fans
- Optimise the cooler exhaust chimney height to reduce exhaust fan power
- Install water spray in cooler to minimise fan power consumption

Long-term
- Install system for firing waste tyre, bark, rice husk and urban waste in precalciner
- Conversion from pneumatic conveying of kilnfeed to mechanical mode
- Conversion from single channel to multichannel burners
- Replace planetary cooler with grate cooler
- Replace conventional coolers (planetary / grate) with high efficiency coolers

Coal yard & coal mill
- Elimination of spontaneous combustion, by proper stacking
- Avoid idle running of coal conveyor & crusher
- Optimise starting & stopping sequence of coal mill to reduce idle operation of fans
- Maintain higher residue for precalciner firing
- Increase residue of coal mix, if possible

Cement Grinding, Storage & Packing

Short-term
- Water spraying on the clinker at cooler outlet (Temp above 90oC, consumes more grinding energy)
- Reduce cement mil vents and recirculate to reduce cement loss
- Avoid idle running clinker conveyor – dust collector fan
- Avoid idle running of cement silo exhaust fans
- Optimise starting & stopping sequence of cement mill to avoid idle running
- Increase production of blended cement (PPC and PSC)
- Use of grinding aids
- Optimise water spray compressor capacity

Long-term
- Optimise cement grinding fineness - particle size analyser and optimise PSD
- Install belt conveyor / bucket elevator system instead of pneumatic conveying
- Installation of roller press / impact crusher / VRM as a pregrinder before the ball mill

Compressors & Compressed Air System

Short-term
- Eliminate compressor air leakages by a vigorous maintenance programme
- Maintain compressed air filters in good condition
- Install compressed air traps for receivers
- Optimise compressor discharge pressure

Medium-term
- Install screw compressors with VFD in place of old compressors
- Replace multiple small units with single larger units
- Install intermediate control system for compressed air systems

Electrical System

Short-term
- Avoid unnecessary lighting during day time
- Use energy efficient lighting
- Distribute load on transformer network in an optimum manner

- Improve power factor
  - Individual compensation
  - Group compensation
  - Centralised compensation
- Replace over sized motors
- Replace with energy efficient motors
- Use VFD for low / partial loads
- Convert delta to star connection for motors loaded below 50% of full load
- Install energy saver in fluorescent lighting circuit
- Fixing of light fixtures at optimum height
- Operate lighting system at lower voltage (say 360 V in 3 phase)
- Use servo stabliser in lighting circuits
- Replace conventional fluorescent tubes (40 W) with slim tubes (36 W)
- Optimise system operating voltage level

Medium-term

- Install demand controller for maximum utilisation of demand
- Use of electronic ballast in place of conventional chokes

DG Sets

Short-term

- Increase loading on DG sets
- Install VFD for cooling tower pumps and fans
- Convert electrical heating furnace to thermal heating

Long-term

- Install WHR system in DG set for preheating furnace oil
- Install vapour absorption refrigeration systems utilising DG jacket heat or exhaust heat

Newer technologies (Long-term)

- Install high efficiency cooler – CFG / CIS / SF across bar / Pyrostep / IKN pendulum
- Install low pressure drop cyclones for preheater
- Install latest high-level control systems for kiln, raw mill and cement mills
- Install WHR systems to recover heat from preheater and cooler exhaust

Annexure-3: GHG Emission estimation procedure (Sample Calculation):

1) Cement to Clinker factor :

Cement to clinker factor	:	Cement Production
		Clinker consumption
Cement to clinker factor	:	155.66
		117.58
	:	1.3239

2) Fly ash addition in PPC

Estimated by matching the cement to clinker factor actual as per step 1 and estimating by the following method

Overall Cement to clinker factor : Fppc X_{ppc} + F_{psc} X_{psc} + F_{opc} X_{opc}

F_{ppc} – Cement to clinker factor for PPC (based on gypsum, fly ash addition)

X_{ppc}- Percentage of PPC in overall cement

Assumptions :

1.0 Gypsum addition considered as 5%

2.0 % Filler addition in OPC considered as 2%

3.0 Slag addition in PSC considered as 50%

Data : PPC : 60.11% PBFS : 8.26 % OPC : 31.63 %

% Fly ash (y) =

1.3239 = 1 / {(0.6011 * (1-0.05-y)) + (0.0826* (1-0.05-0.50)) +

(0.3163*(1-0.05-0.02)}

Solving the above equation we get y = 0.2446 = 24.46%

3) GHG Estimation (Scope 1 & 2) :

a) Emissions due to calcination : 525 kg CO_2 / kg clinker (as per IPCC default value)

b) Emission due to fuel consumption in kiln :

Specific heat consumption x Emission factor
710 kcal / kg clinker x kg CO_2 / kcal
710 x 0.402 = 285. 2 kg CO_2 / kg clinker

c) Emission due to power consumption :

Specific power consumption x Emission factor
82 units / kW Cement x 0.9 kg CO_2 / kW
73.8 kg CO_2 / kg cement

d) Overall GHG emission

(Emission due to calcinations + emission due to fuel consumption)
+ Emission due to power consumption

$$= \frac{525}{1.3239} + \frac{285.2}{1.3239} + 73.8$$

$$= 396.6 + 215.4 + 73.8$$

= 685.8 kg CO_2 / Cement

4) GHG reduction potential

a) Increasing the portion of blended cement from (68% to 73%)

Cement to clinker factor

for 68% = $F_{ppc} X_{ppc} + F_{psc} X_{psc} + Fopc X_{OPC}$

= 1/ {(0.60*0.71)+(0.08*0.45)+(0.32*0.93)}

= 1.3239

Cement to clinker factor

for 73% = $F_{ppc} X_{ppc} + Fpsc X_{psc} + Fopc X_{opc}$

= 1/ {(0.65*0.71)+(0.08*0.45)+(0.27*0.93)}

= 1.3439

Reduction in GHG = 685.8 – (1.3239 * 685.8 / 1.3439)

= 10.2 kg CO_2 /Kg Cement

1% increase in PPC will reduce 2.04 kg CO_2 / Cement keeping all other parameters as constant.

b) Increasing the portion of fly ash in PPC cement (from 24% to 28%)

Cement to clinker factor

for 24% flyash = $F_{ppc} X_{ppc} + F_{psc} X_{psc} + F_{opc} X_{opc}$

= 1/ {(0.60*0.71)+(0.08*0.45)+(0.32*0.93)}

= 1.3239

Cement to clinker factor

for 28% fly ash = $F_{ppc} X_{ppc} + Fpsc X_{psc} + F_{opc} X_{opc}$

= 1/ {(0.60*0.67)+(0.08*0.45)+(0.32*0.93)}

= 1.3674

Reduction in GHG = 685.8 – (1.3239 * 685.8 / 1.3674)

= 21.8 kg CO_2 /Kg Cement

1% increase in fly ash in PPC will reduce 5.45 kg CO_2 / Cement keeping all other parameters as constant.

c) Reducing the specific power consumption by 5 kW / MT Cement

Reduction in GHG = kW / MT * kg CO_2 / kW

= 5 * 0.9

= 4.5 kg CO_2 /MT Cement

1 unit reduction in specific power consumption (kW /MT cement) will reduce 0.9 kg CO_2 / Cement keeping all other parameters as constant.

d) Reducing the specific thermal energy consumption by 10 kcal / kg clinker

Reduction in GHG = kcal / kg clinker * kg CO_2 / kcal * kg clinker/kg cement

= 10 * 0.402 / 1.3239

= 3.04 kg CO_2 /MT Cement

10 unit reduction in specific fuel consumption (kcal / kg clinker) will reduce 3.0 kg CO_2 / Cement keeping all other parameters as constant.

d) GHG emission reduction due energy efficiency and improving the blended cement portion

Reduction in GHG = Improving the blended cement portion from 68% to 73%, increasing the fly ash in PPC from 28% to 32%, reducing the specific power consumption by 5 kW / MT and reducing the specific heat consumption to 710 kcal / kg clinker

Cement to clinker Factor = 1/ {(0.65*0.67)+(0.08*0.45)+(0.27*0.90)

= 1.4083

Reduction in GHG = 685.8 – {(525+710*0.402)/1.4083 + 77*0.9}

= 685.8 – 644.8

= 41.0 kg CO_2 / MT Cement

= 41.0* 100/ 685.8

= 5.98%

e) Increasing the portion of composite cement

Cement to clinker factor for composite cement

= Slag 40%, fly ash 25% and gypsum 5%

= 1/ 0.30

= 3.333

Cement to clinker factor for 1% opc with composite cement = $1/ F_{ppc} \ X_{ppc} + F_{psc} X_{psc} + F_{opc} X_{opc} + FCC \ X_{cc}$

= 1/ {(0.60*0.71)+(0.08*0.45)+(0.31*0.93)

+ (0.01 * 0.30)}

= 1.3275

Reduction in GHG = 685.8 – (1.3239 * 685.8 / 1.3275)

= 1.86 kg CO_2 /Kg Cement

1% production of composite cement will reduce 1.86 kg CO_2 / Cement keeping all other parameters as constant.

g) Increasing the portion limestone (filler) in OPC from 2% to 10%

Cement to clinker factor = $1/ F_{ppc} \ X_{ppc} + F_{psc} X_{psc} + F_{opc} X_{opc}$

= 1/ {(0.60*0.71)+(0.08*0.45)+(0.32*0.85)}

= 1.3624

Reduction in GHG = 685.8 – (1.3239 * 685.8 / 1.3624)

= 19.4 kg CO_2 /Kg Cement

1% increase in limestone addition in opc will reduce 2.43 kg CO_2 / Cement keeping all other parameters as constant.

Annexure-4 : Leadership in building a Green Economy – CII's Climate Change Initiatives

CII activities ensure bringing climate change discussions from back room to board room.

- Advocacy
- Advisory Services
- Research
- Training/Capacity Building
- Publications

Advocacy

CII engages Indian Government both at the central and state level in climate change policy formulation

- Partnering government in devising mitigation and adaptation strategies to combat climate change
- Promoting Clean Coal technologies such as Carbon Capture and Use (for Methanol production/ Algae cultivation)
- Promoting renewable energy, energy efficiency technologies/approaches
- Spearheading Green Building movement in the country
- Working with State Governments to develop low carbon policies
- Developing green public procurement guidelines
- Devising strategies and an industry position for international climate change negotiations
- Devising Programmatic approaches and international partnerships towards Intensity reduction of GHG emissions through voluntary schemes

Advisory Services

CII renders services towards building a low-carbon economy

- Green Building Certification
- Energy Audits
- Energy Management Services
- Water Management Services
- Environment Management Services
- Handholding signatories of the CII Code for Ecologically Sustainable Business Growth
- Connecting green entrepreneurs to markets & finance
- GHG Emission Inventorization - base line development and target setting
- Green Audits

Research

CII conducts research on climate change mitigation, adaptation and economic & social impact analysis

- Estimating Carbon foot-prints of the States and recommending amendments in industrial policy to help reduce carbon emission
- Quantifying carbon reduction potential in the Indian industry through various voluntary/ mandatory approaches
- Study on 'Role of ICT in meeting the objectives of the NAPCC missions'
- 2nd National Communication on GHG Inventory from India to the UNFCCC - industrial processes & product use sector
- CDP Report with CDP-UK and WWF-India for the year 2007, 2008 and 2009 (in progress)

- Research study on 'Sustainability as a Driver for Innovation and Profit'
- Developing and administering green building rating systems to suit various types of buildings
- Developing manuals on global best practices in the energy sector

Training/Capacity Building

CII builds capacity within Industry to develop Low Carbon Growth Strategies

- Training & counseling services on Corporate Climate Change Strategies (3CS)
- Counseling services on sustainability-driven innovation for low-carbon inclusive growth
- Training on Green House Gas (GHG) emission inventory development

Publications

CII creates knowledge & information base on climate change

- Corporate GHG Inventory Program Guide
- CII Discussion Paper 'Building a low-carbon Indian Economy'
- Report on 'Energy Trading & Derivatives'
- Bi-monthly e-Newsletter titled 'Sustainability Outlook'
- Film on 'Climate Change and How it affects our Health'
- Report on 'India's Ecological Footprint- A Business Perspective'
- Manual on best practices in Indian & International Cement Plants
- National & International Best Practices Manual- Pulp & Paper Sector
- Manual on Waste Heat Recovery in Indian Cement Industry
- Case study booklets - Cement Industry, Ceramic & Fertilizer Industry
- Case study booklet on Renewable Energy
- Directory on Green Building Material & Service Providers
- Green Building Reference Guides - LEED-India for New Construction (NC) & Core & Shell (CS)
- IGBC Green Homes Rating System
- IGBC Green Factory Building Rating system

World class Energy Efficiency in Cement Industry

CII – Sohrabji Godrej Green Business Centre initiated a unique activity to facilitate emergence of 'World Class energy efficient cement plants by 2010'.

As part of this activity, detailed training programme, identification of energy efficiency projects and facilitation in implementation of energy efficiency projects identified, inter plant visits among the participating companies and visit to international Cement Plant s were organized. This entire activity is lead by a steering committee, chaired by Mr. G. Jayaraman, Executive President, Birla Corporation.

Note :

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About CII

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes.

CII is a non-government, not-for-profit, industry led and industry managed organisation, playing a proactive role in India's development process. Founded over 115 years ago, it is India's premier business association, with a direct membership of over 7800 organisations from the private as well as public sectors, including SMEs and MNCs, and an indirect membership of over 90,000 companies from around 396 national and regional sectoral associations.

CII catalyses change by working closely with government on policy issues, enhancing efficiency, competitiveness and expanding business opportunities for industry through a range of specialised services and global linkages. It also provides a platform for sectoral consensus building and networking. Major emphasis is laid on projecting a positive image of business, assisting industry to identify and execute corporate citizenship programmes. Partnerships with over 120 NGOs across the country carry forward our initiatives in integrated and inclusive development, which include health, education, livelihood, diversity management, skill development and water, to name a few.

Complementing this vision, CII's theme for 2009-10 is 'India@75: Economy, Infrastructure and Governance.' Within the overarching agenda to facilitate India's transformation into an economically vital, technologically innovative, socially and ethically vibrant global leader by year 2022, CII's focus this year is on revival of the Economy, fast tracking Infrastructure and improved Governance.

With 64 offices in India, 9 overseas in Australia, Austria, China, France, Germany, Japan, Singapore, UK, and USA, and institutional partnerships with 221 counterpart organisations in 90 countries, CII serves as a reference point for Indian industry and the international business community.

About CII-Godrej GBC

CII – Sohrabji Godrej Green Business Centre (CII – Godrej GBC), a division of Confederation of Indian Industry (CII) is India's premier developmental institution, offering advisory services to the industry on environmental aspects and works in the areas of Green Buildings, Energy Efficiency, Water Management, Renewable Energy, Green Business Incubation and Climate Change activities.

The Centre sensitises key stakeholders to embrace green practices and facilitates market transformation, paving way for India to become one of the global leaders in green businesses by 2015.

The centre is housed in a green building which received the prestigious LEED (Leadership in Energy and Environmental Design) Platinum rating in 2003. This was the first Platinum rated green building outside of U.S.A and the third in the world.

The centre was inaugurated by H.E Shri A P J Abdul Kalam, the then President of India, on July 14, 2004. CII-Sohrabji Godrej Green Business Centre is a unique and successful model of public-private partnership between the Government of Andhra Pradesh, Pirojsha Godrej Foundation and the Confederation of Indian Industry (CII), with the technical support of USAID.

Confederation of Indian Industry
CII-Sohrabji Godrej Green Business Centre

Survey No 64, Kothaguda Post, Hyderabad - 500 084
Tel: +91 40 23112971-73 Fax: +91 40 23112837
Email: kiran.ananth@cii.in / k.muralikrishnan@cii.in
Website: www.greenbusinesscentre.com / www.cii.in