GHG reduction opportunities in China's iron and steel sector

Wenjia Cai
Tsinghua University
2009-5-13

Research objectives

- 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? How will the mitigation options develop?
    - Mainly look into electricity, cement, iron and steel, and transport
  - How to design the domestic policy as well as the international support to promote the development of mitigation option and policy in China?

Outline

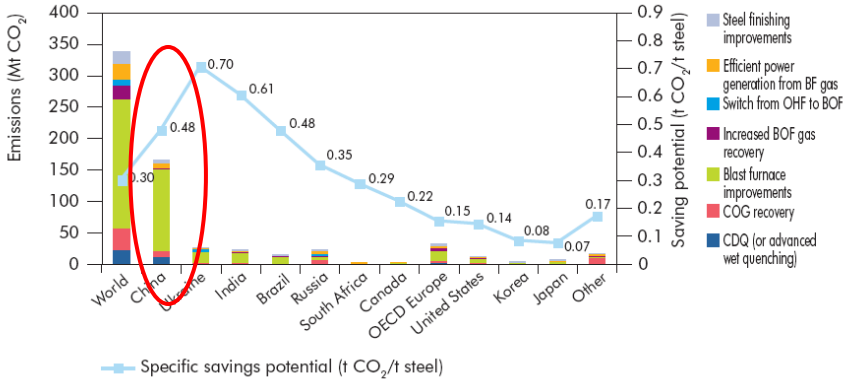
- Iron and steel sector overview
- Emission baseline projection
- Mitigation options in iron and steel sector and their policy implication
- Domestic management system and design of international support – case study: TRT in Shandong
- General mitigation policies and international support mechanism discussion

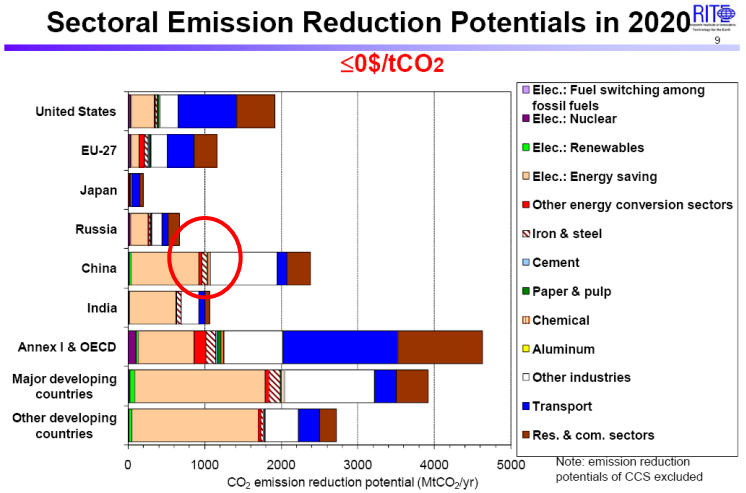
Sector overview

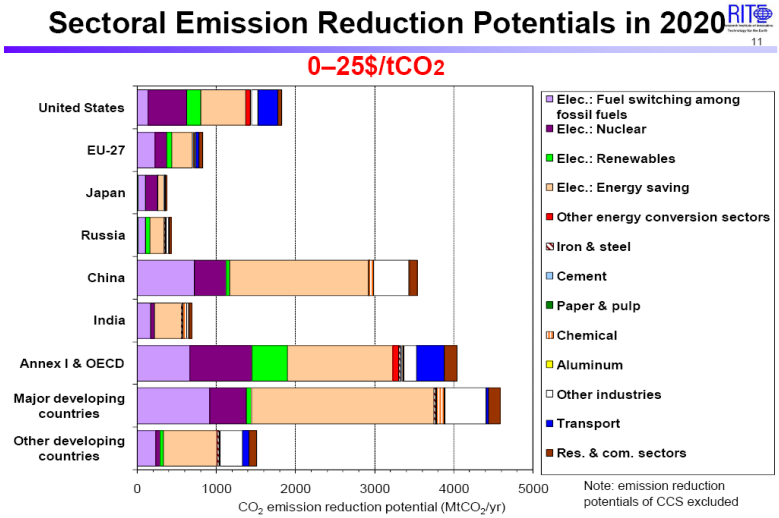
- Steel production: ranked 1st in the world for the last 13 years. 502 million tons of steel in 2008 (37.8% of global production).
- Growth rate of production: decreased from 27.2% in 2004 to 2.6% in 2008.
- Very low concentration level compared to other big steel production countries – 41% in 2008.
- 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.

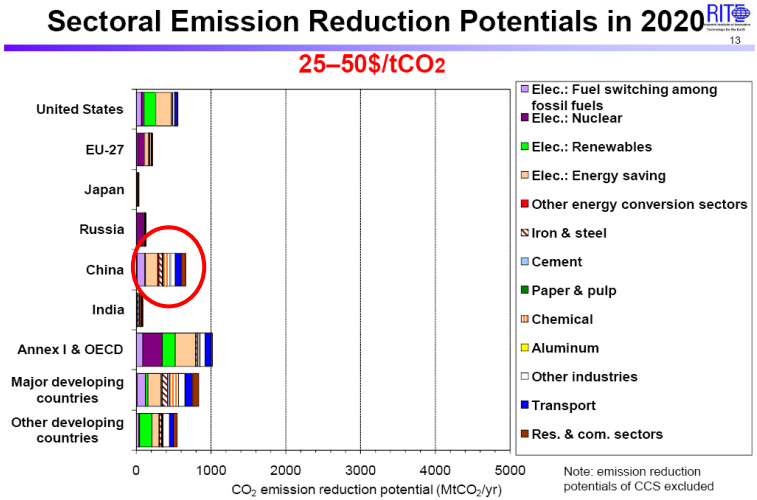
Other researches abt mitigation potential and cost

Figure 16.8 ▶ CO_2 emission reduction potentials in 2005, based on best available technology





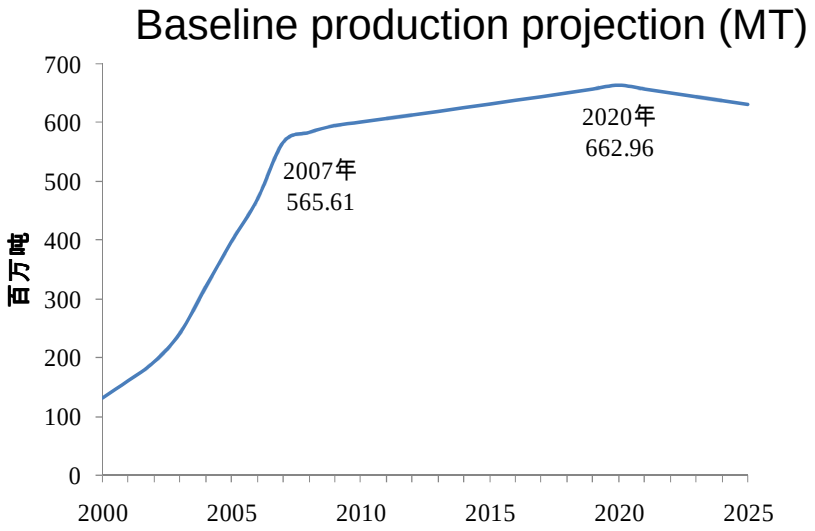


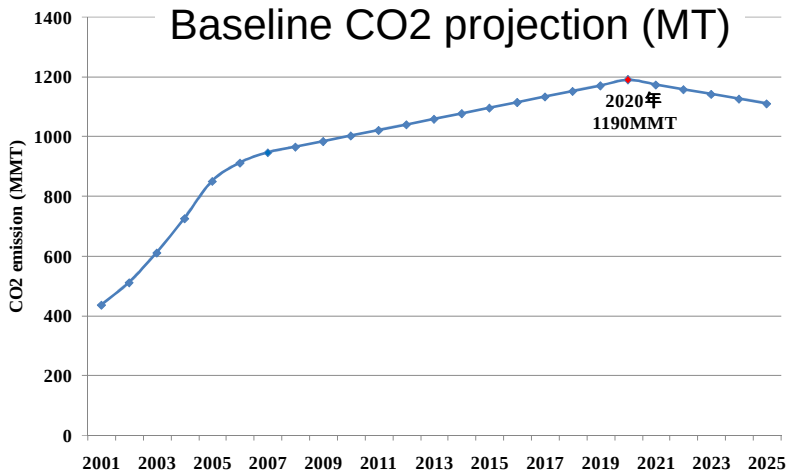


Source: Energy Technology Perspectives 2008 (pp.486)
RITE results presented in 2nd International Workshop on Sectoral Emissions Reduction Potential Oct2008

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 ($/ton CO_2)	Total Emission Reduction ($MMTCO_2$)
Establish energy management center	-3.07	
Advanced coke oven	3.51	
Advanced blast furnace technology	6.21	25.36
Adjust ratio of iron/steel	9.49	
Advanced sinter machine	27.16	
Advanced direct steel rolling machine	29.95	4.56
Dry coke quenching	31.91	
Smelt reduction technology	45.23	
Advanced converter	52.35	
Advanced EAF	112.83	5.85

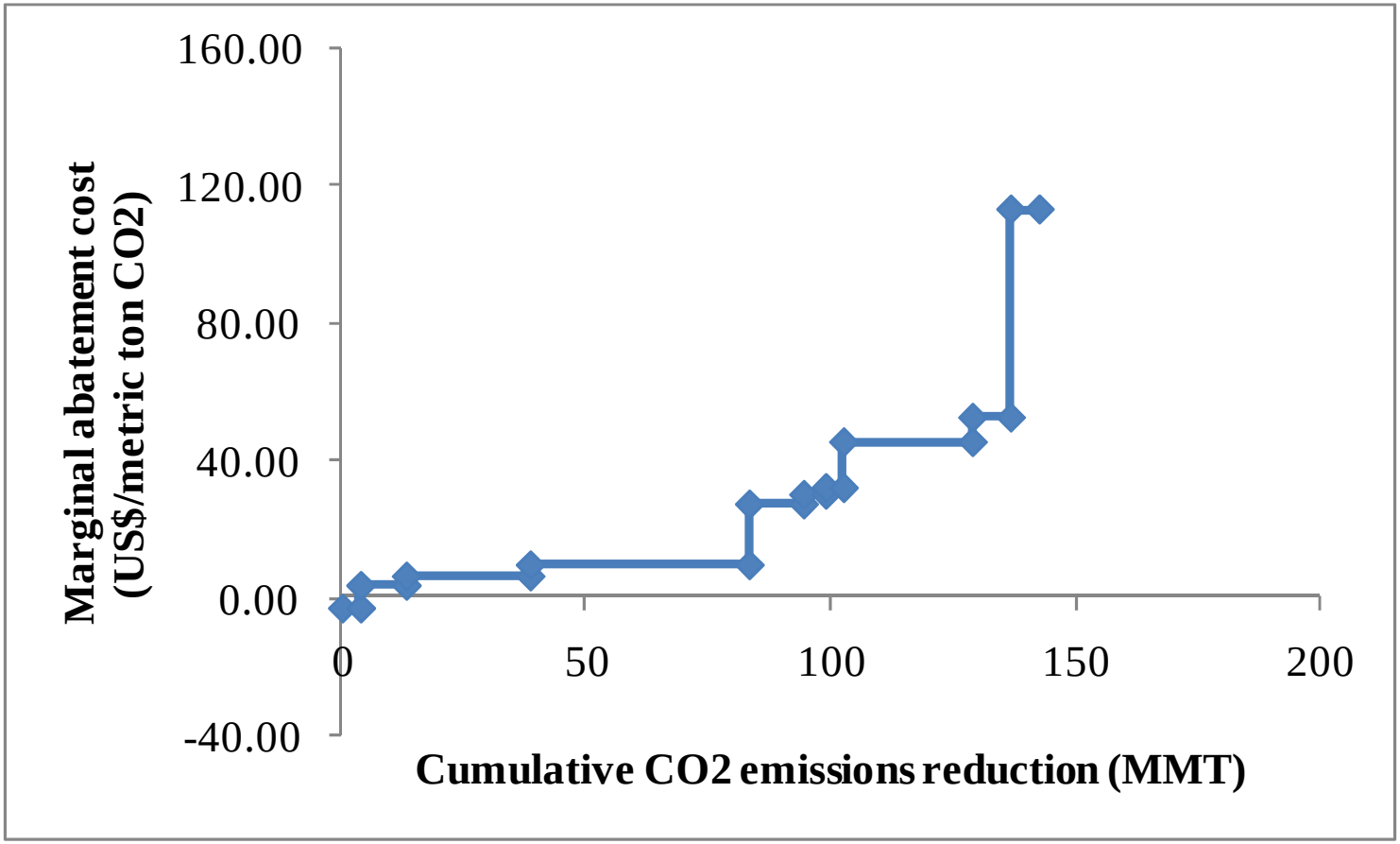
Advanced blast furnaces

Advanced sintering machines and coke ovens

Advanced Electric Arc Furnaces

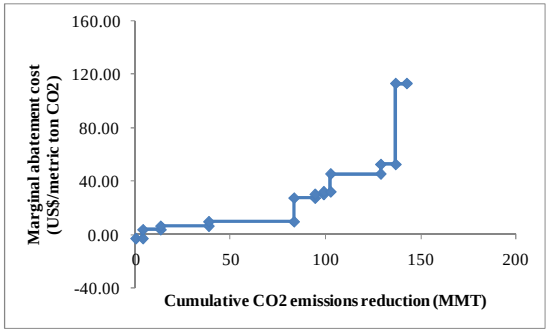
Smelt reduction

MAC curve in 2020



MAC interpretation

- 3% of emission reduction potential can be realized by negative-cost technologies.
- 20% of emission reduction potential can be realized by technologies with the average cost of near zero.
- To realize the total 143 MT of reduction potential, the corresponding average cost will rise abruptly to 24 USD/ton; 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.



Industry structural barriers to mitigation plan

- （1）The economic recession and the weak steel market in 2008 augmented the difficulties for energy saving and emission reduction in iron and steel sector.
- （2）The economic stimulus package saved the lives of some small plants (which originally are to be eliminated), and increased the difficulties to mitigation.
- （3）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.
- （4）China’s iron and steel sector is in big transition period (merging), causing a great demand for money and for mature and advanced technology to escape from lock-in effects. Urgent task.
- （5）Subsequent social problems (unemployment and wage cuts) are causing big concern.

The case study to promote key mitigation options - TRT in Shandong

- Why a provincial analysis and why Shandong?
- Why TRT?
  - Previous researches
  - National strategies
  - Sectoral and provincial experts interview

	Invest-ment cost	Emission effects	Technological deployment potential
CDQ	**	****	*
TRT	****	***	***
CCPP	*	*****	*****
Waste heat recovery of circular cooler at sintering plant	***	*	****
Converter steel-making with negative energy consumption	*****	**	**

Current TRT status in Shandong and barrier analysis

- **62 blast furnaces had 11 TRT units in 2006.**
- **Why such a low penetration rate when industrial policy requires new BF to have TRT?**
  - **Technical barrier?** No.
  - **Management barrier?** No. Consistent to industrial policy.
  - **Operational barrier? YES.**
  - **Financial barrier? YES.**

Barrier analysis - continued

- **Operational barrier? - YES.**
  - Plants cannot directly use the electricity generated from TRT.
  - Ideal situation: use the electricity directly, and buy the extra from grid
  - Actually: sell the electricity generated from TRT to grid company, and then buy it with a higher price. Negatively affect the positivity of iron and steel sector to recover residual pressure. Plus, a very complex procedure for TRT electricity to go on-grid (sometimes takes half a year or more than a year).

However, to break up this monopoly process and speed up the approval is not easy, according to the difficult reform going on in the electricity sector.

Barrier analysis - continued

- **Financial barrier? YES.**
  - Esp. SME plants, big problem.
  - Take QingGang for example (the third biggest plant in Shandong): 2 BFs of 350m^3, 1 BF of 400m^3, 3 BF of 500m^3. Total profits in 2005 was 169 million Yuan. In 2006, QG installed 2 TRT units, costing 59% of the profit in 2005.
  - For those small plants needed to renew their BF, the investment is hard to bear. A new BF costs 400 million Yuan.
  - In all, (1) downward demand market (2) small sized plants with weak financial strength (3) industrial restructuring pressure as well as energy saving and environmental protection pressures

Key solution: discount loan

The utilization of special mitigation fund in Shandong

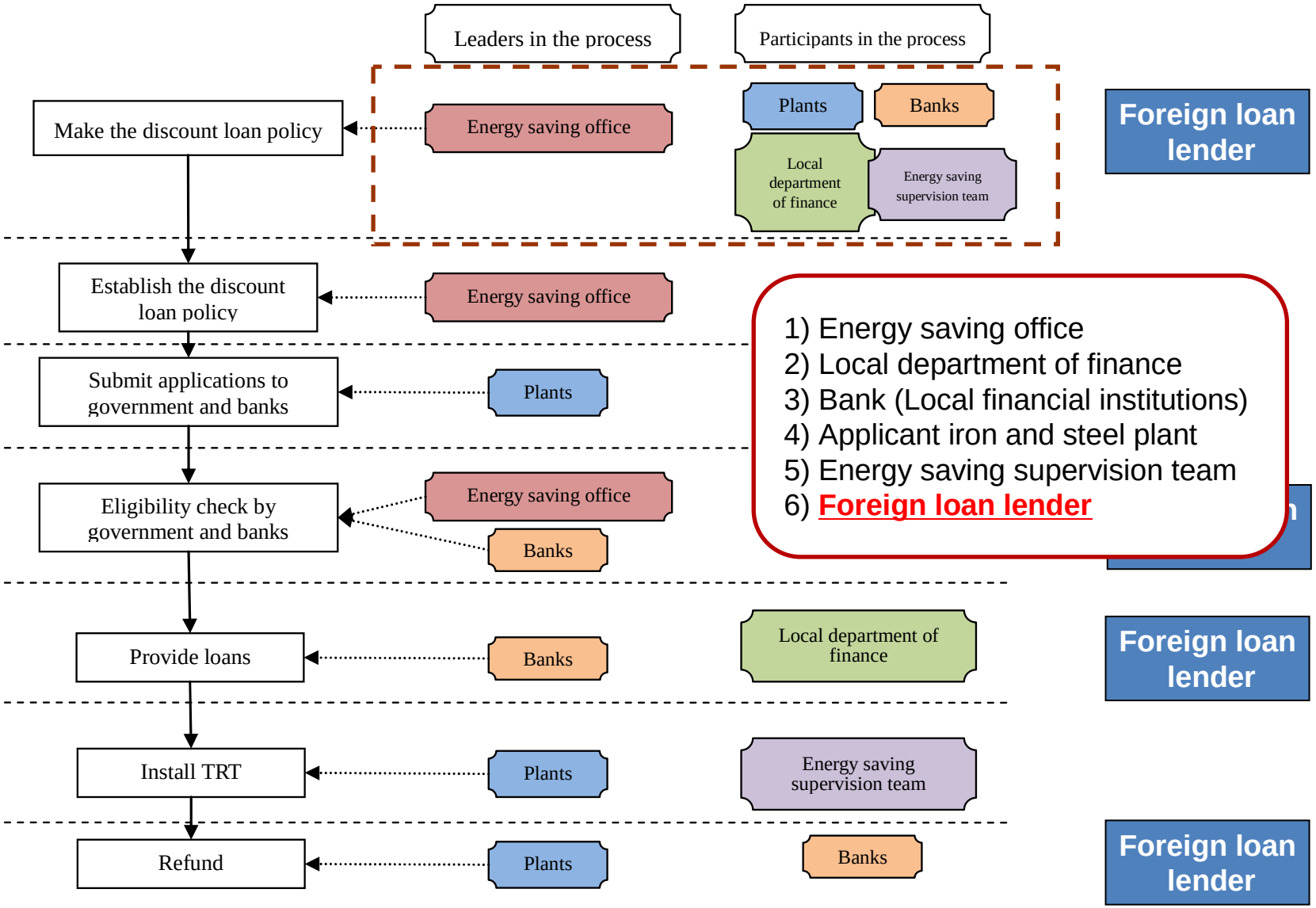
- In 2007, Shandong had planned a 2.1 billion Yuan for provincial energy saving and emission reduction (normal pollutants) :
  - About 580 million Yuan is for energy saving and water
- Among the 580 million, 300 million were to be from provincial finance bureau. They are respectively used in:
  - 100 million - to support 50 key energy saving programs
  - The three “100 energy saving programs” (100 energy saving technologies, 100 energy saving equipments, 100 energy saving programs”) (but each technology and equipment would relate to many plants)
  - Eliminating energy-consuming equipments
  - Energy-saving bo[illegible]d this support
  - Setting up energy consumption criteria

Money for each plant is very very limited !

Options to combat implementation barriers

- Budget increase ?
  - Difficult. Too many mature energy-saving technologies.
- Improve investment environment ?
  - Comparatively easier. Build up the multi-channel investment environment; allow applying for loans from foreign countries or international financial institutions; improve the current financial system;

The discount loan system design



From this case to all mitigation options in I&S sector in China..

Options	Costs	Effects
CDQ	150-300 million Yuan	It can save 50-60 kgce per ton of coke made. It a
TRT	30-50 million Yuan	
CCPP	300-1000 million Yuan (may be higher according to scale)	
Waste heat recovery of circular cooler at sintering plant	40-50 million Yuan (if the sintering machine is around 90 m^2*2 large)	
Converter steel-making with negative energy consumption	20 million Yuan	
Direct Reduction Iron making	富蕴金山矿冶有限公司建设的年产2×15万吨直接还原铁项目，计划总投资4．5亿元，	
Smelt Reduction iron making	宝钢花142亿引进了COREX-3000熔融还原炼铁系统。 我国只有宝钢有实际动作，其他相关研究曾因资金不足搁浅。	平 比高炉高。但通过回收生产中产生的煤气，就可以回收大约60%的热量，使净能量消耗低于高炉水平，同时减少二氧化碳排放。

1）Re the difficulties to diffuse some mature energy saving technologies: ensure the stable development, increase the sector concentration level, money for technology upgrade, enhance government support; use foreign lender to broaden the financial channels.

2）Re the advanced technologies: increase the domestic R&D investment, enhance the communication and exchange between internationally advanced companies and institutions; speed up TT.

3）Re operational barriers: coordinate and get over them when doing domestic policy design

Regulatory policy suggestion

- Stricter technology standard
  - Mitigation is finally dependent on technology. Some of the mature energy saving technologies still have large potential to penetrate in China.
  - Similar actions being planning recently
- But some preconditions (or indirect cost) must be bear in mind before the large-scale diffusion of the technology:
  - Maybe based on the rise of concentration level, as well as some technical basis, which are very costly.
  - Considerations of social costs, and the proper arrangement of surplus staff.

Possible international support in China's iron and steel sector

- Financial support
  - A 3.4 billion USD in need to achieve the total technical mitigation potential in China's iron and steel sector
- Technology support
  - CCPP, UHP-DC-EAF, Smelt reduction with pre-reduction or gas recovery and etc
- Capacity building
  - Energy saving and emission reduction policy design of the government, energy saving supervision system construction, and etc
- Training and education
  - Operation and utilization of new energy-saving equipments and technologies

Thank you!

caiwj05@mails.tsinghua.edu.cn