

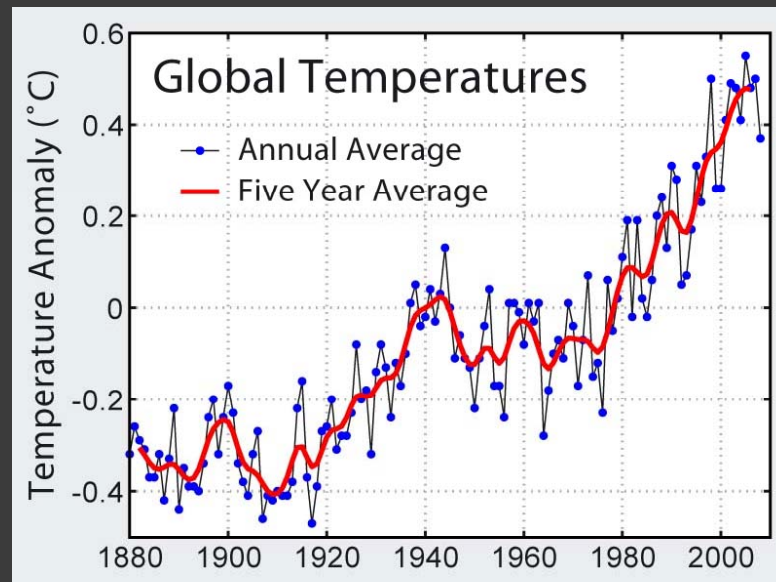
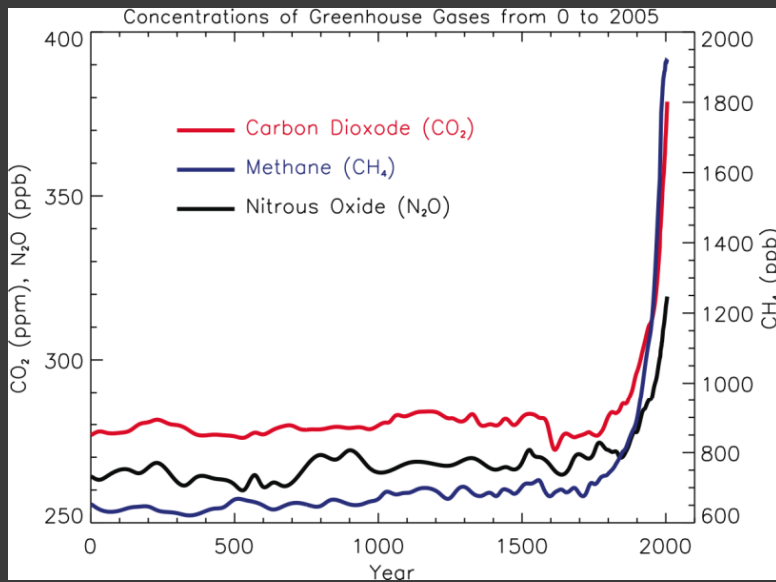
**Steel Industry in India: Potentials and
Technology for Reduction of CO2
Emissions,**

December 07, 2011 New Delhi

**CO2 REDUCTION
TECHNOLOGY:
INDIAN STEEL INDUSTRY**

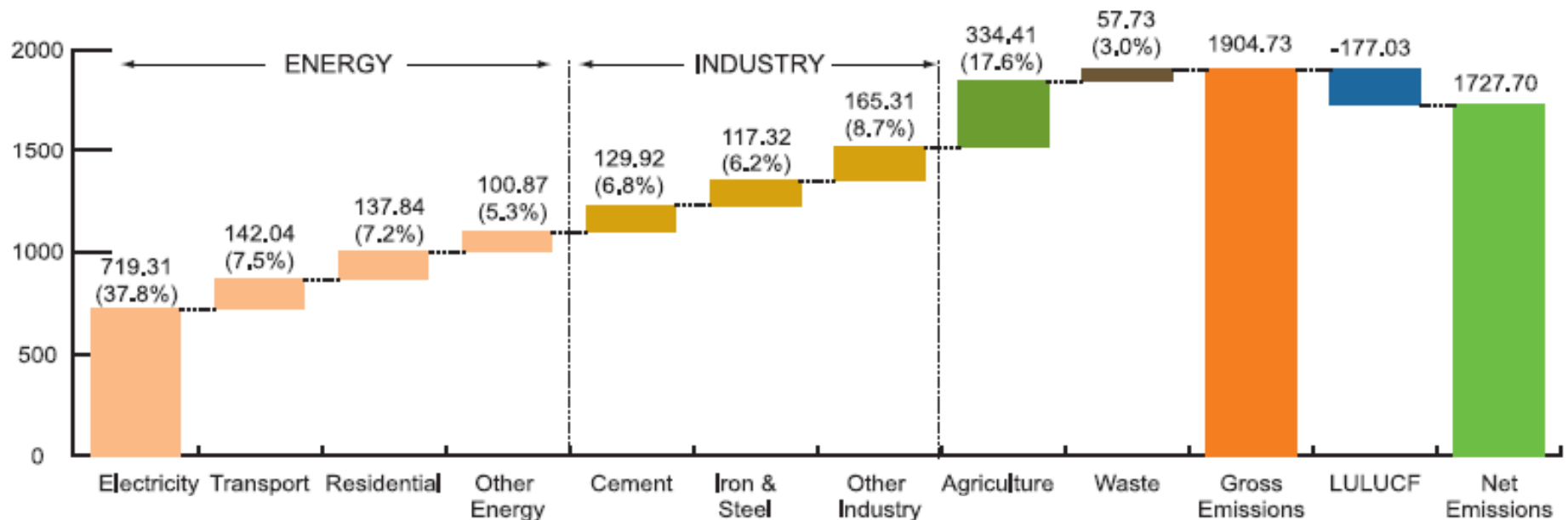
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Former Adviser,
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Industrial Pollution and Global Warming



Global CO₂ Pollution and Rising Earth temperature

Growing Emissions from Metal Industry in India



Note:

Other Energy: includes GHG emissions from petroleum refining, manufacturing of solid fuel, commercial & institutional sector, agriculture & fisheries and fugitive emissions from mining, transport and storage of coal, oil and natural gas.

Other Industry: includes GHG emissions from production of glass and ceramics, soda ash, ammonia, nitric acid, carbides, titanium dioxide, methanol, ethylene oxide, acrylonitrile, carbon black, caprolactam, ferro alloys, aluminium, lead, zinc, copper, pulp and paper, food processing, textile, leather, mining and quarrying, non specific industries and use of lubricants and paraffin wax.

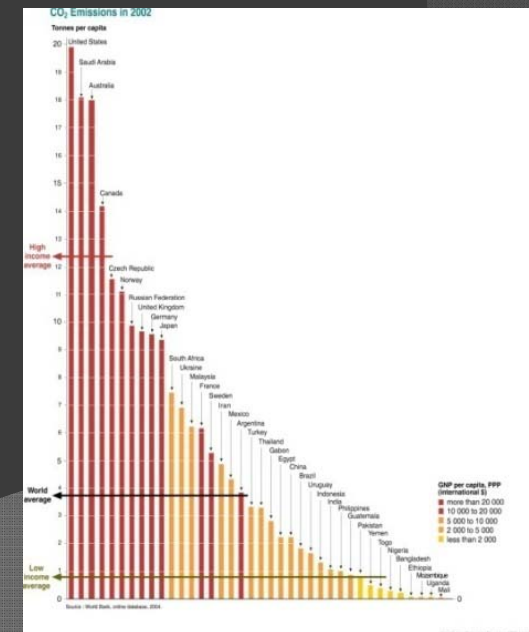
Agriculture: includes GHG emissions from livestock, rice cultivation, agricultural soils and burning of crop residue.

Waste: includes GHG emissions from municipal solid waste (MSW), industrial and domestic waste water.

LULUCF: includes GHG emissions and removals from changes in forest land, crop land, grass land, wet land, settlements and combustion of fuel wood in forests.

India – Current Situation and Consequences of Emissions

- Indians knew the art of making steel in crucibles more than 3000 years ago by melting and adding ingredients, such as high carbon content (nearly 1.5%)
- Current production of steel in India is 65 MT (Dec 2010) and consumption per capita is one third of the global average
- Steel industry contributes 15% of the total industrial emissions and 4.0% of CO₂ emissions (Total 161 MT)
- According to World Development Report – 2010 it is estimated that developing countries would bear 75-80% of the cost of damage caused by climate change



Policy infrastructure

- ⦿ Liberalization of industrial policy, fiscal incentives, simulation packages and support to R&D.
- ⦿ Noteworthy R&D contribution has been made by the industry in making technology improvements.
- ⦿ Specific energy consumption in steel production has reduced up to 30 – 35%

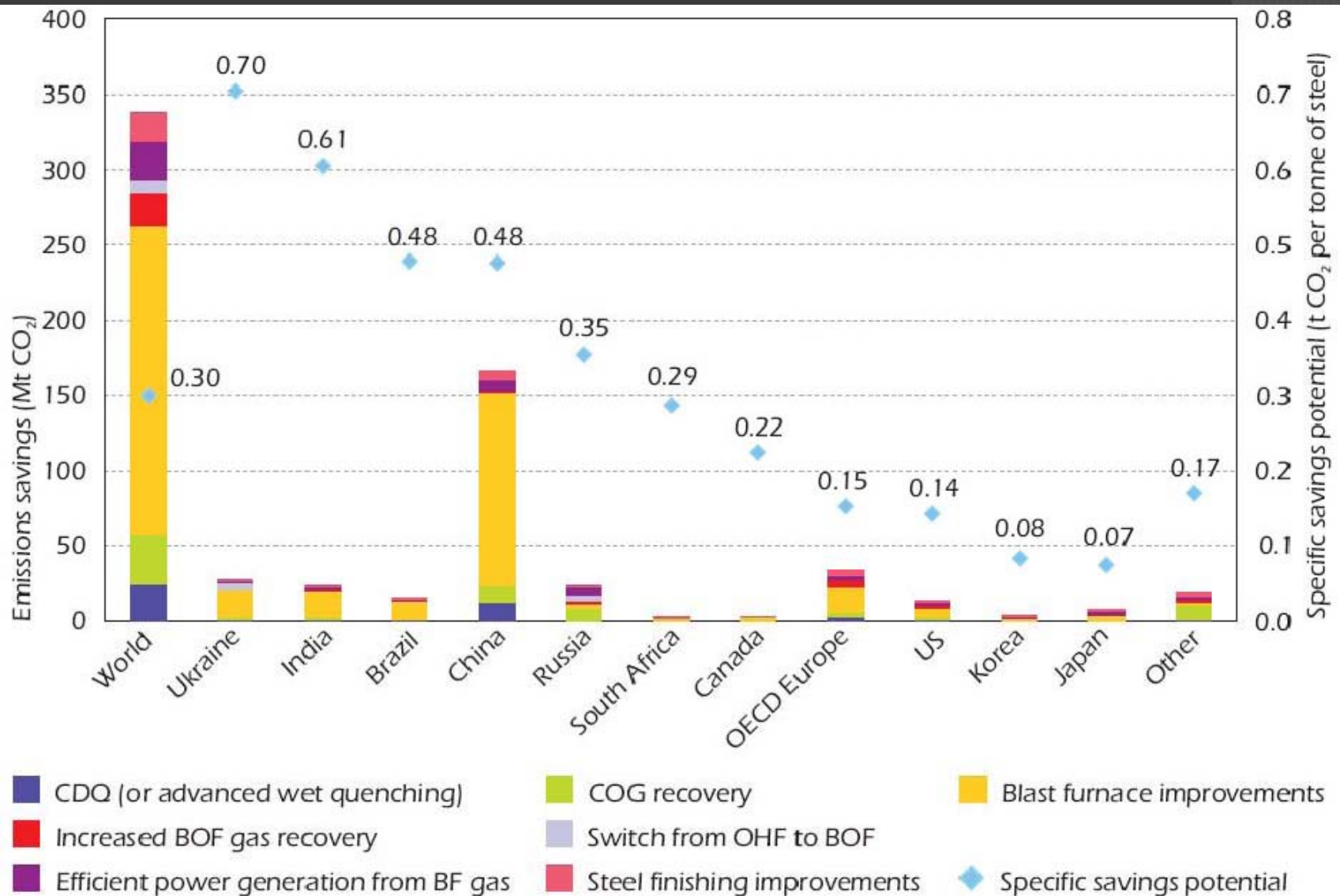
Policies in 2000's

- The National Steel Policy 2005 has laid down the long-term vision of growth for the Indian steel Industry
- India joined Asia Pacific Partnership in Clean Development and Climate (APP6) in 2006 comprising of six nations representing over 50% of steel production to address energy issues vis-à-vis CO₂ emissions reduction through technology and process know how transfer.
- Charter on Corporate Responsibility for Environment Protection (CREP) came in to being in 2003. It envisaged voluntary control of pollution to achieve clean energy development
- Clean Development Mechanism introduced in 2003 under Kyoto Protocol of UNFCCC for trading of CERs among developed and developing countries. Each of the steel production process in the Value Chain is admissible for carbon market and high potential exists.
- NMEEE – National Action Plan on Climate Change 2008

Challenges before Us

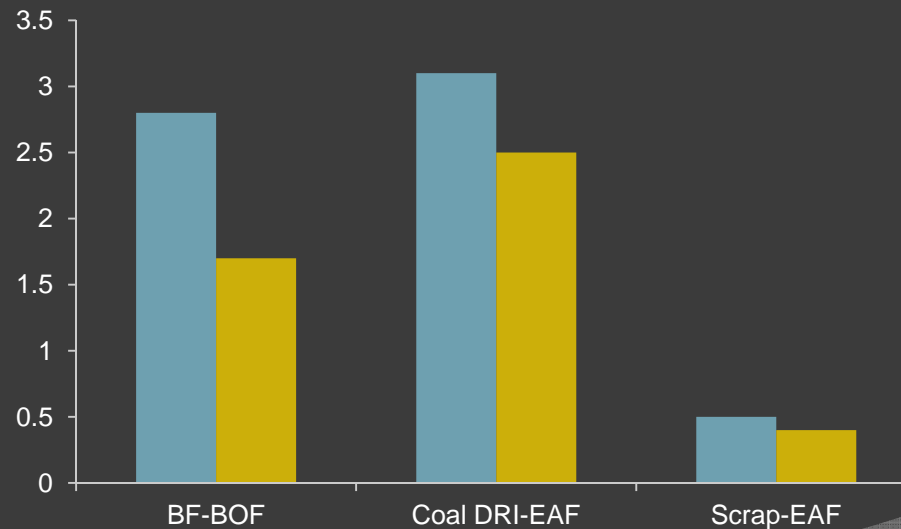
- ◎ Steel comprises of 85 % of all metals produced in industry
- ◎ Most recycled material World wide – up to 40% is recycled
- ◎ More than 90 per cent of the steel produced can be reused
- ◎ Ultra Low CO₂ Steel targeted to achieve 50% further reduction from Steel industry
- ◎ India faces challenge of both meeting targets for Production and CO₂ emission Reduction

CO₂ Saving Potential in ton per ton of Steel



Basic Steel Making Technology in India

- ◎ **Blast furnace/basic oxygen furnace (BF/BOF): (41%)**
- ◎ **Scrap Electric Arc Furnace (EAF): (25%)**
- ◎ **Direct Reduction Process (DRI): (31%)**
- ◎ **Non coking coal Based DRI (COREX): (3%)**



Energy consumption in India and World

CO₂ Concentrations in Flue Gases in a Steel Plant

Equipment	Approx. Volume (Nm ³ /hr)	CO ₂ Concentrations (%)
Reheating Furnaces	248983	17 - 18
Blast Furnace Stoves		27
Coke Oven - 3	80754	20.5 - 21
Coke Oven - 2	84295	7
Coke oven - 1	97880	7
CRMP Kilns	347228	25 - 30
TPP Boilers	1329363	20
Sinter Machine	2903600	12

Data source: U. Devi, Andhra University, VIZAG

CO₂ Emission Reduction Technologies

Innovations

Development of Non Recovery Type Coke Oven

Top Gas Recycling Blast Furnace (TGR-BF)

Design Modification Rapid Melting technology

Breakthrough Technologies - Hydrogen reduction, byproduct gas fired GTCC

Electrolysis of iron ore in place of using coal

Photo-bioreactor for enhanced CO₂ fixation

Chemi-absorption of CO₂ in Metal slag

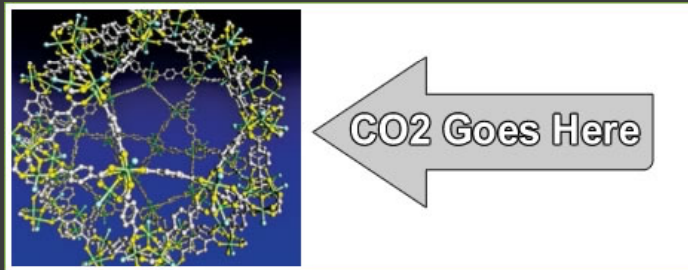
Waste Gas CO₂ Fixation

- Waste gases from blast furnaces containing oxides of carbon have been used for converting them into higher- Btu (more calorific value) methane using thermophilic methanogens. A column bioreactor operated at 55 °C and pH 7.4 was used for the process.
- Laboratory research reported in Andhra University using flue gas from blast furnace chimneys of Vizag steel plant. Initial trials indicated fresh water algal species *Corella*, *Scenedesmus*, *Haematococcus* were seen to grow 3 times faster in a medium made from the flue gas enriched water compared to control (source: U. Devi, Andhra University, VIZAG)
- Flue gas containing 15% or more CO₂ was supplemented further to get a CO₂ fixation rate of 26 g CO₂ m⁻³ h⁻¹. Research is in progress on the development of a novel photo-bioreactor for enhanced CO₂ fixation and CaCO₃ formation

Carbon Dioxide Sequestration in Metal Waste

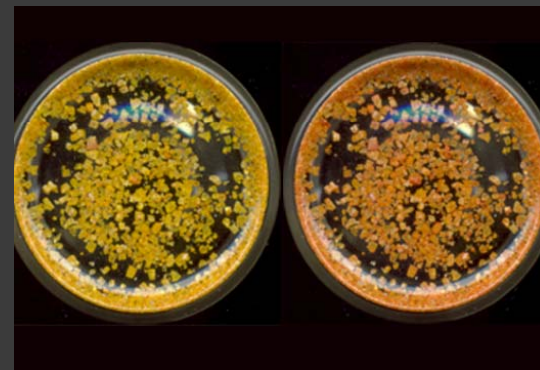
- Steel production results in 2.1 to 3.2t CO₂ emissions per ton of steel much higher than global benchmark
- Steel slag is also produced in large quantity up to 200kg per t of steel and its disposal is a problem
- Slag from blast furnace, basic oxygen furnace or electric arc furnace comprises of over a dozen of chemicals as basic and acidic oxides. Alkaline basic earth oxides CaO and MgO are in higher quantity up to 30-50%
- Chemi-absorption of CO₂ on the slag can result in formation of stable carbonates. 0.25kg CO₂ /kg of slag can be sequestered in this manner.

Carbon Dioxide Sequestration



Zeolite Imidazolate Framework (ZIF) as new material porous metal structure, exhibit unusual selectivity of CO₂ capture from CO₂/ CO mixtures and caging it

Mineral carbonation of slag in presence of CO₂ is chemical sequestration process - Carbon sponge



Future Vision

- Global Warming concern is increasing, coal as primary fuel for energy security, will continue to be used in Industry and emission will rise
- **Indian steel industry has high CO₂ intensity compared to global**
- In Industry various options to CO₂ reduction processes exist. Integration and knowledge sharing, collaboration is an important aspect
- **Further advancements in technology can lead not only to lowering of CO₂ emissions, but also production of high strength steel.**
- Creating an Independent Organization for Training in Low Carbon Technologies with special Focus to Carbon Capture and Storage

Acknowledgements

- The Importance of R&D and Market Based Mechanisms for Technology Management in Steel Industry, **JPC Bulletin on Research and Development in Iron and Steel**, 2006.
- **DST - Carbon Dioxide Sequestration through culture of medically useful microalgae in photo bioreactors linked to gas outlets of industries – Dr. Umadevi Koduru, Andhra University, 2007**
- Strategic Approaches For CO₂ Reduction Rate From Fossil Fuel Use In Steel Industry, TMS 2010, February 10-14, 2010, Seattle, USA
- **Sustainable Energy And Growth Of Indian Metal Industry, Minerals, Metals, Metallurgy & Materials International Conference & Exhibition, Feb 11-14, 2011 New Delhi**

Thank You