The Role of Engineers and Technologists in Sustainable Development

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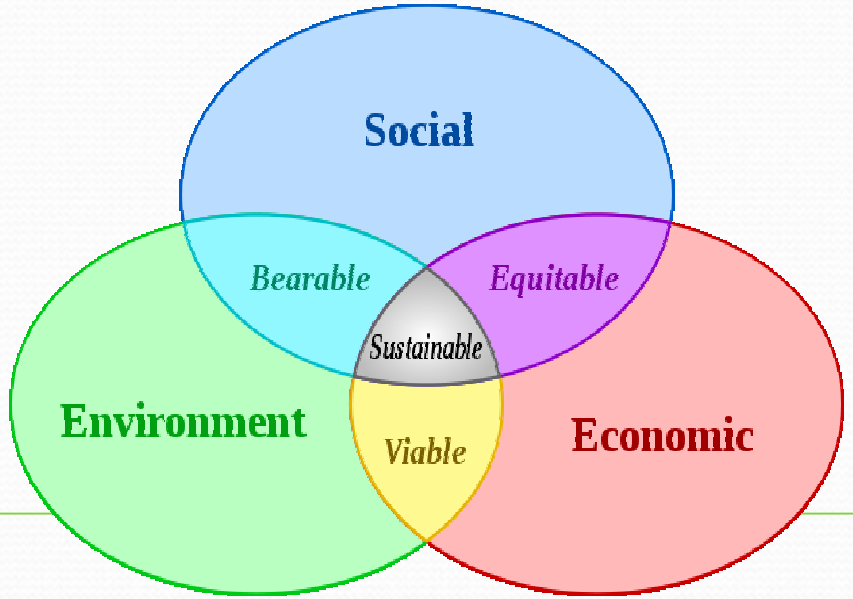
What is Sustainability?

- Derived from Latin word 'Sustinere', meaning 'to hold'

- ***The Brundtland Commission, United Nations, March 20, 1987***: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

Three Pillars of Sustainability

- ***United Nations 2005 World Summit, New York***: Sustainability defined in terms of three pillars of sustainability. These three pillars, often, overlap each other and can have a synergistic effect on each other



Three Pillars of Sustainability (1/3)

Environmental Sustainability

- Operations consume resources from environment and provide some output and waste material to this environment
- Natural resources are limited

Three Pillars of Sustainability (2/3)

Economic Sustainability

- Income generation for a group, based on optimal utilization of a set of resources
- When an eco-system and the operating environment are disturbed from their equilibrium position, the connected economic activity takes a hit as well
- Average per capita consumption in developing world can be sustainable in view of existing natural resources, but only by maintaining environmental equilibrium

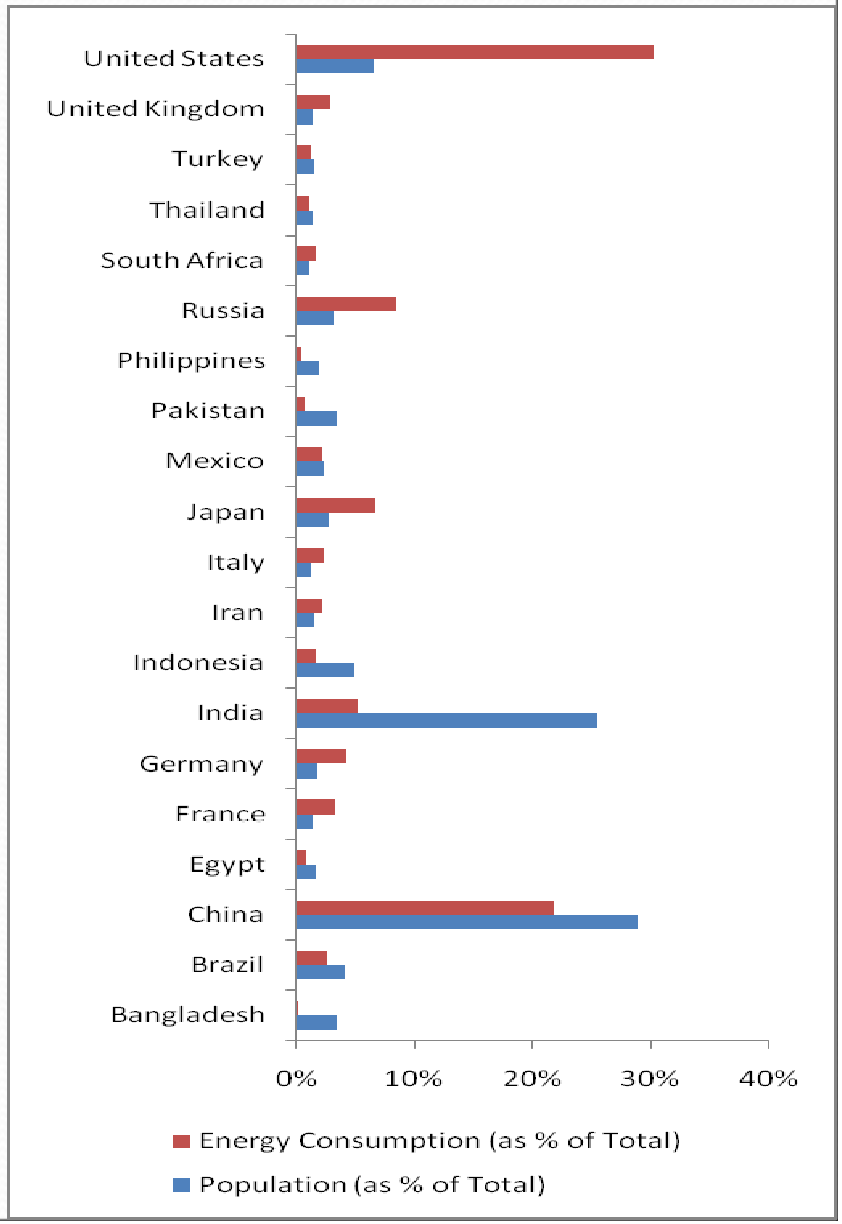
Three Pillars of Sustainability (3/3)

Social Sustainability

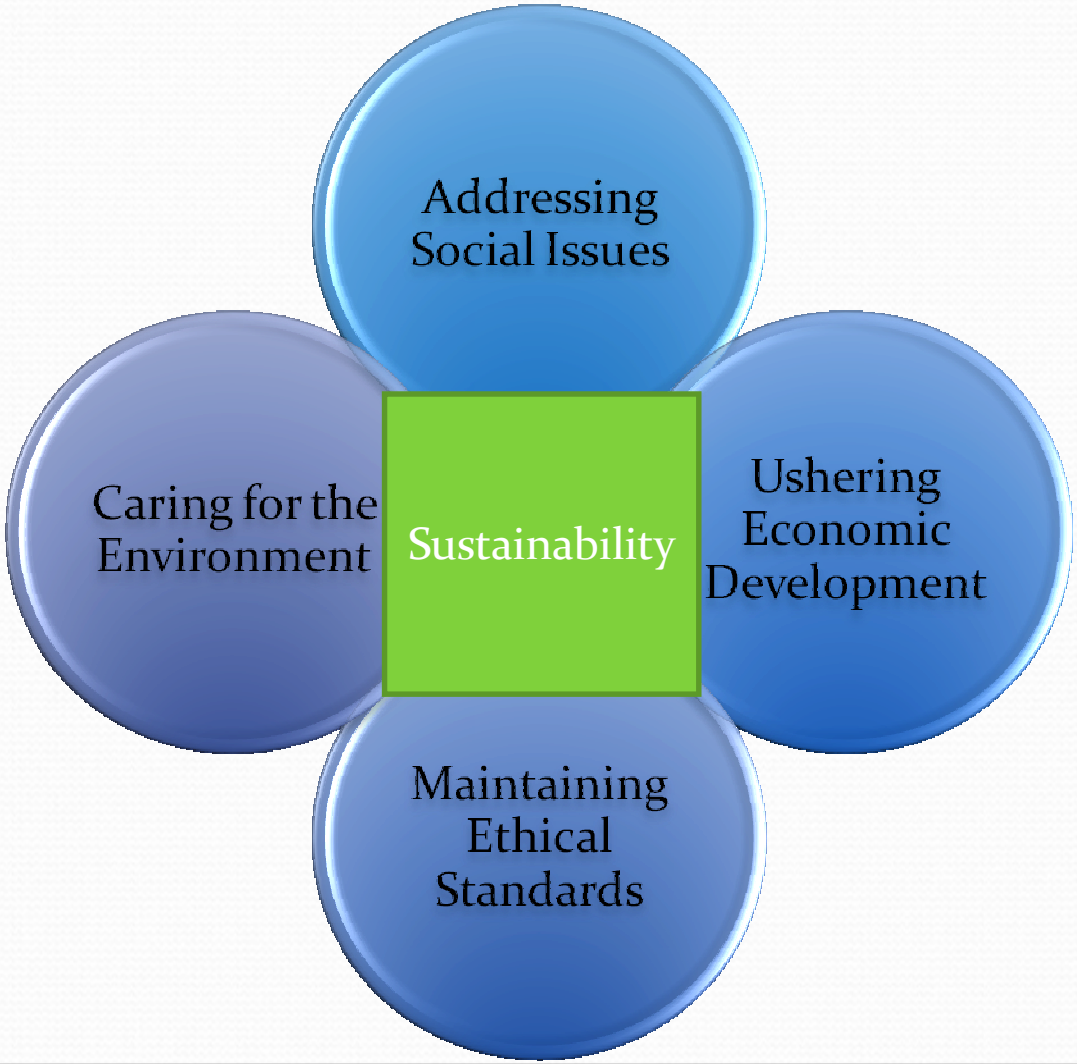
- Any operation has to closely deal with the locals involved and needs to overcome the local challenges
- Social Sustainability deals with issues pertaining to the health, education and other such factors pertaining to the local society in general
- Imperative for the authorities to take necessary action for preserving the cultural values and local diversity

Impact of aspirations for a better quality of life

- People are used to a certain way of life in developed economies
- May not be an optimum way of utilizing the natural resources
- At times, may lead to wasteful consumption of resources and energy
- Much of this lifestyle relies heavily on the non-renewable resources
- To sustain such a lifestyle seems unsustainable in the



A Truly Sustainable Society



- We should also add a fourth pillar to the three existing pillars in the definition of Sustainability
- Because the aspiration to attain, *very quickly*, a "better quality of life", often shortchanges the foundations of ETHICS

Role of Engineers and Technologists in Society (1/2)

- Progress of any economy and its technological viability is measured by the "Innovations" activity in the country.
- For progressive economic growth and social development, technology is often called upon to redefine, restructure and reorganize our technological and physical environment
- Engineers form a sort of interface between the operations team and the end customer

Role of Engineers and Technologists in Society (2/2)

Engineers & Technologists are engaged in:

- Conceptualization and Designing and adapting them to their applications in industry and infrastructure
- Production of goods and services, at optimum costs, and offering wide choices therein
- Promoting technologies and services to increase public comfort and welfare; and thereby bettering their ***Quality of Life***

The World Federation of Engineering Organisations (**WFEO**) held a meeting in September 1991 of its General Assembly in Arusha, Tanzania. At this meeting WFEO adopted the *Arusha Declaration on the future role of engineering,* developed from a study of ***Our Common Future***, (the report of the World Commission on Environment and Development)

World Federation of Engineering Organisations Model Code of Ethics, 2001

As population and economic growth place increasing pressures on our social and biophysical environment, engineers must accept increased responsibilities to develop sustainable solutions to meet community needs, overcome extreme poverty and prevent segregation of people. The education of engineers needs to inculcate an understanding of sustainability and cultural and social sensitivities as well. The engineering code of ethics must reflect a strong commitment to principles of

Role of Engineers in mitigation of negative impacts of Industrial Development (1/3)

- Through more energy efficient and least, or inferior, raw material demanding technologies
- By suggesting better materials to reduce volume and weight requirements
- Developing innovative design and engineering for longer life cycle

Role of Engineers in mitigation of negative impacts of Industrial Development (2/3)

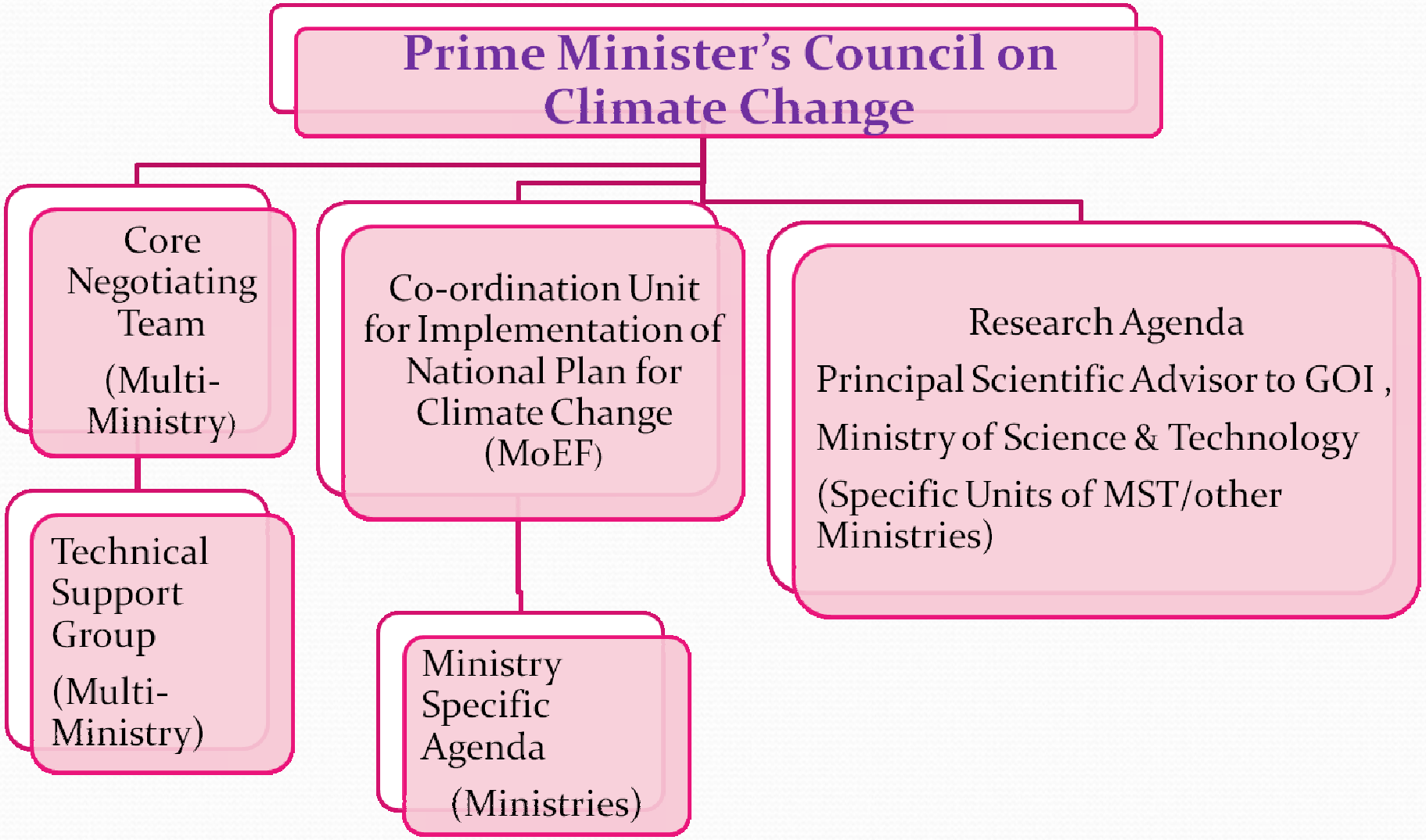
- **One essential feature of Kyoto Protocol that has direct relevance to the role of engineers and technologists is the requirement that countries limit, or, reduce their greenhouse gas emissions.**
- **CDM (Clean Development Mechanism) allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits which can be traded/sold.**
- **Engineers can help in development of "Green" plants for lesser CO_2 emissions.**

Role of Engineers in mitigation of negative impacts of Industrial Development (3/3)

- **Another area where engineers and technologists can make significant contribution is towards:**

"Green Chemistry", which works on the principle that "it is better to prevent waste than to treat or clean up waste after it is formed"

NATIONAL ACTION PLAN ON CLIMATE CHANGE



The Way Forward:

Eight National Missions

- National Solar Mission
- National Mission on Enhanced Energy Efficiency
- National Mission on Sustainable Habitat
- National Water Mission
- National Mission for Sustaining Himalayan Ecosystem
- National Mission for a Green India
- National Mission for Sustainable Agriculture
- National Mission on Strategic Knowledge for Climate Change

Some Initiatives in India (1/3)

National Solar Mission

- The government plans to generate 20,000 MW solar power by 2022 under the three-phase National Solar Mission, with 2000 MW capacity equivalent off-grid solar applications, including 20 million solar lights, also planned to be installed during this period.

Clean Energy and Technology

- The Energy Efficiency Indicator (EEI) survey for corporate India, released in June 2009, reveals that 47 per cent of the respondents are paying more attention to energy efficiency, compared to 2008 and 94 per cent of the respondents feel that energy management is extremely

Some Initiatives in India (2/3)

CII Climate Change Center

- Established with the objective of spreading awareness of climate change issues in the Indian Industry

Greenhouse Gas Pollution Prevention Project-Climate Change Supplement

- Organised jointly by CII, Development Alternatives, ICICI, and Lal Bahadur Shastri National Academy of Administration; the program aims to create a forum for greater dialogue and technical cooperation on global climate change and clean energy issues between US and Indian Government.

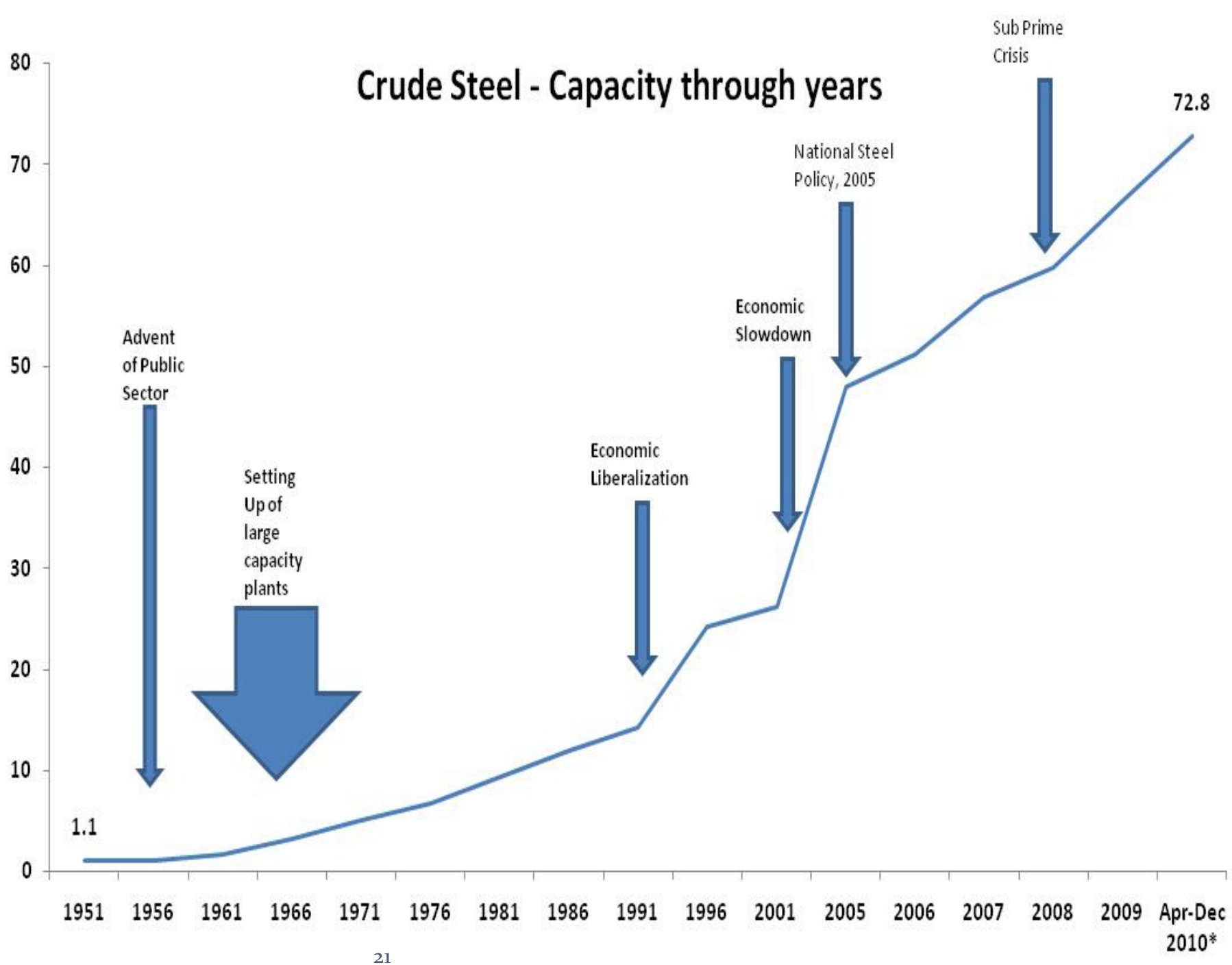
Some Initiatives in India (3/3)

The Indian Renewable Energy Development Agency Ltd (IREDA), Power Finance Corporation, SIDBI, PTC India Ltd and HSBC India have come together to develop an energy efficiency investment market in India, as they join the Bureau of Energy Efficiency's (BEE) proposed financing platform.

Environment

and the

Steel Industry

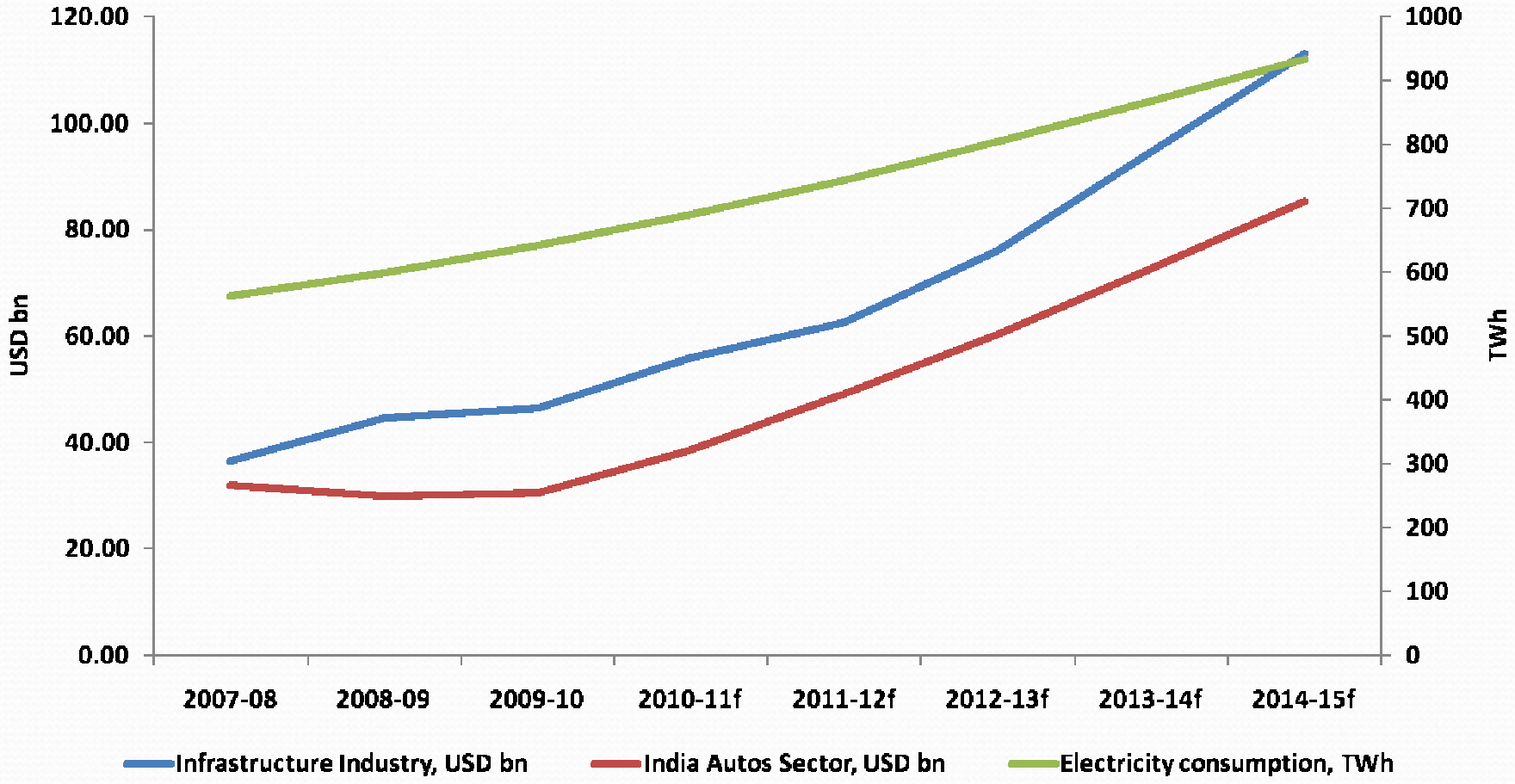

Crude Steel - Capacity through years
80
70
60
50
40
30
20
10
0
1.1
72.8
Advent of Public Sector
Setting Up of large capacity plants
Economic Liberalization
Economic Slowdown
National Steel Policy, 2005
Sub Prime Crisis
1951
1956
1961
1966
1971
1976
1981
1986
1991
1996
2001
2005
2006
2007
2008
2009
Apr-Dec 2010*

National Steel Policy – 2005

	Production	Imports	Exports	Consumption
2019-20	110	6	26	90
2004-05	38	2	4	36
Compounded Annual Growth Rate	7.3%	7.1%	13.3%	6.9%

NSP Projections for Production, Imports, Exports and Consumption of Steel (MT)

Some Growth Parameters in India



Source: Business Monitor International study, July-Sep 2010

Fundamentals of Steel Industry in India

Strengths

- Availability of iron ore and coal
- Low labour wage rates
- Abundance of quality manpower
- Mature production base

Weaknesses

- High Energy Consumption
- High Carbon Dioxde Load
- Coking coal import dependence
- Low R&D investments
- High cost of debt
- Inadequate infrastructure
- Logistics do not support the growth

Opportunities

- Unexplored rural market
- Growing domestic demand
- Exports
- Consolidation

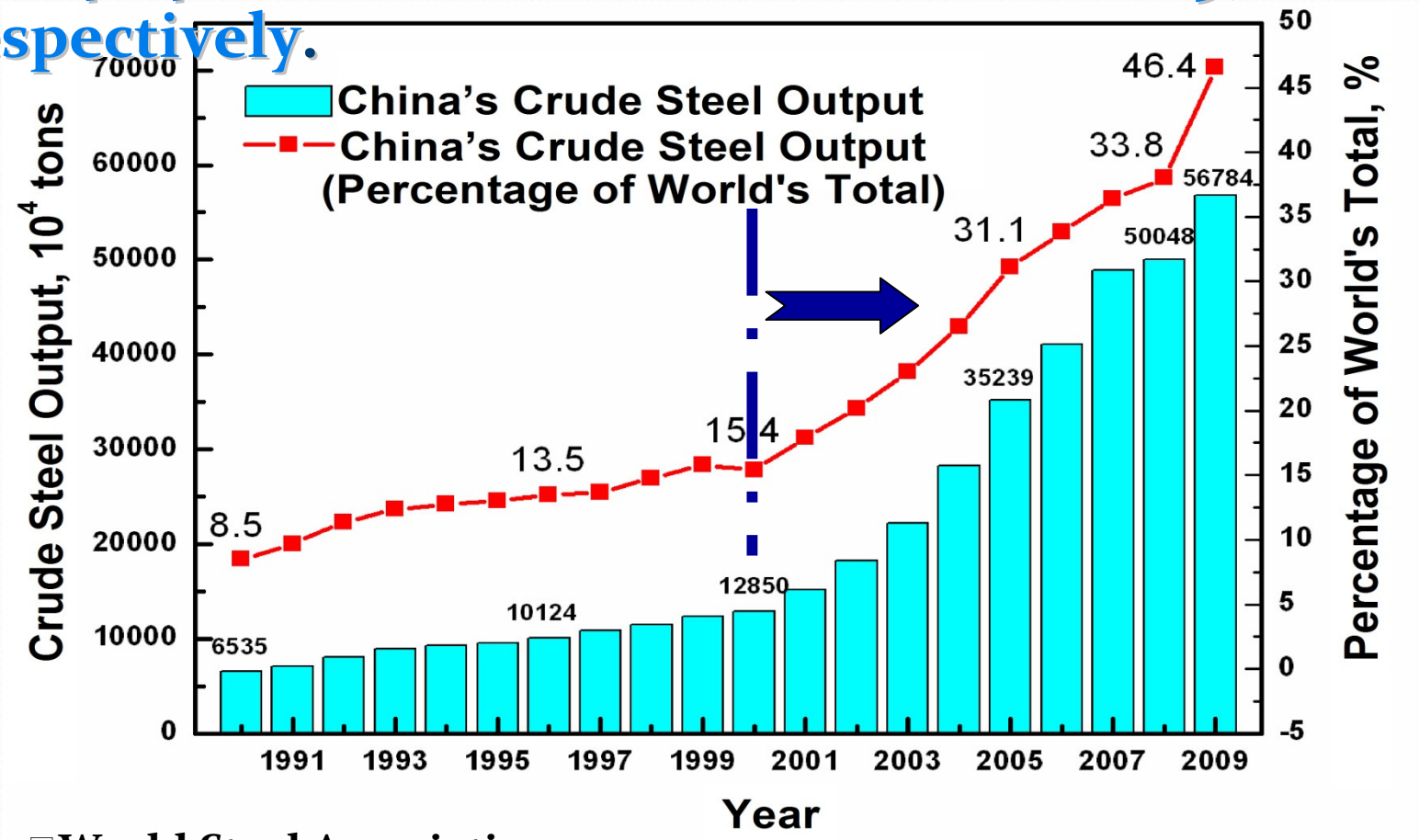
Threats

- China becoming net exporter
- Protectionism in the West
- Dumping by competitors
- Increase in prices of raw material especially coking coal

Over 90% of CO_2 emission in steel making is on account of energy consumption. Therefore the energy saving is the most important approach to reduce CO_2 emission.

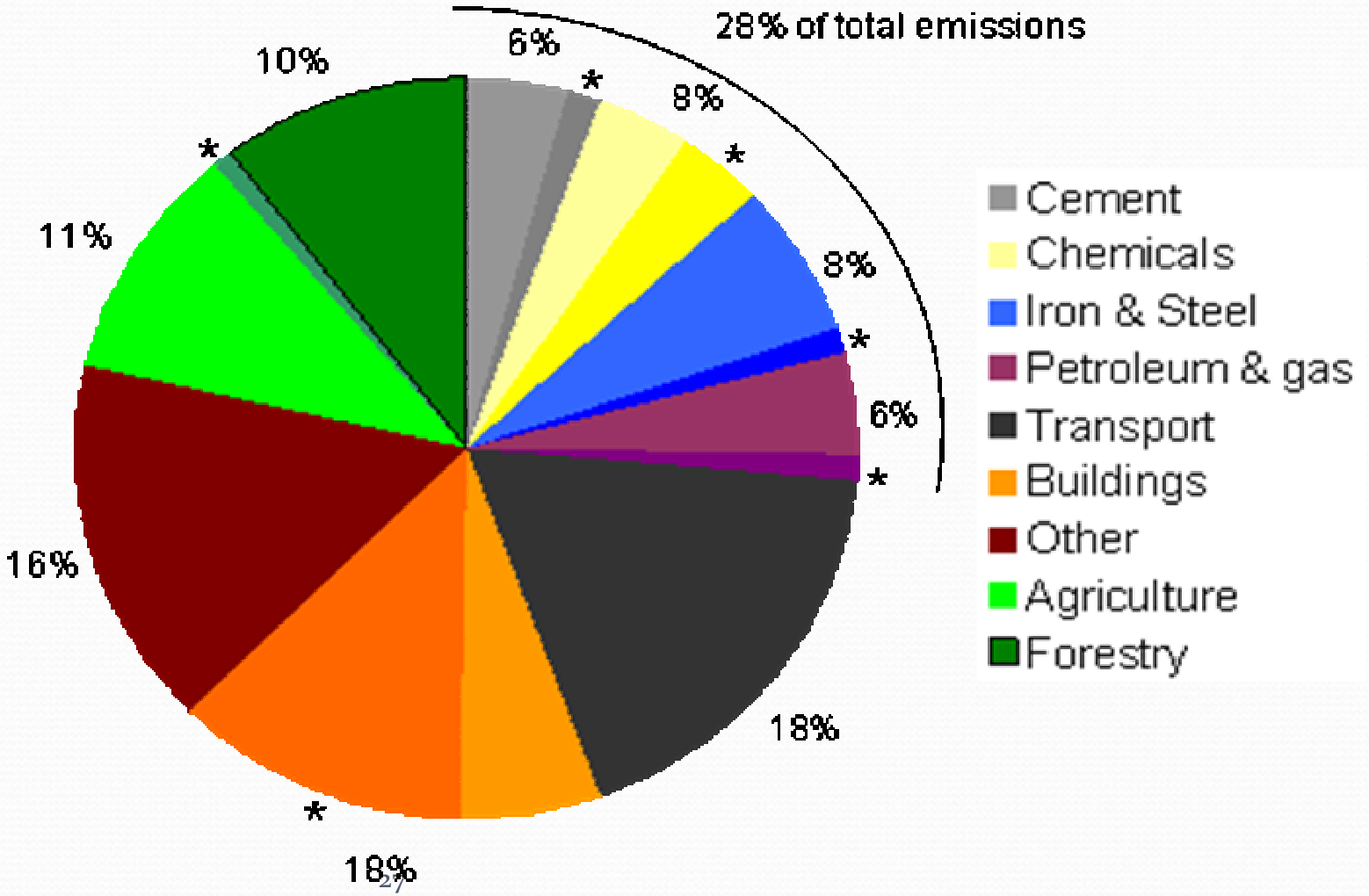
- ***World CO_2 emission of iron and steel industry accounts for 6% of world's total.***
- ***China: In 2008, CO_2 emission of iron and steel industry accounted for 15.6% of China's total.***

Rapid development of China's Iron & Steel Industry：China's crude steel output has ranked No.1 in the world for 13 years, which accounted for 15.4% and 46.4% of world's total in 2000 and 2009, respectively.



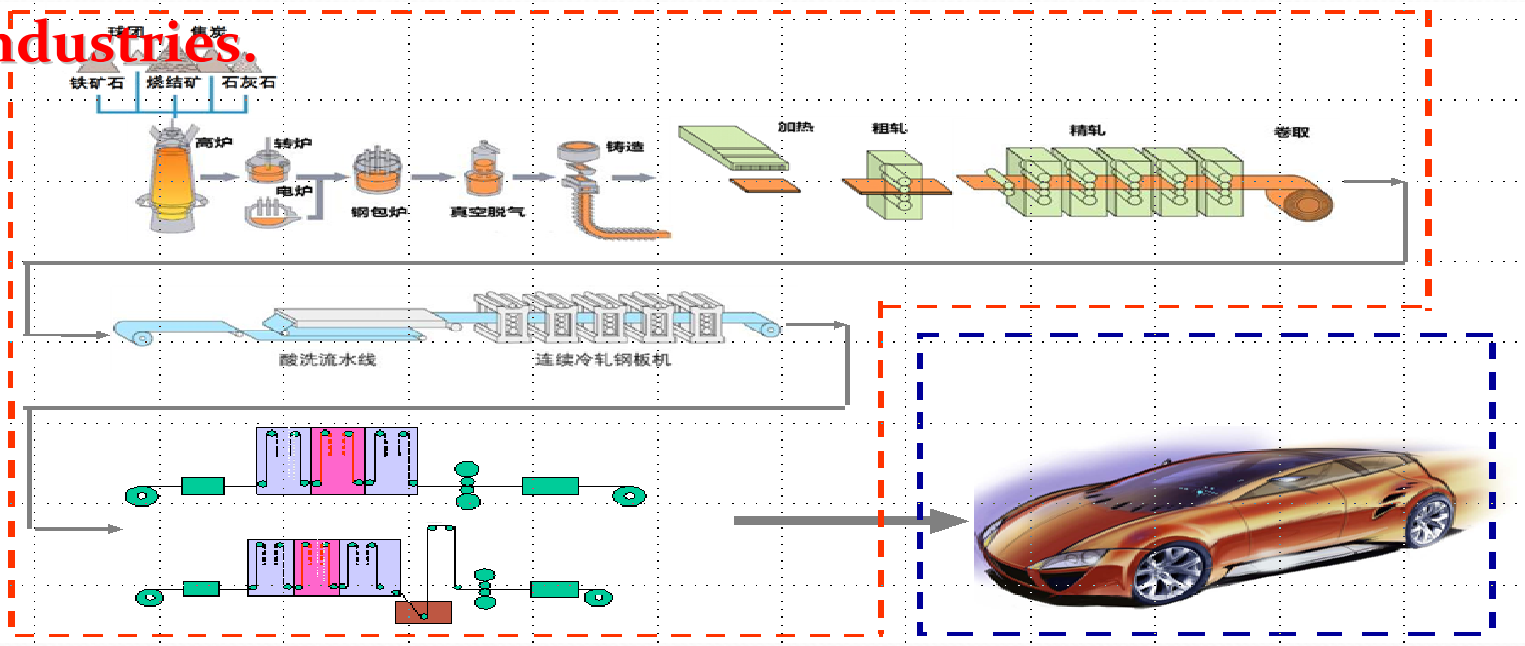
Source：World Steel Association

Emissions (CO_2), 2030

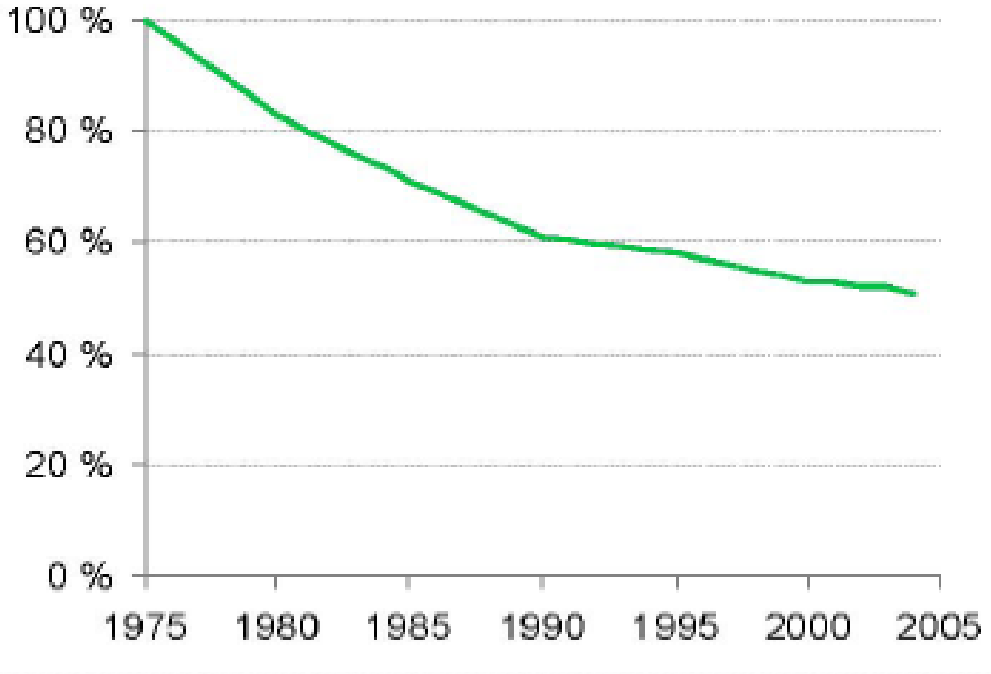


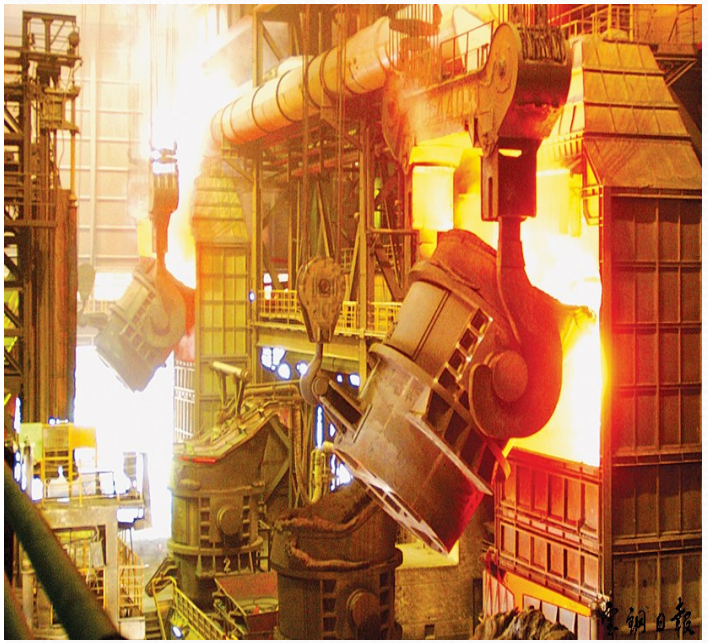
Main measures of iron and steel industry to save energy and reduce CO_2 emission

- **Innovative manufacturing technologies to realize the energy conservation and emission reduction in steel making.**
- **Innovation steel materials to support the energy conservation and emission reduction of downstream industries.**

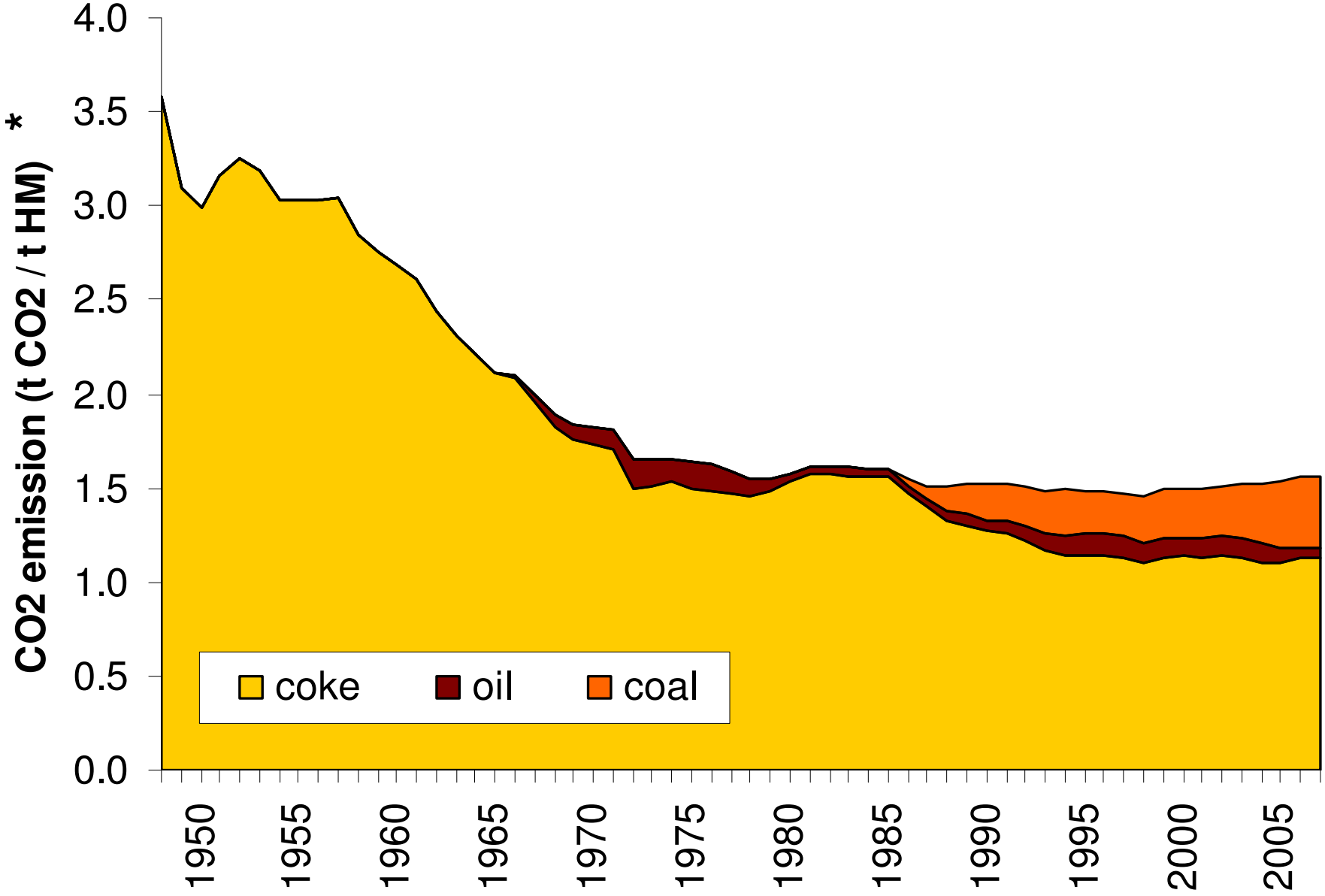


Over the past 30 years, global steelmakers have made remarkable improvement in reducing energy consumption: In such developed areas as North America、Japan、Europe, etc, within the 30 years from 1975 to 2005, average energy consumption per ton of steel has decreased by about 50%.



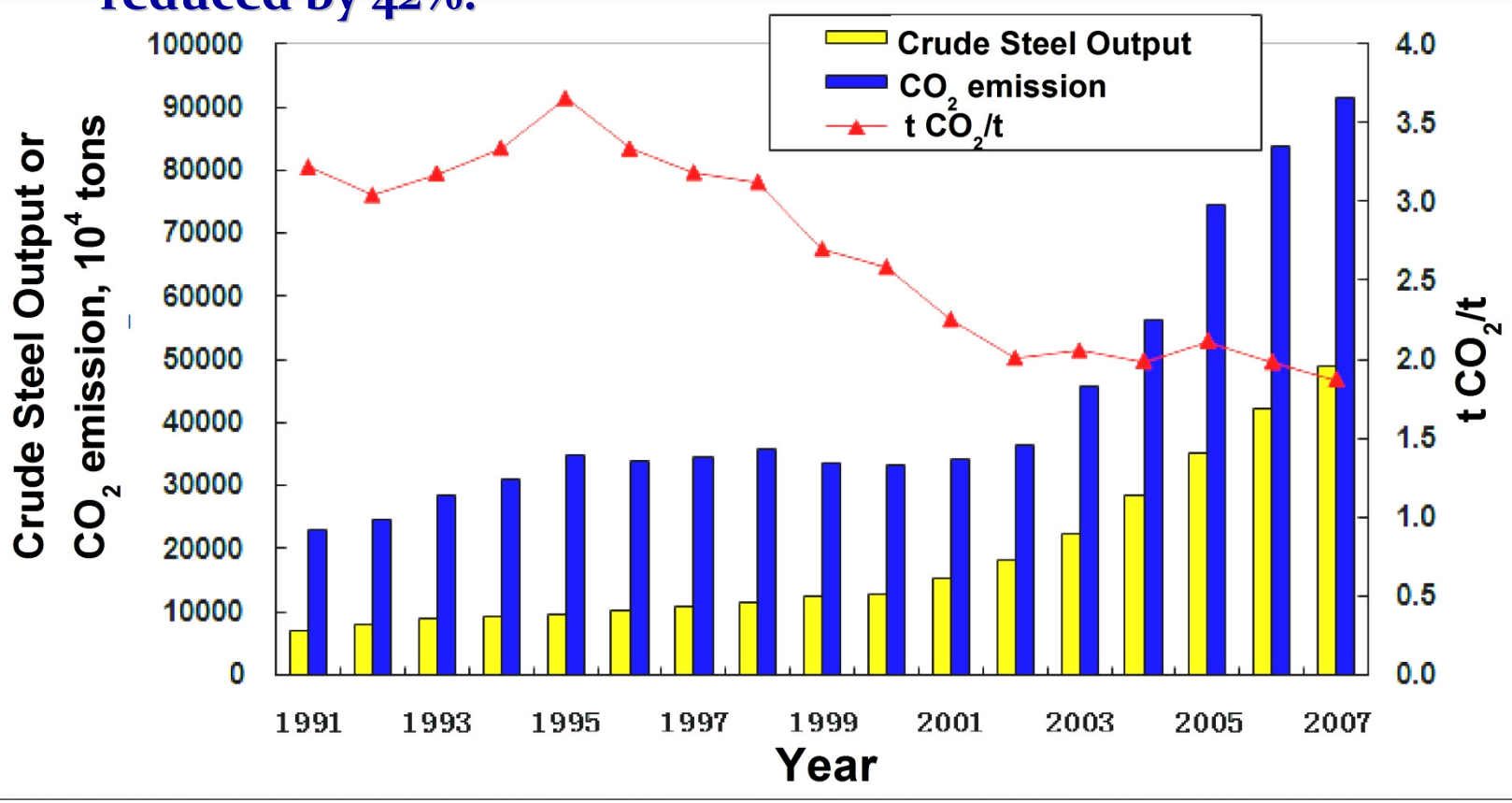


Source：IISI, AISI, JISF, and JFE (2008)
"Global Steel Sectoral Approach"


CO2 emission (t CO2 / t HM) *
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
coke
oil
coal
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005

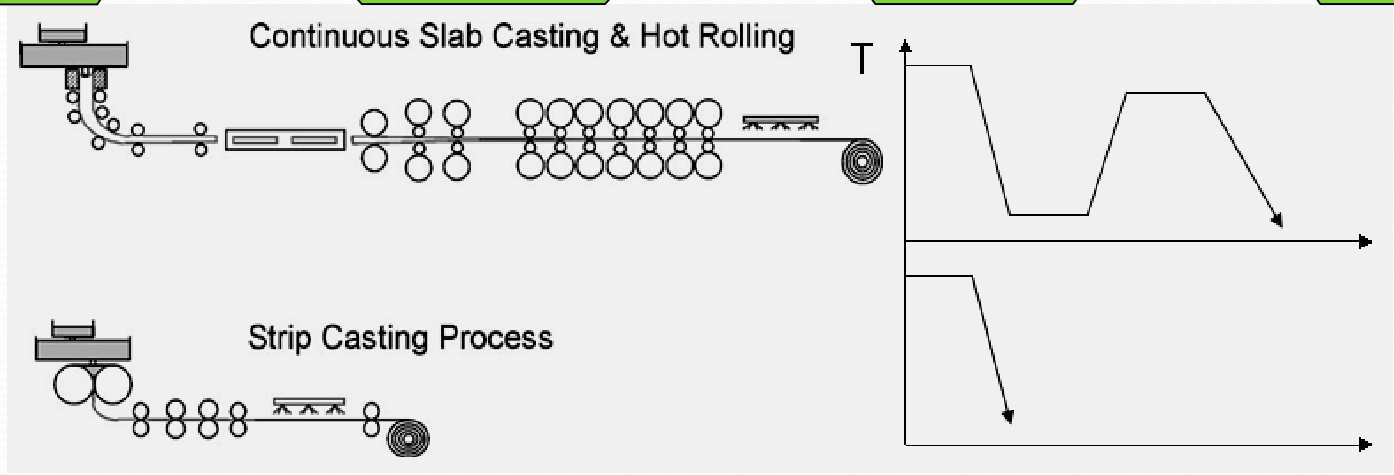
Great achievements have been made in energy conservation and emission reduction of China's steel industry over the past 30 years

- **Standard coal consumption per ton of steel: 2.04 tons in 1980, 0.62 tons in 2009; reduced by nearly 70%.**
- **CO2 emission per ton of steel: 3.22 tons in 1991, 1.87 tons in 2007, reduced by 42%.**



- Innovation in the techniques of steel making also play a critical role on energy conservation and emission reduction.
- Example: Improvement in the casting techniques leads to a great energy saving.

Mould Casting → Continuous Casting → Thin Slab Casting → Strip Casting



Case Study – Reduction of direct CO_2 emission by Steel Industry (1/3)

- **AISI- In North America AISI sponsors a number of university programs, that cover among others,**
  - ***Gas-Solid Suspension Iron making Technology based on hydrogen reduction***
  - ***Technical Feasibility of Steelmaking by Molten Oxide Electrolysis***
- **Australian program- The Australian national program focuses on the use of bio-mass as a substitute to coal.**

Case Study – Reduction of direct CO_2 emission by Steel Industry (2/3)

- **Bao Steel program in China** focusses on Energy saving projects. Bao steel is also member of CO_2 breakthrough program
- **JISF CO_2 Taskforce program in Japan for JFE, NSC, Sumitomo and Kobe** explores two interesting avenues:
  - Reduction of CO_2 emissions from Blast Furnaces
  - Capture of CO_2 from Blast Furnace gas: chemical and physical absorption to capture, separate and recover CO_2

Case Study – Reduction of direct CO_2 emission by Steel Industry (3/3)

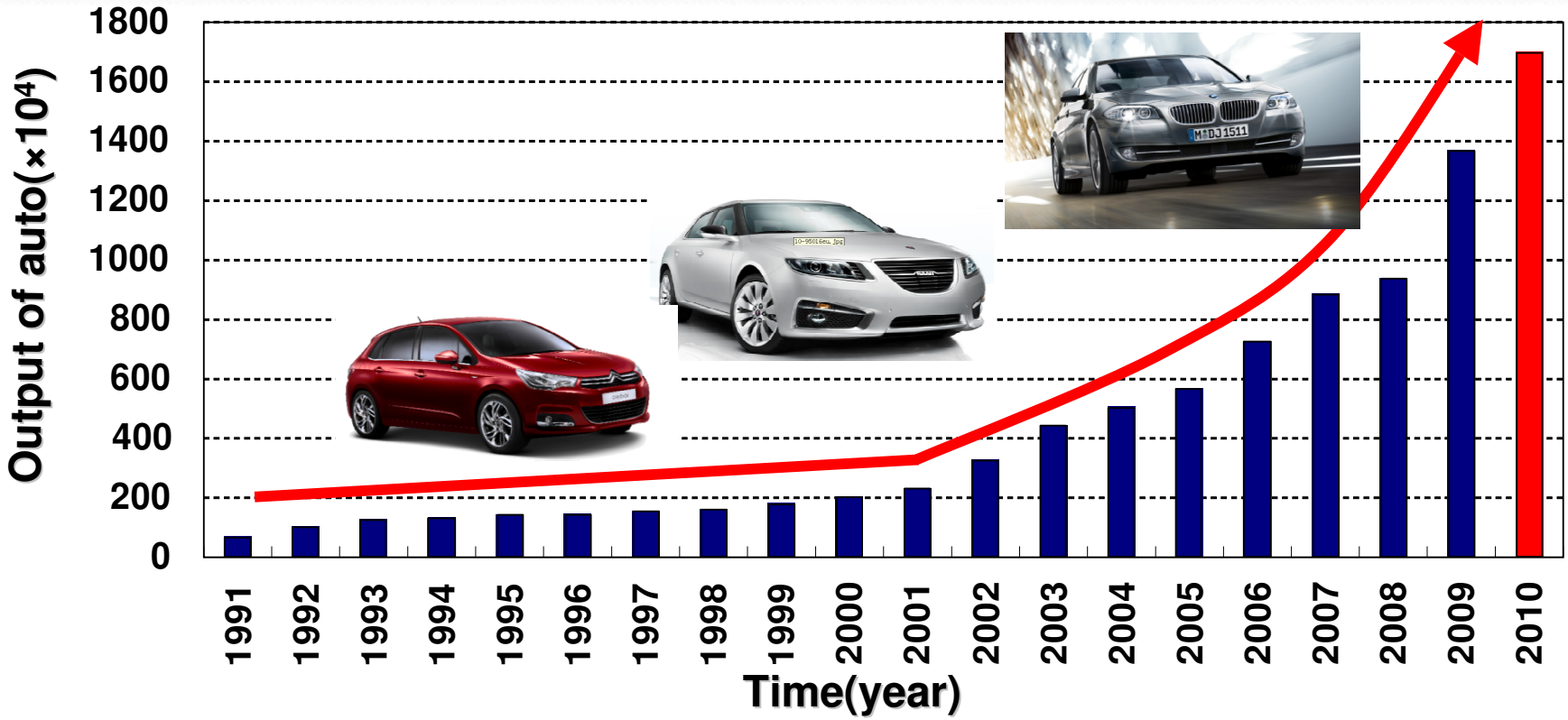
- **The Shougang** plant with its environnemental management systems is a benchmark model for greenfield sites demonstrating the ambition in terms of energy efficiency and minimisation of resources in production process.
- **Posco CO_2 project** looking at capturing the CO_2 with subsequent storage from the FINEX process. The program uses Hydrogen Steelmaking with Iron ore reduction of FINEX using hydrogen-enriched syngas.
- **China Steel Corporation** in Taiwan is developing solutions on CO_2 capturing technologies (including adsorption, absorption, etc.) in reheating furnaces

ULCOS PROGRAM

- The ULCOS Program started in 2004, bringing together 48 partners in Europe with a budget of 75 M€ with **ArcelorMittal** as the leader. It is one of the most ambitious, with objective of steel production emission reduction in the range of 30-70%. Of all the technologies studies by ULCOS the Top Gas Recycling (TGR) coupled with Carbon Capture & Storage (CCS) is the most immediately promising route.
- ***ULCOS is presently moving into the final stage of the scale up of the Top-Gas Recycling Blast Furnace technology to commercial size. This second-step Demonstration initiative is called ULCOS II. The next phase of the project will include a pilot step focused on demonstrating the capture part of the technology and a demonstrator step where the capture will be scaled up to the size of an average EU blast furnace***

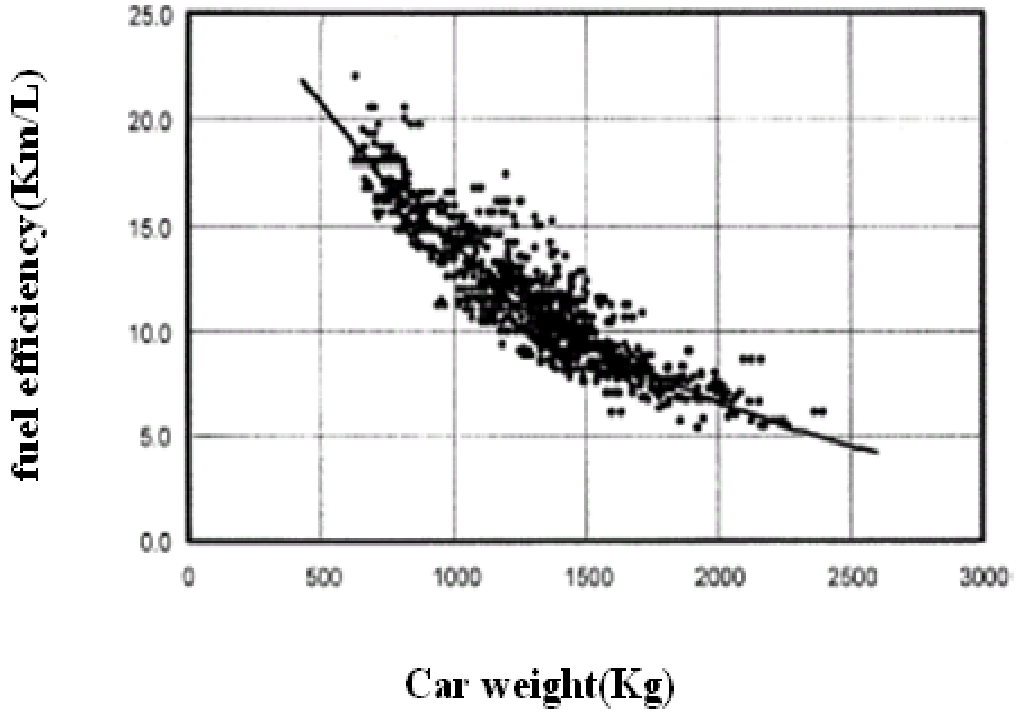
Fuel Economy of Automobile & High Strength Steel

- China Automobile: Over the past 10 years，China's automobile industry has been rapidly developed. In 2010, sales volume of China automobile market expects to exceed 17 million.
- Oil Consumption: Recently automobile accounts for 1/3 of total oil consumption in China, and is estimated to rise to 57% in 2020
- Providing the material solution to automotive lightweighting is significant to low carbon society.



Fuel Economy of Automobile & High Strength Steel

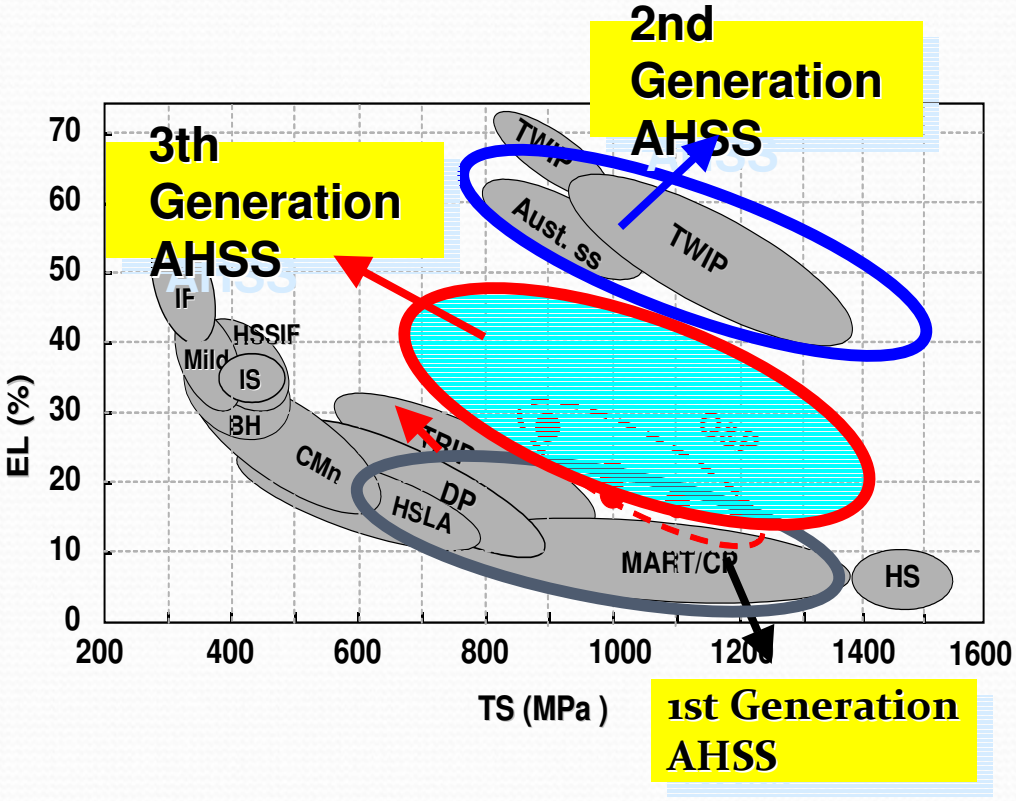
The technical solution to energy saving of automobile is weight-lightening, since each 10% weight losing could reduce 3□7% fuel consumption and 13% CO_2 emission.

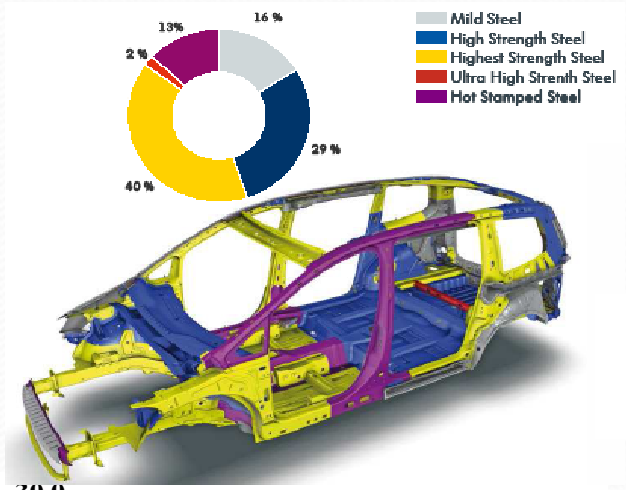


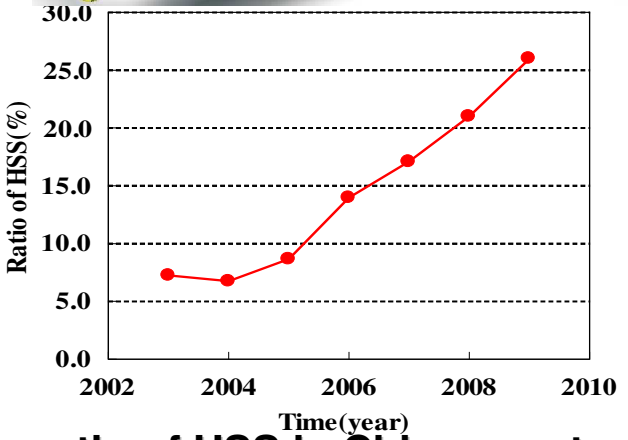
Fuel Economy of Automobile & High Strength Steel

Steel solution to automotive lightweighting: application of HSS. R&D of new generation AHSS with better comprehensive properties.

In 2009, the application proportion of HSS in Chinese automobile industry was only about 25□ □while that value abroad was over 50□.

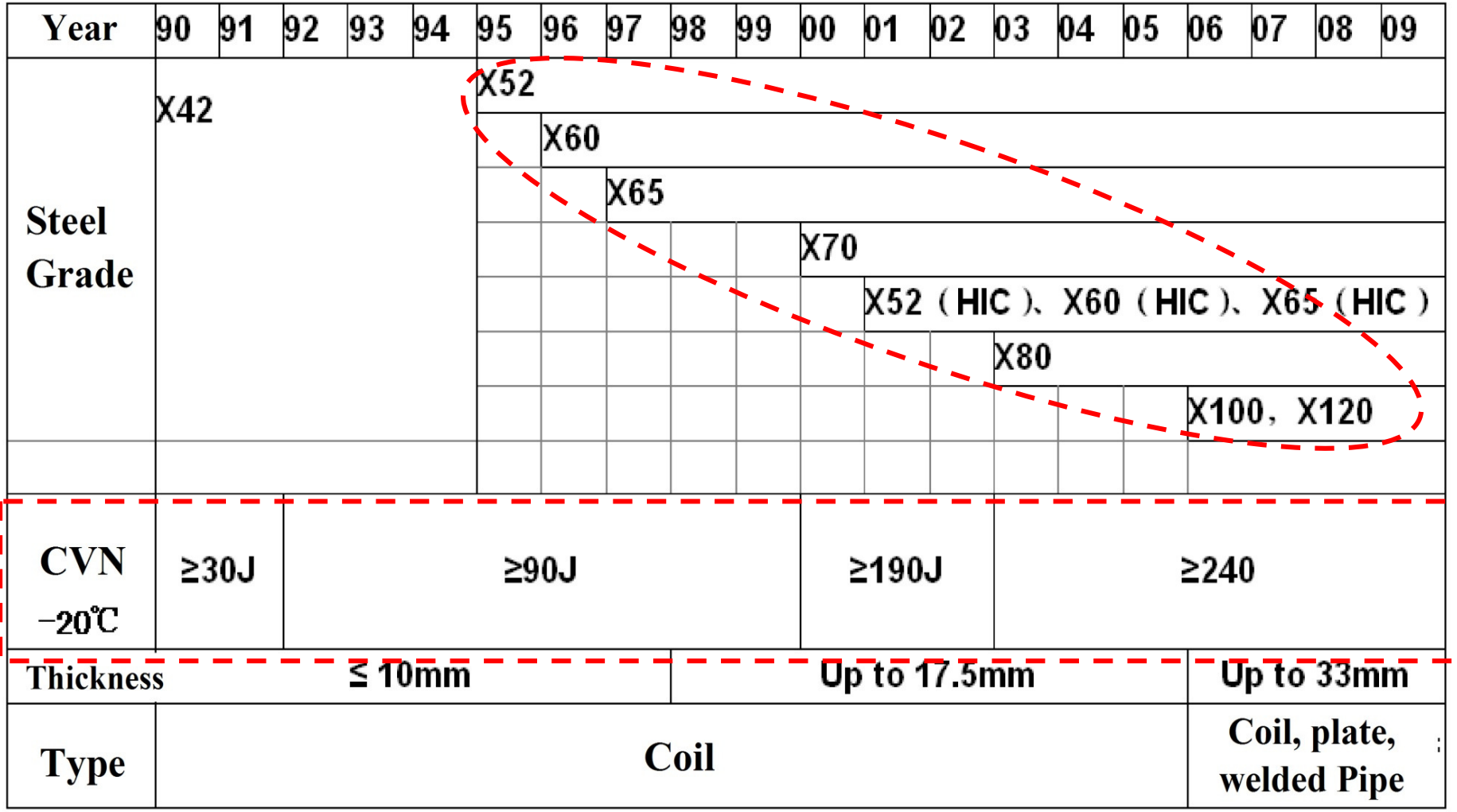






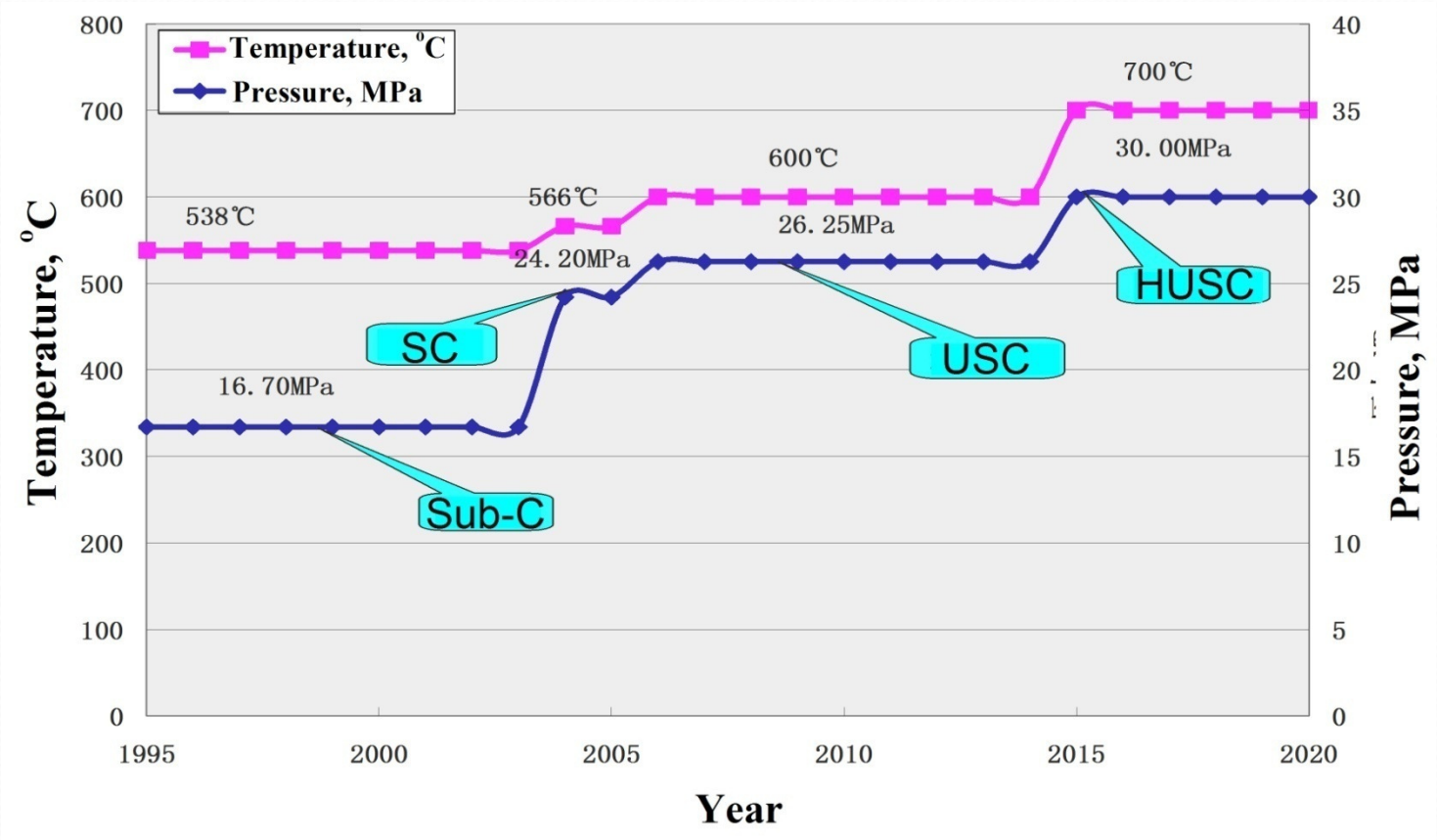
Average ratio of HSS in Chinese automobile

Oil/gas transportation & pipeline steels with high strength and high toughness



Energy Efficiency of Power Plant Boiler Tubes (China)

Material researchers should make greater efforts to develop more competitive steel material with higher high-temperature strength and higher oxidation resistance to improve the thermal efficiency of power plants.



Ultra High Strength Steel

1500m

High Strength Steel

750m

Wrought Iron

300m

Construction of high-rise Eiffel tower with high strength steel.

Thank You