# GHG reduction opportunities in China's cement, iron and steel and electricity sectors

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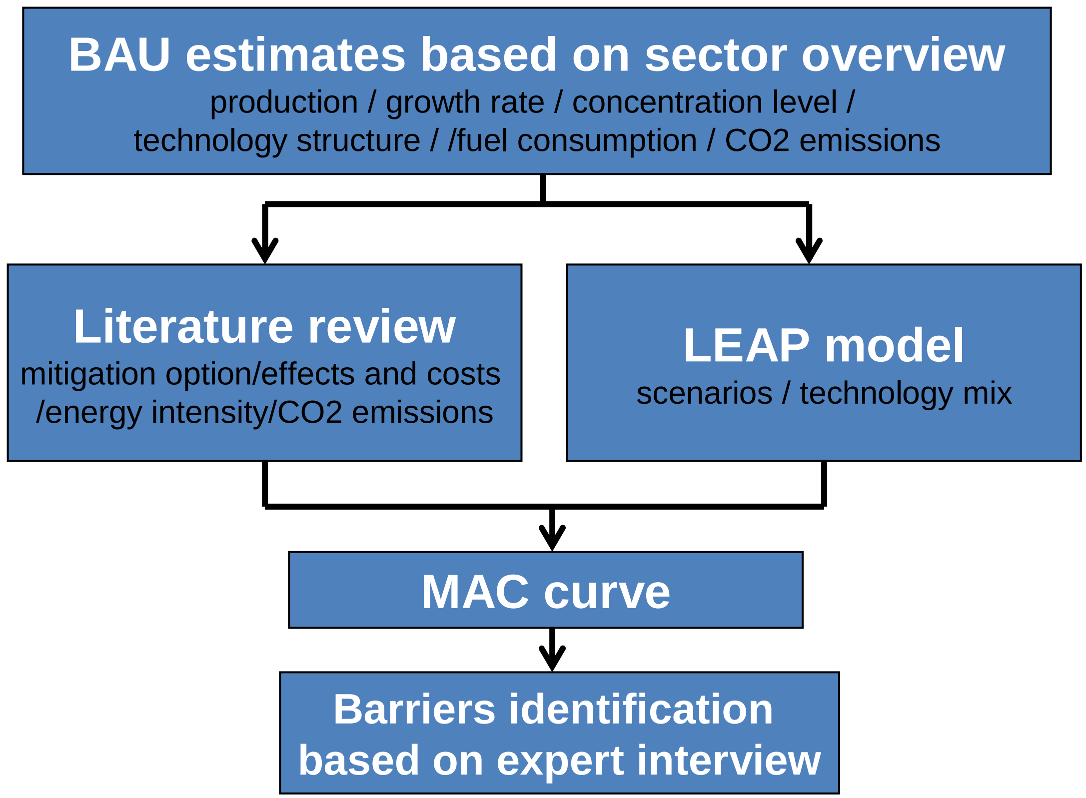
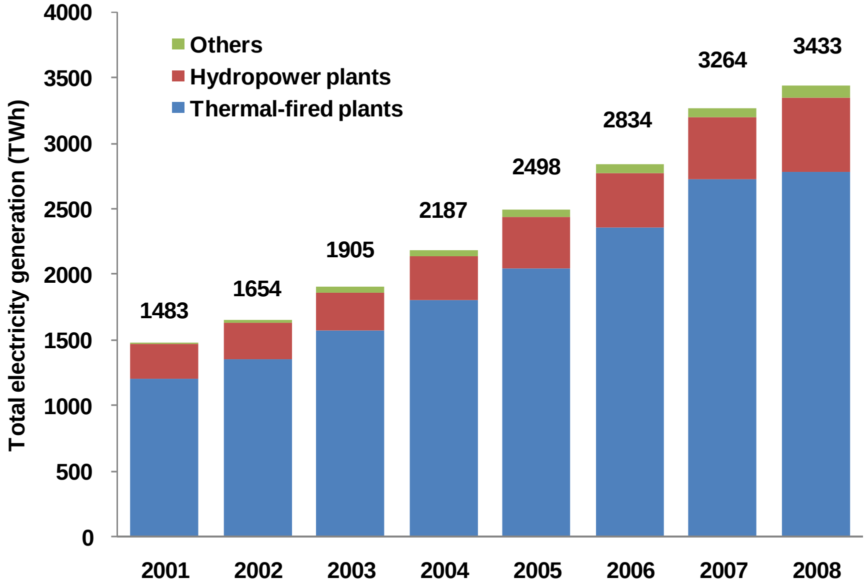
# About Tsinghua’s work

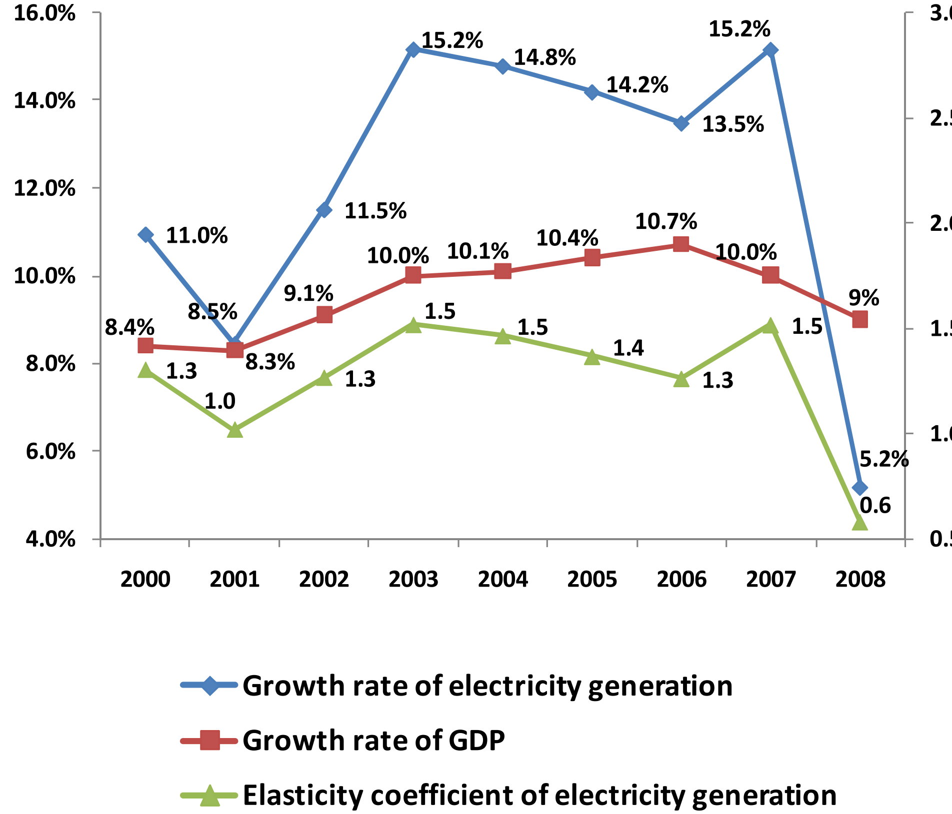
- Objectives: how can China achieve more GHG mitigation in post-Kyoto era
- Questions to answer：
  - What are the opportunities and challenges of GHG mitigation in the energy-intensive sectors in China? ( Mainly look into electricity, cement, and iron and steel )
  - How to design the domestic policy as well as the international support to promote the development of mitigation option and policy in China?
- Content for each sector
  - Sector overview
  - Baseline
  - Mitigation options and their reduction potentials
  - MAC interpretation
  - Barrier analysis and policy recommendations

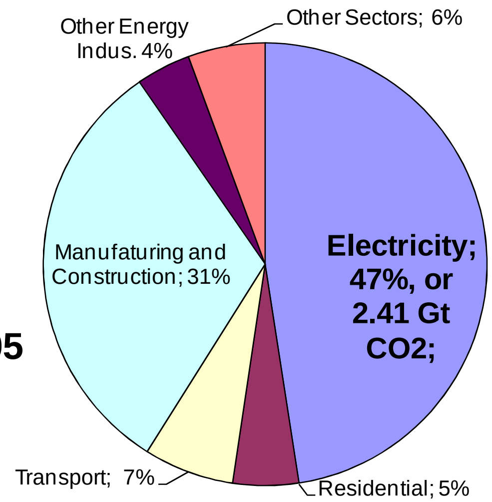
# Research Methodology



# China's Electricity Sector Overview

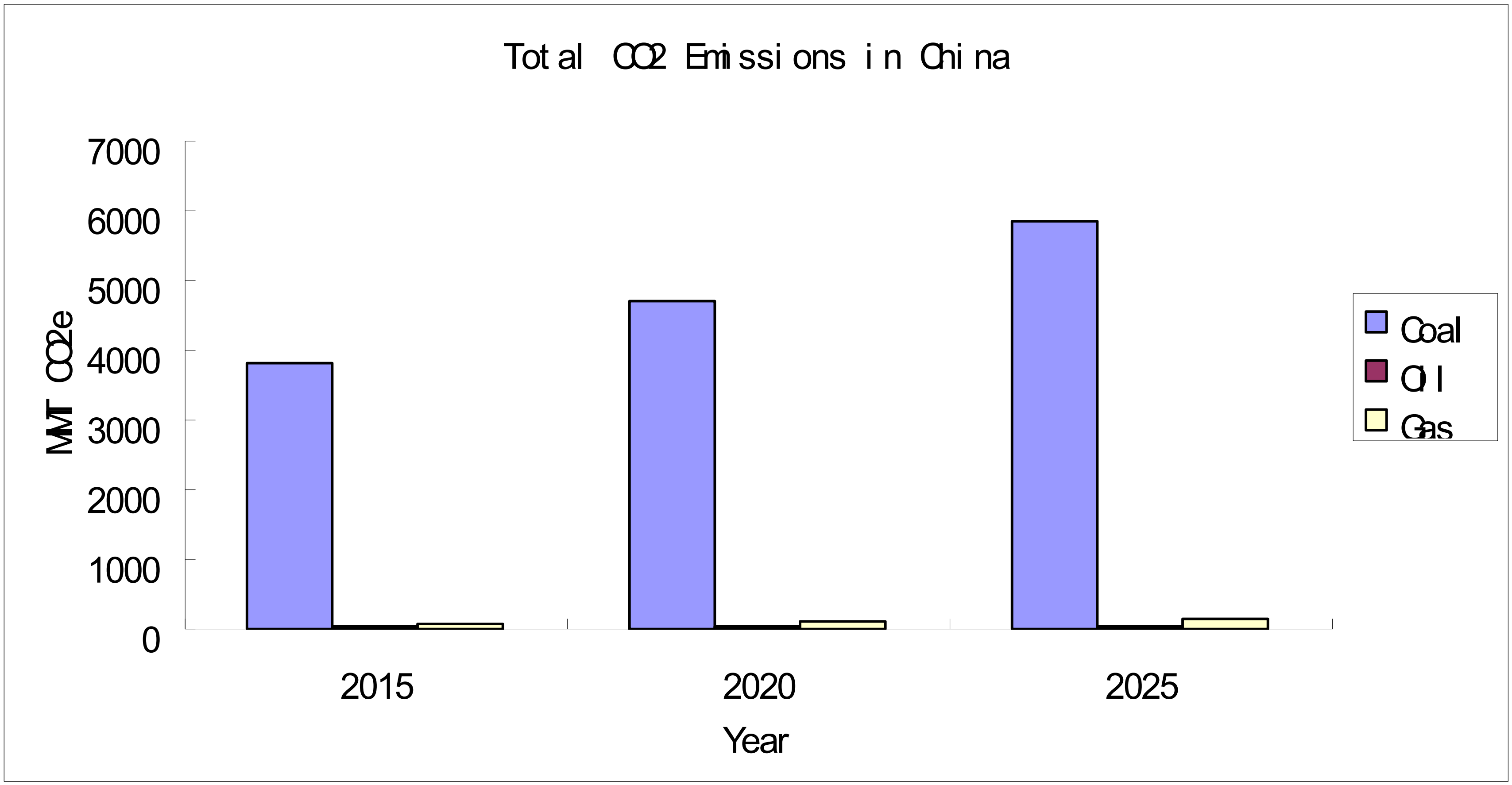



**Data in 2005**

# China's Electricity Sector's BAU Emissions

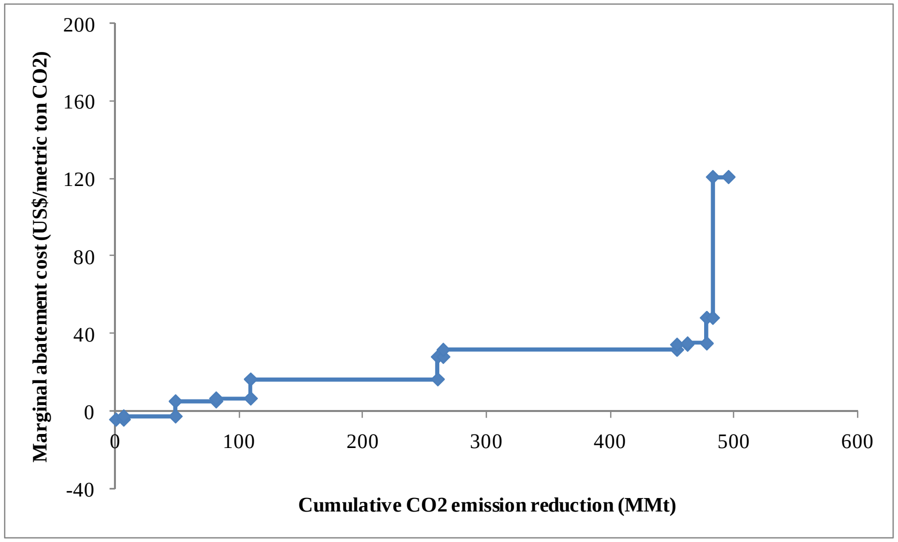



About 5000 MMT in 2020 and 6000 MMT in 2030; Coal plays dominant role.

# Mitigation Options

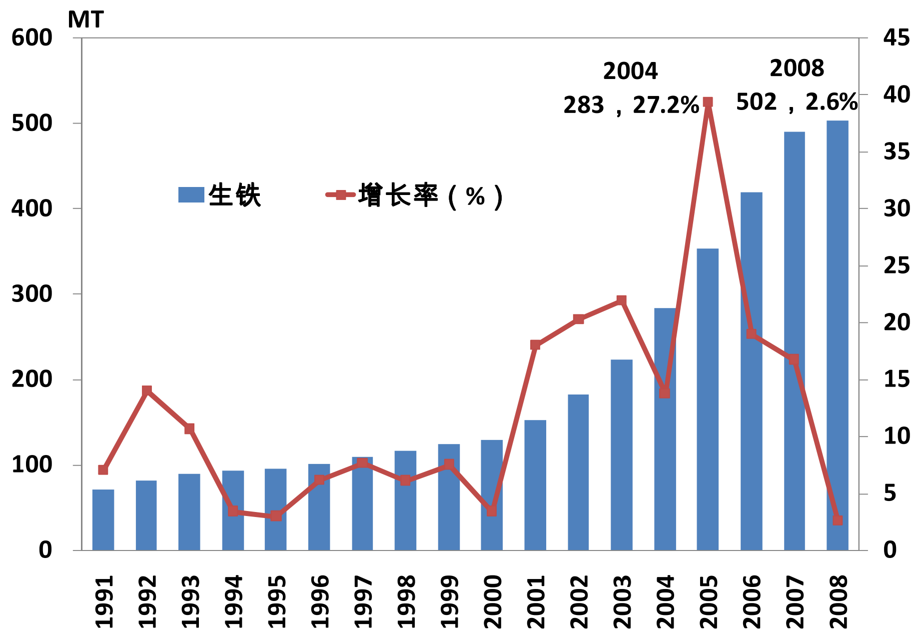
- *Demand Side Management (DSM)*
- *Reconstruction of Conventional Thermal Power*
- *Supercritical / Ultra-Supercritical Plants (SC/USC)*
- *Integrated Gasification Combined Cycle (IGCC)*
- *Carbon Capture and Storage (CCS)*
- *Renewable Energy*

# Marginal Abatement Curve in 2020




- *0 - 50 MMt*: MAC are **negative** (energy saving benefits higher than its related costs); e.g. demand side management
- *50 MMt – 480 MMt*: MAC become **positive but less than 50 USD/t$CO_2$**; e.g. supercritical and ultra-supercritical plants
- **Abrupt rise** of mitigation costs (more than 100 USD/t$CO_2$) in order to reach the maximum emission reduction potential 495MMT in 2020 e.g. solar and CCS

# China's Iron and steel Sector overview

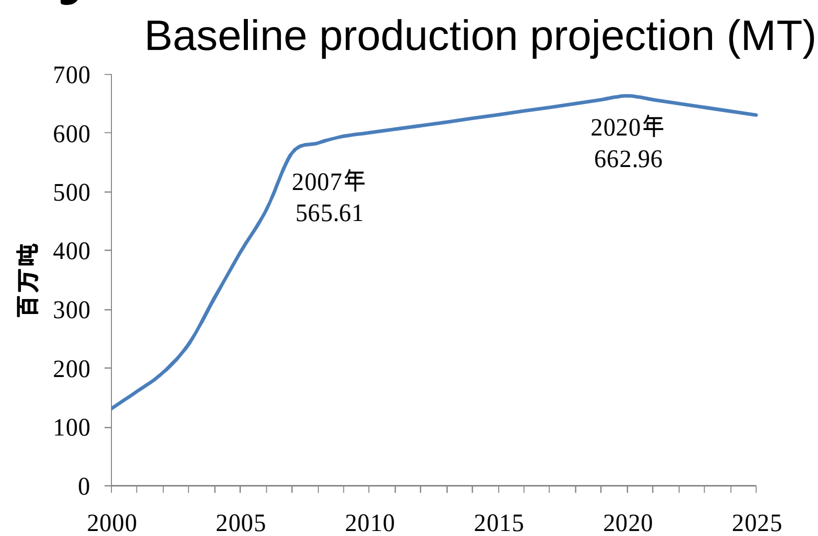


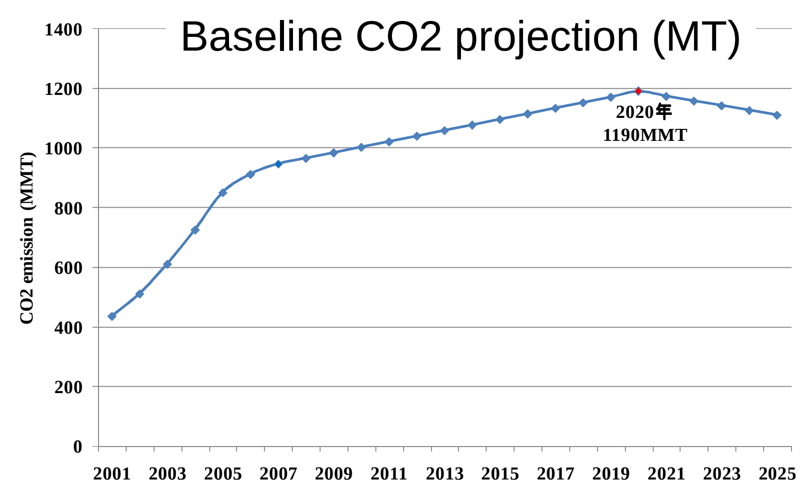

- Steel production: ranked 1st in the world for the last 13 years. 37.8% of global production in 2008
- Growth rate of production

- Very low concentration level compared to other big steel production countries – 41% in 2008.
- Energy efficiency: 15% gap between China's big and medium IS plants and international advanced level. But even bigger difference between the large plants in China and the small ones.
- Emissions: About 900 MT of $CO_2$ emissions in 2006 in China's iron and steel sector (about 15% of national emissions), only after power generation and cement sectors.

# Baseline projection

- Mainly based on：
  - Iron and Steel Industrial Development Policy
    - “no big expansion of production capacity in principle”
  - Development rule of developed countries
    - “Steel production per capita per year will reach 400-600 kg when realizing industrialization”
  - Literature research, expert interview of the future development and production, as well as technological structure



# Mitigation options and reduction potentials

Table 12. Cost of mitigation options and relevant emission reduction in 2020

| Mitigation Options | Cost Effectiveness ($/ton $CO_2$) | Total Emission Reduction (MMT$CO_2$) |
|---|---|---|
| Establish energy management center | -3.07 | [illegible] |
| Advanced coke oven | 3.51 | [illegible] |
| Advanced blast furnace technology | 6.21 | 25.36 |
| Adjust ratio of iron/steel | 9.49 | [illegible] |
| Advanced sinter machine | 27.16 | [illegible] |
| Advanced direct steel rolling machine | 29.95 | 4.56 |
| Dry coke quenching | 31.91 | [illegible] |
| Smelt reduction technology | 45.23 | [illegible] |
| Advanced converter | 52.35 | [illegible] |
| Advanced EAF | 112.83 | 5.85 |

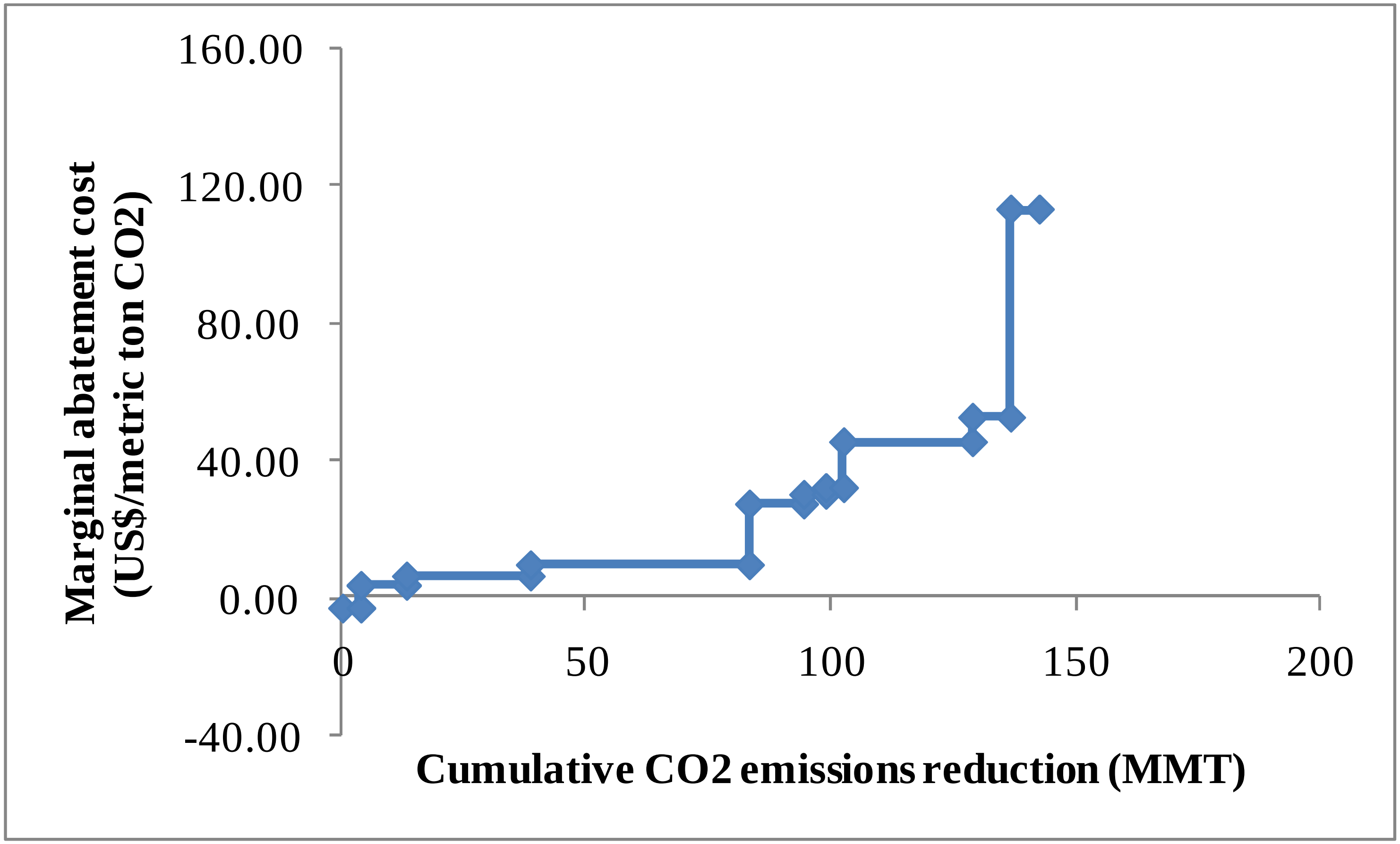
**Advanced blast furnaces**

**Advanced sintering machines and coke ovens**

**Advanced Electric Arc Furnaces**

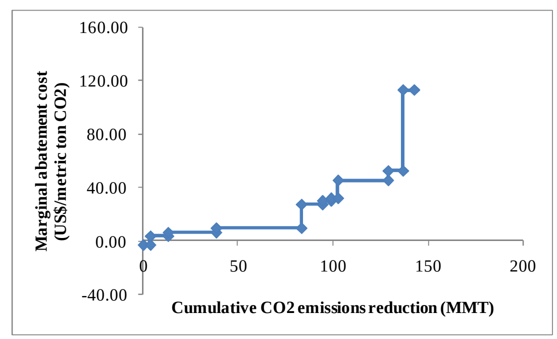
**Smelt reduction**

# MAC curve in 2020

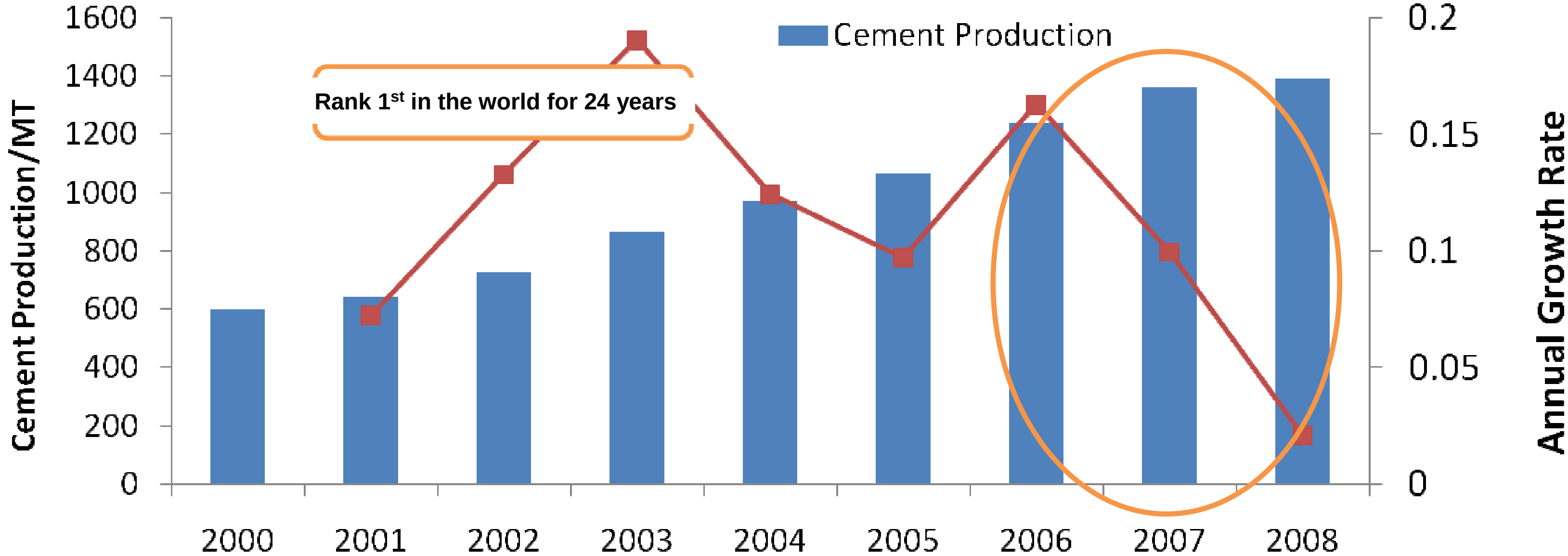


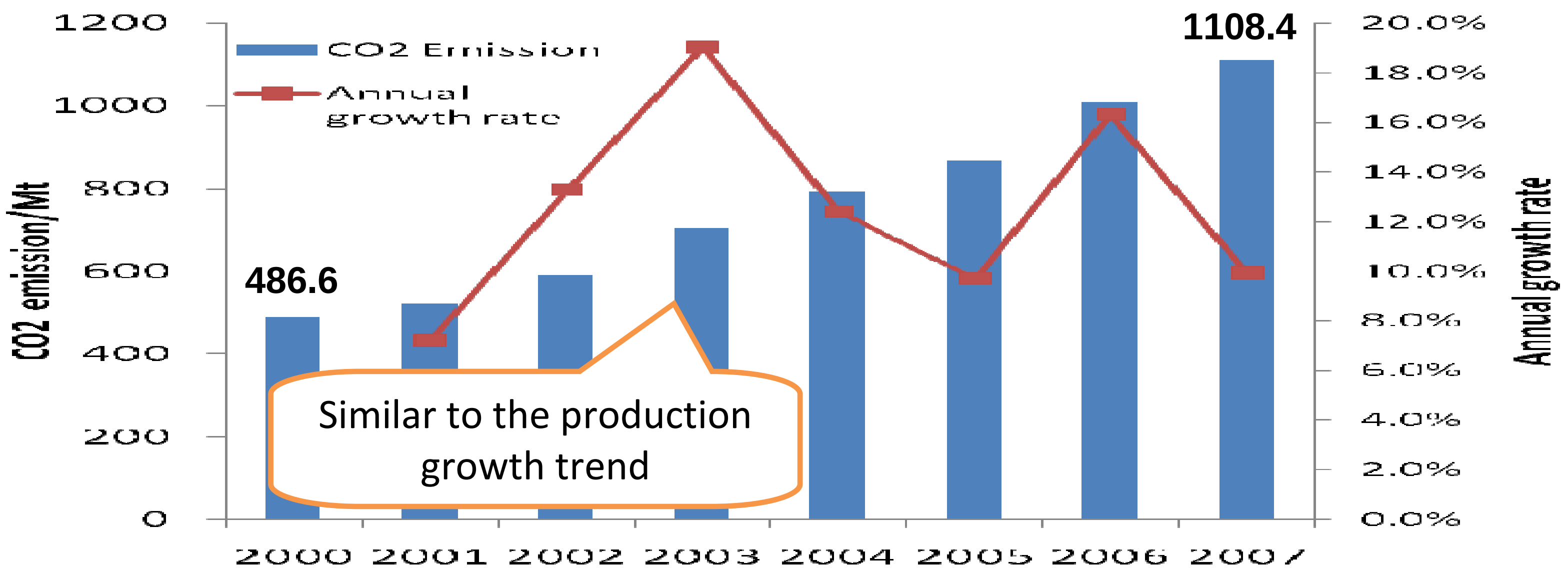
# MAC interpretation

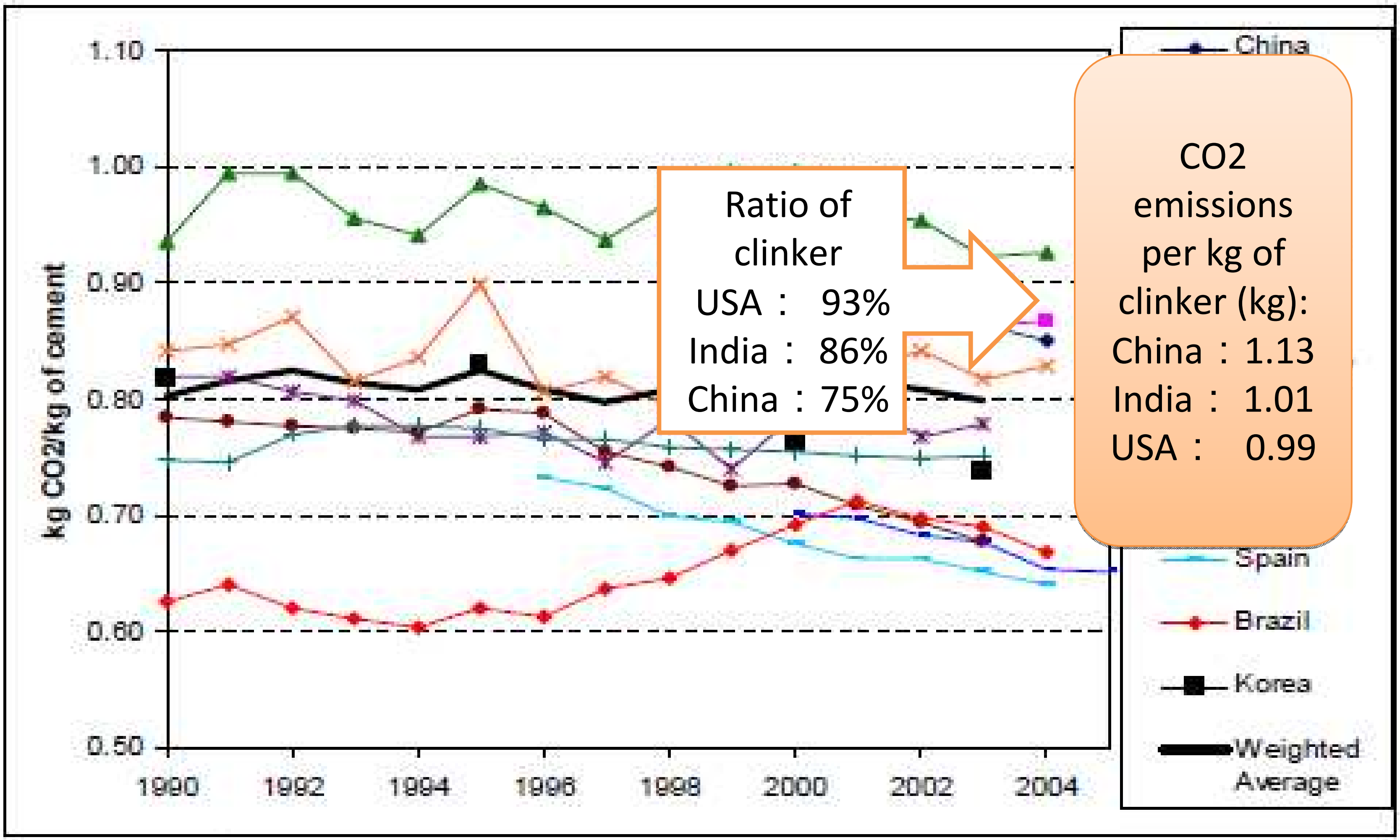
- 3% of emission reduction potential can be realized by negative-cost technologies, e.g. establish energy management center.
- 20% of emission reduction potential can be realized by technologies with the average cost of near zero, e.g. advanced coke oven technology.
- To realize the total 143 MT of reduction potential, the corresponding average cost will rise abruptly to 24 USD/ton (due to the use of technologies such as advanced EAF and smelt reduction process) ; while the total cost is as high as 3.4 billion USD.
- If China can get support in developing and diffusing advanced technologies such as CCPP, ultra-super direct currency EAF and smelt reduction with pre-reduction and gas recovery, China will save energy and promote GHG reduction in iron and steel sector more efficiently.



# China's Cement Sector Overview





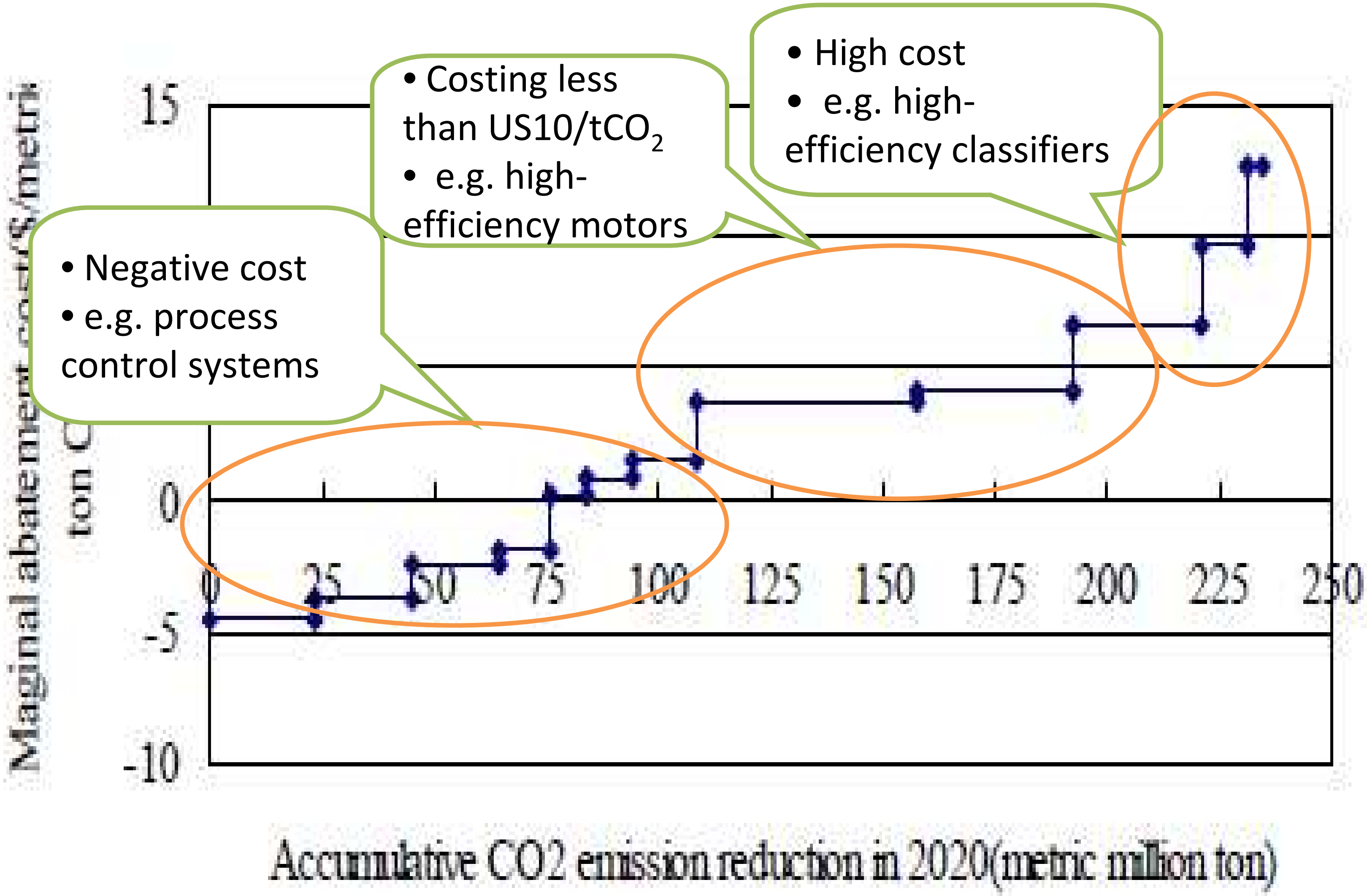

*Source: IEA, 2007b.*

*Note: Numbers show $CO_2$ emissions per kilogramme of cement, including thermal energy, upstream electricity emissions and process emissions. Note that a lower clinker-to-cement ratio - i.e. more use of additives - implies lower $CO_2$ emissions per tonne of cement. The above data does not reflect the energy efficiency performance of clinker, but rather the $CO_2$ performance of the whole energy chain leading to cement manufacturing.*

# Mitigation options in cement sector

| | |
|---|---|
| **Raw materials preparation (wet process)** | **Raw materials preparation (dry process)** |
| Mechanical transport systems | Mechanical transport system |
| | Raw meal blending system |
| | High efficiency roller mills |
| | High efficiency classifiers |
| **Clinker production (wet process)** | **Clinker production (dry process)** |
| Kiln combustion systems | Kiln combustion systems |
| Kiln shell heat loss reduction | Kiln shell heat loss reduction |
| Use of waste fuels | Use of waste fuels |
| Conversion to grate cooler | Conversion to grate cooler |
| Conversion to semi-wet process | Low pressure-drop cyclones |
| Optimize heat recovery(grate cooler) | Heat recovery for power generation |
| Conversion to precalciner kiln | Conversion to multi-stage preheating |
| | Conversion to pre-calciner kiln |
| | Conversion to PH/PC-kiln |
| | Optimize heat recovery(grate cooler) |
| **Finish grinding** | **General measures** |
| Improved grinding media | Variable speed drives |
| High-pressure roller press | High-efficiency motors |
| Roller press/Horomill | Process control systems |
| High efficiency classifiers | |
| **Product changes** | |
| Blended cement | |

# MAC curve



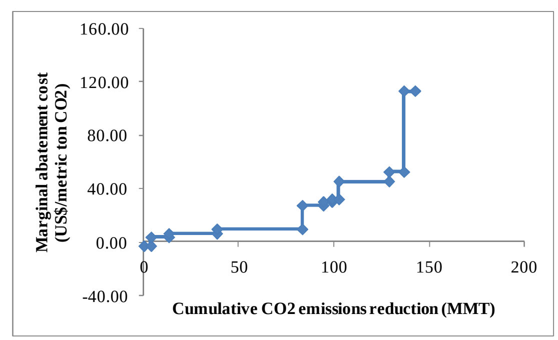
• Costing less than US10/tCO2
• e.g. high-efficiency motors
• High cost
• e.g. high-efficiency classifiers
• Negative cost
• e.g. process control systems
Maginal abatement cost($/metric ton CO2)
15
0
-5
-10
0
25
50
75
100
125
150
175
200
225
250
Accumulative CO2 emission reduction in 2020(metric million ton)

# Mitigation barriers summary

- The expansion of energy-intensive sectors are mostly due to the growing need from rapid economic growth in China, which makes it difficult to mitigate their GHG emissions;
- The unstable economic environment has augmented the difficulties for energy saving and emission reduction in energy-intensive sectors.
- Technical and financial gap of China's energy-intensive sectors compared to developed countries
- Large number of plants and low concentration level are hindering the development and diffusion of mature emission reduction technologies, not to mention those advanced technologies. Also, these SMEs are lack of enough financial capacities to mitigate.
- Subsequent social problems (unemployment and wage cuts) are causing big concern.

# Summary and recommendations

- China has been doing and will continue doing remarkable emission reduction actions unilaterally.
- International support for technology, financing and capacity building will help China escape from lock-in effects.
- The sectoral MAC analyses can give technical support to decisions related to NAMAs. Principles need further definition.



# Thank you!

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