Analysis of GHG Mitigation Policy and Implications in China's Electricity Sector

中国电力行业GHG减排的政策和影响分析

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Haoping Wang, Tsinghua University
王昊平，清华大学

Research objective
研究目的

- Main objective: How can China contribute to mitigation of GHG emissions in the Post-Kyoto Period?

  目的：在后京都时代，中国可以如何更多的减缓温室气体排放？
- Answer following questions: 回答以下问题：
  - What are the main challenges and opportunities of the most carbon-intensive sectors?

    主要高耗能行业的温室气体减排有哪些机遇和挑战？
    - Electricity, Iron and Steel, Cement and Aluminum

      电力，钢铁，水泥和铝业
  - How can domestic policy and international cooperation mechanisms promote mitigation technologies more efficiently?

    如何设计国内政策和国际合作机制来促进减排技术和政策在中国的发展？

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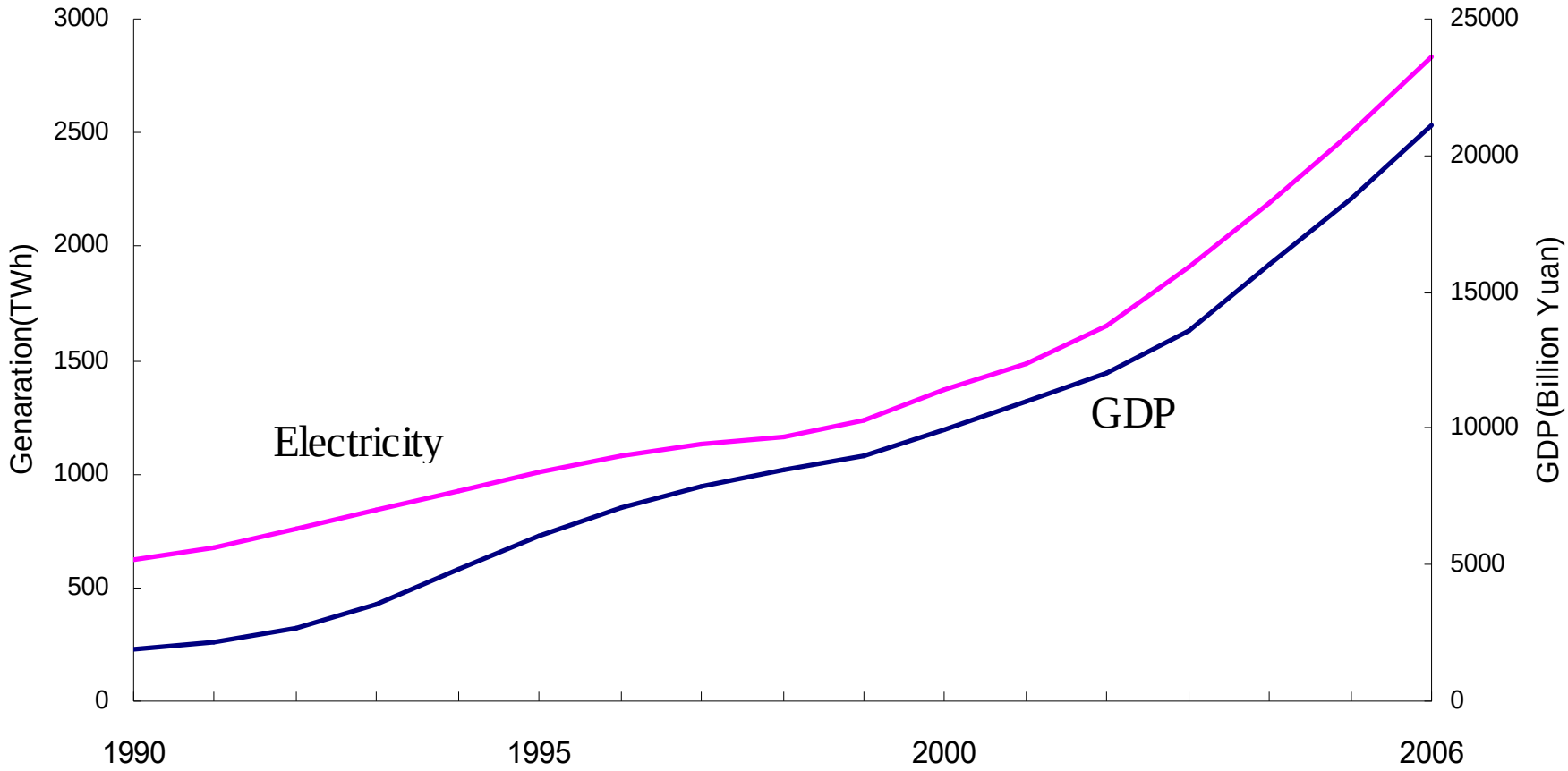
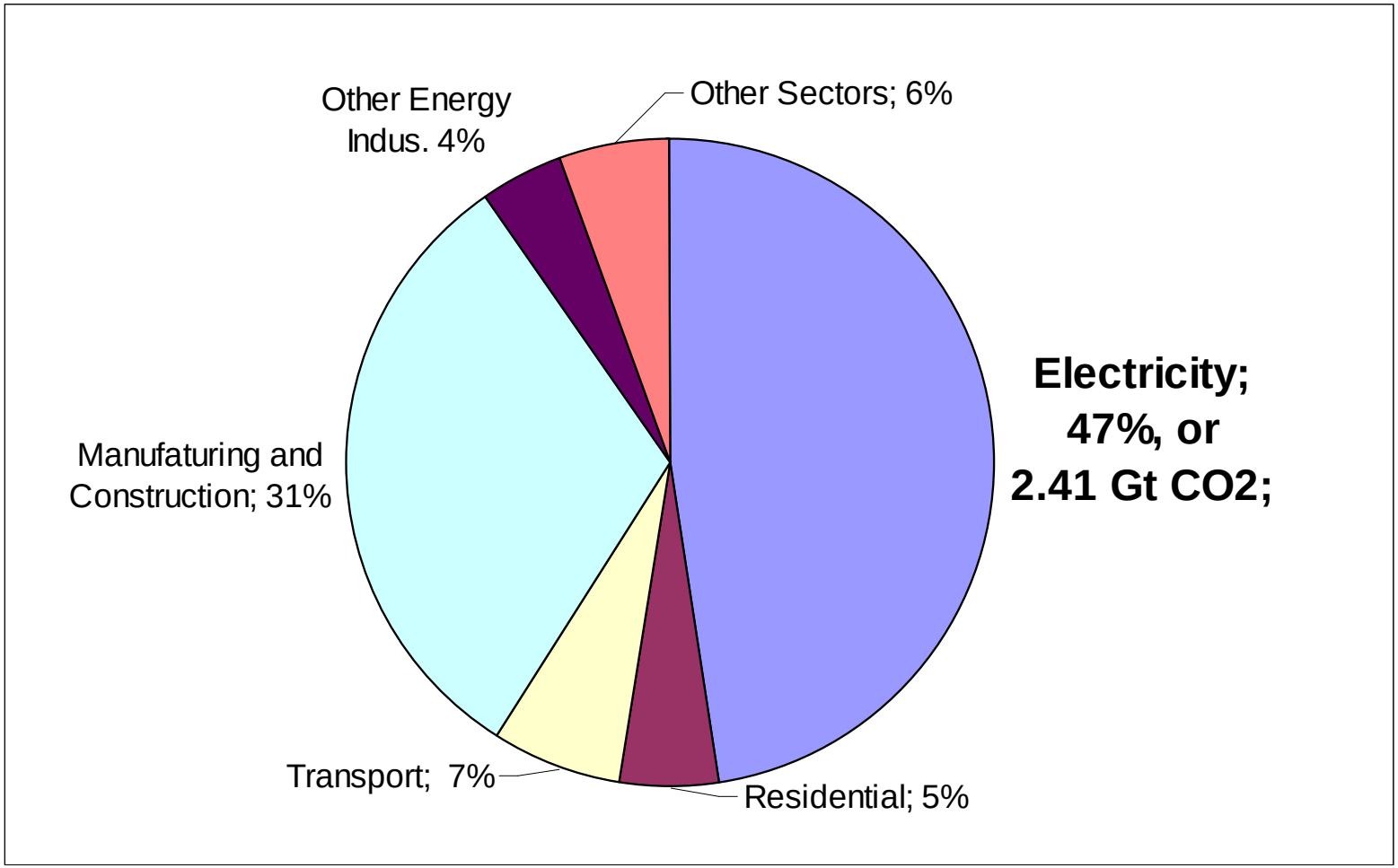
The Chinese Power Sector

中国电力行业

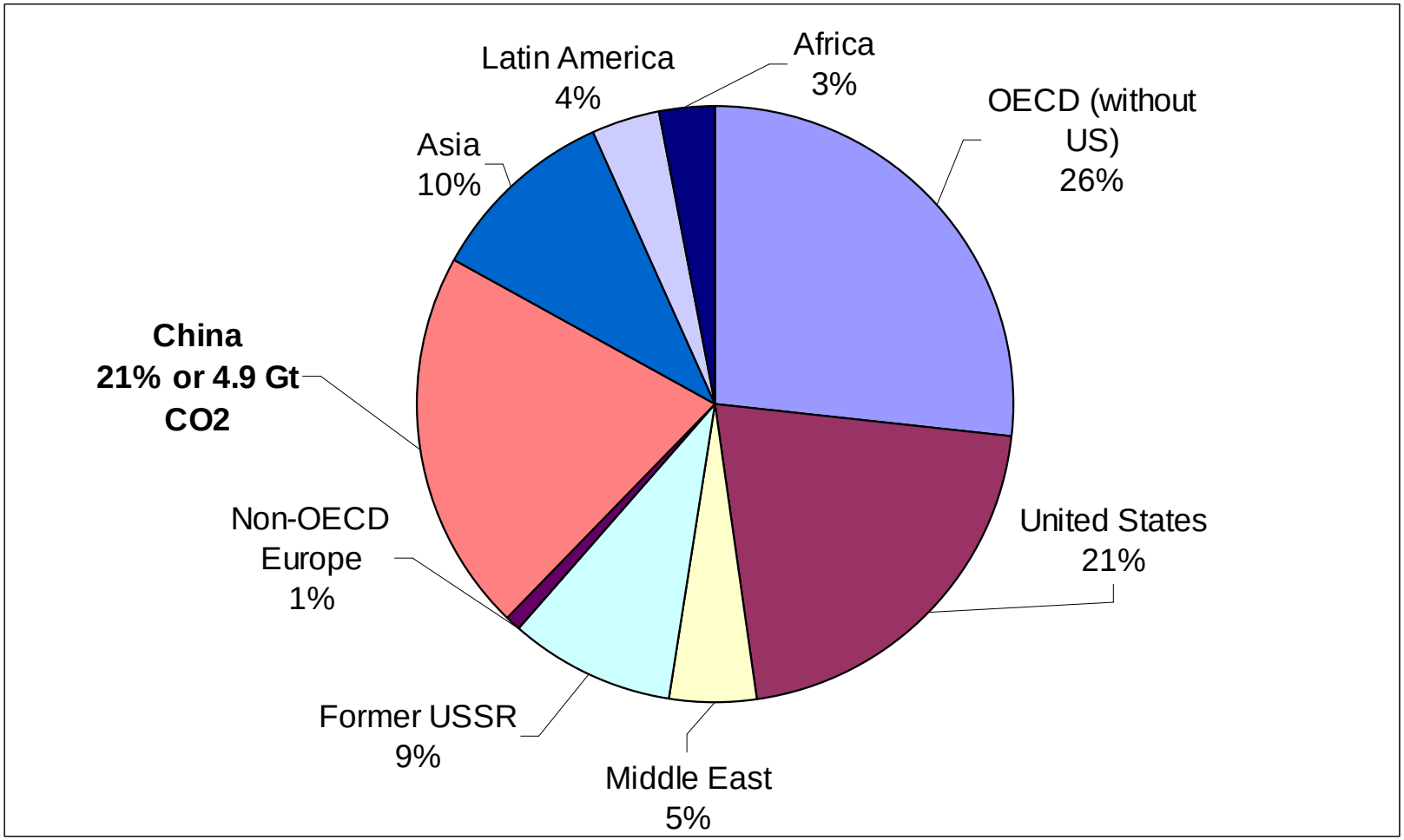
China‘s GDP and electricity generation
中国年GDP和年发电量之间的关系（1999-2006）



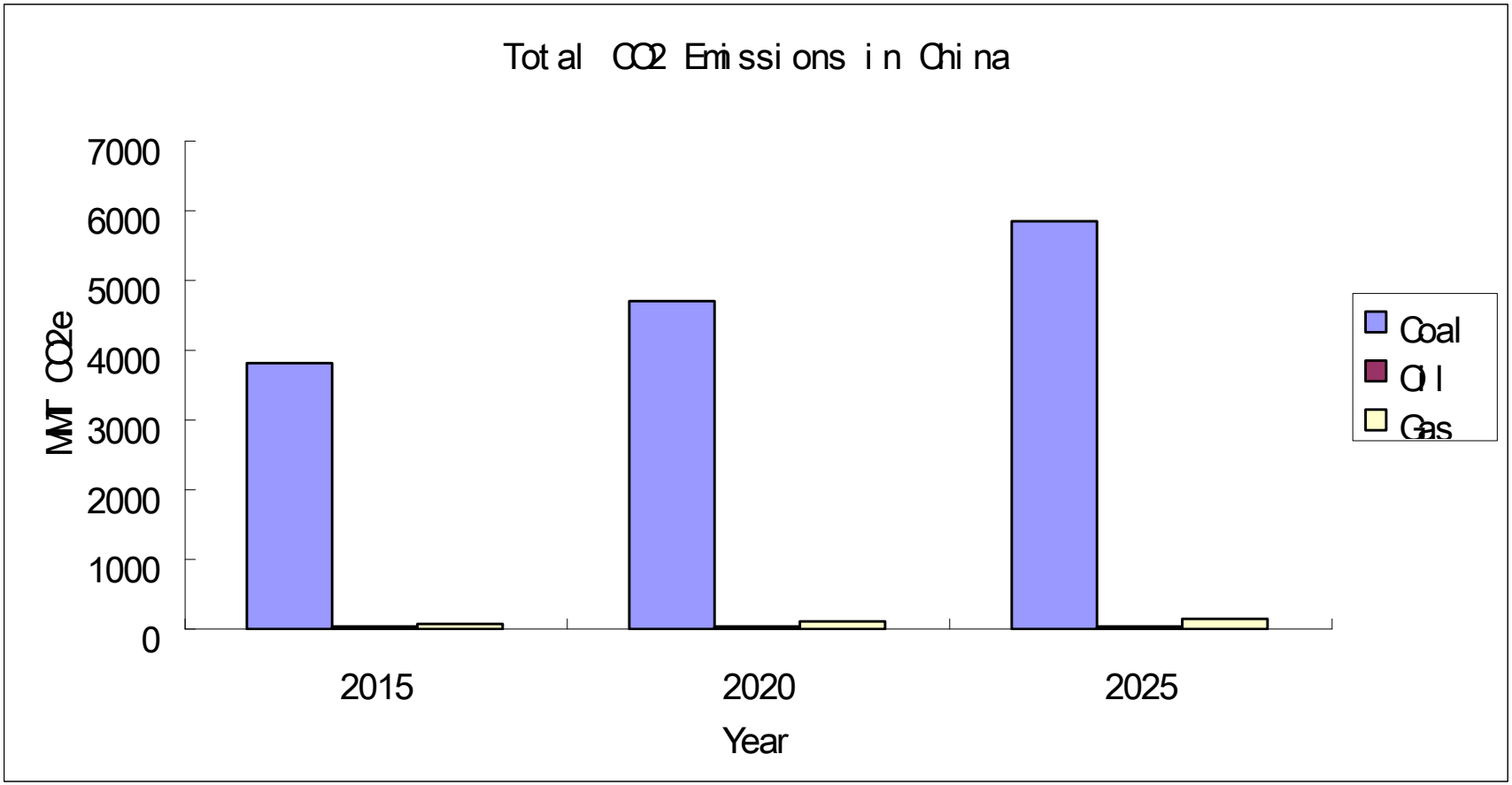
China's CO_2-Emissions in 2005
2005年中国各行业的CO_2排放比例



World's CO_2 Emissions in 2006
2006年世界各国CO_2的排放比例



Chinese electricity sector's BAU Emissions
中国电力行业基础线排放量



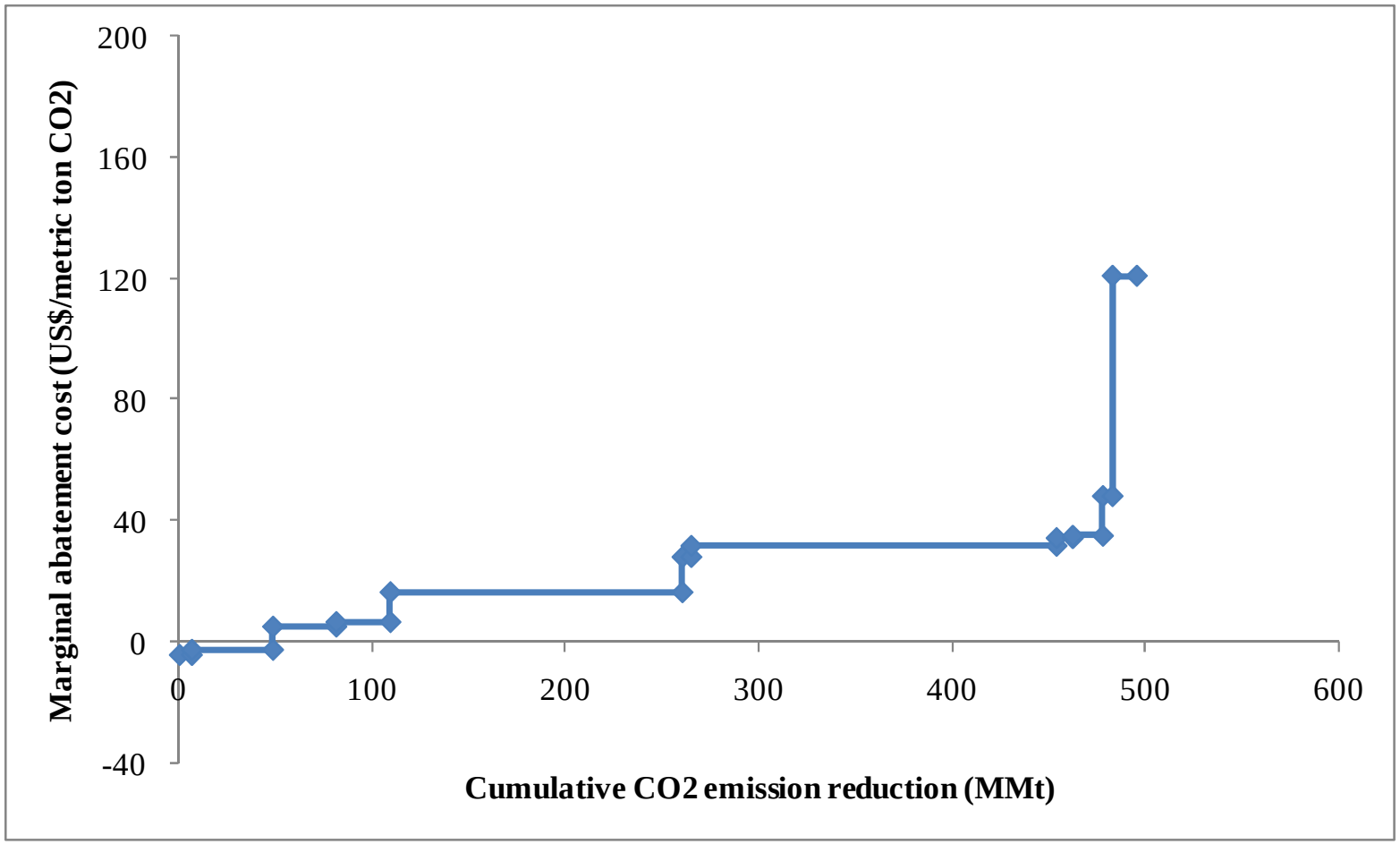
Mitigation Options and Potential

减排技术和减排潜力

Mitigation Options 减排选择

- *Demand Side Management (DSM) 需求侧管理*
- Reconstruction of Conventional Thermal Power
  常规火电厂改造
- Supercritical / Ultra-Supercritical Plants (SC/USC)
  超临界、超超临界发电厂
- *Integrated Gasification Combined Cycle (IGCC)*
  整体煤气化联合循环
- *Carbon Capture and Storage (CCS)*
  碳捕捉和储存
- *Renewable Energy可再生能源*

Marginal Abatement Curve in 2020
2020年边际减缓曲线



Interpretation 图解

- *0 - 50 MMt*: MAC are **negative** (income due to energy saving is higher than its related costs); 边际成本为负
- *50 MMt – 480 MMt*: MAC are **positive but low**; raising until *480 MMt* (costs of energy efficiency improvement measures are higher than the revenues); 边际成本为正，但保持较低水平
- **Abrupt rise** of mitigation costs by *480 MMt* of CO_2 reduction due to measures with much higher costs than revenues.

  边际成本急剧上升

5 Mitigation Scenarios (1)
五种减排情景

Methodology 方法:

- Literature research;
  文献调研
- Multiple interviews with experts;
  专家访谈
- Calculation Models with specific assumptions.
  基于一定假设下的模型计算

5 Mitigation Scenarios (2)
五种减排情景

- Scenario 1

  All mitigation measures which have *net negative marginal costs* are implemented, such as DSM.

  采用负边际成本的减排措施，如DSM。

- Scenario 2

  All mitigation measures (with rising costs along the cost curve) with *total aggregated costs = 0* are implemented, such as DSM and SC/USC.

  采用总成本为零的技术组合，如DSM和SC/USC 。

- Scenario 3

  All mitigation measures *(without consideration of costs)* are implemented to achieve the maximum GHG reduction amount.
  采用能获得最大减排量的措施（不考虑成本）。

5 Mitigation Scenarios (3)
五种减排情景

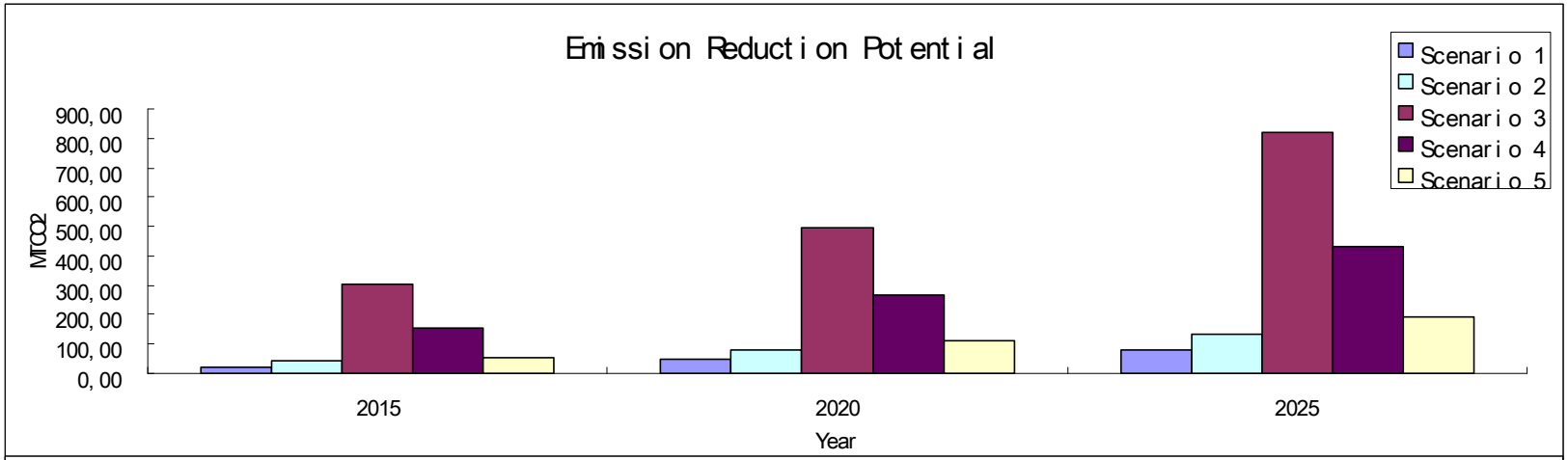
- Scenario 4

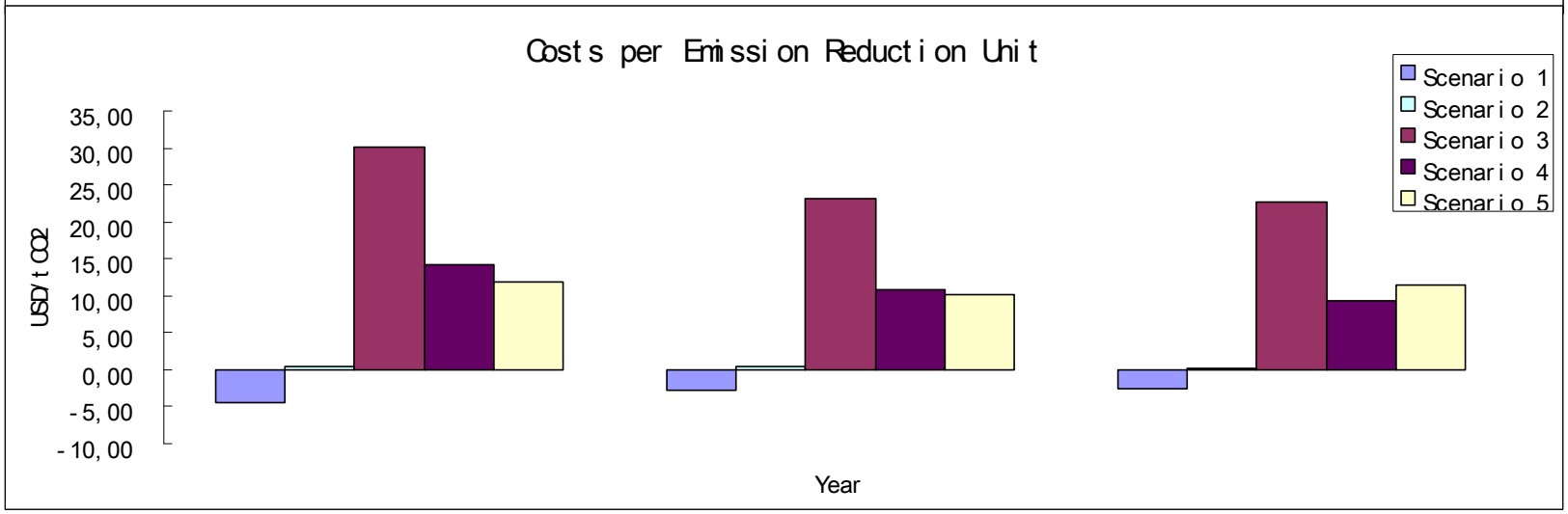
  All mitigation measures *up to a specified higher cost level* are implemented, such as DSM, SC/USC, reconstruction of conventional thermal power, nuclear power and natural gas. 采用特定成本的减排措施，如DSM, SC/USC, 常规火电产改造、核能和天然气。

- Scenario 5

  All mitigation measures up to a higher cost level are implemented; *additionally, some selected high cost measures* requiring transfer of advanced technology are implemented (IGCC-CCS, wind power). 采用特定成本的减排措施，并加入一些技术转让成本高的技术，如IGCC-CCS, wind power 。

Reduction Potential and Costs
减排潜力和减排成本





Results 结果

- Scenario 3 gains the largest amount of emission reductions; however, the related costs are also the highest;

  情景三：最大的减排量和最高的减排成本。
- Scenario 1 is the cheapest option, but the emission reduction amount are also the lowest;

  情景一：最小的减排量和最低的减排成本。
- The other scenarios all represent possible tradeoff options with different levels of mitigation and related costs.

  其他情景：不同水平减排量和减排成本的组合方案

Barriers for mitigation 减排障碍

- China's rapid economic growth and the expansion of its power sector makes it more difficult to mitigate its GHG emissions;
  中国电力行业的快速增长导致GHG减排上的困难
- Technical and financial backlog of China's power sector compared to developed countries;
  相对于发达国家，中国电力行业存在技术和财政的缺口
- Large share of SME's (58%) with low technical and financial capacities among the power companies;
  低技术和少资金的中小型企业占较大比例
- Social costs caused by using advanced mitigation technologies (unemployment, wage cuts).
  采用先进减排技术会导致较高的社会成本（失业、降低工资）

Analysis of key mitigation options

关键减排技术分析

Specific Mitigation Options
特定减排技术

- IGCC-CCS

  整体煤气化联合循环发电技术和碳捕捉及储存技术
- Renewable Energy: Wind Power

  可再生能源：风能
- Demand Side Management

  需求侧管理

IGCC-CCS

- IGCC: 整体煤气化联合循环发电技术
  - Combination of 综合了：
    - Coal Gasification Technology and 煤的气化技术和
    - High-Efficiency Combined Cycle Plant. 高效联合循环技术。
  - Benefits: 优势
    - Higher thermal efficiency 更高的热效率
    - Lower pollutants emission. 减少污染物排放
- CCS: 碳捕捉与封存技术
  - Capture and high-pressure collection of CO_2 emitted by coal-fired plants under high pressure. 对燃煤发电中产生的的二氧化碳进行捕捉和收集，在高压下收集浓缩二氧化碳气流。

Costs and benefits of IGCC
IGCC的成本与优势

Technology	Technological available now?	Cost ($/kW)	Efficiency	Market share in China
Sub-critical	Yes	500-600	30%-36%	Main base of China's current generating fleet
Supercritical	Yes	600-900	41%	About half of current new orders
Ultra-Supercritical	Yes, but further R&D to increase efficiency required	600-900	43%	Two 1000MW in operation
IGCC	**Yes, but high costs and more R&D required**	**1100-1400**	**45%-55%**	**Twelve units waiting for approval by NDRC**

Barriers for implementing IGCC
IGCC的实施阻碍

- High costs, especially initial investment costs;
  高成本，特别是一次性投资高；
- Low commercial competitiveness; 商业竞争力低
- Lack of substantial funding support and human resources required for R&D activities (difficult for small companies);
  研究和开发需大量的资金支持和技术人才（对小企业难）
- Low technical reliability; 技术可靠性低；
- Little technical and management experience;
  缺乏技术与管理经验；
- Reliance on foreign advanced technology;
  依赖国外先进技术；
- Long construction periods. 建设期长。

Policies promoting the IGCC in China
IGCC的政策支持

- Research and Development 研究与开发
  - National High-tech R&D Programme ("863" project); 国家高技术研究与发展计划-863计划
  - National Basic Research Programme of China ("973" project); 国家重点基础研究发展计划-973计划
  - Key technologies: Gasifier, Gas Cleaning Unit, Air separation unit, Combined cycle unit.

    核心技术：汽化炉、烟气净化装置、空气分离装置、联合循环机组。
- Initiatives from big energy companies, e.g. Huaneng's "Green Coal Power" Project: 250 MW by 2010, 300 to 400 MW by 2015.

  大电力集团行动，例如华能"绿色煤炭发电项目"。

Recommendations 建议

- High priority on development of independent innovation capabilities and mastering core technologies;

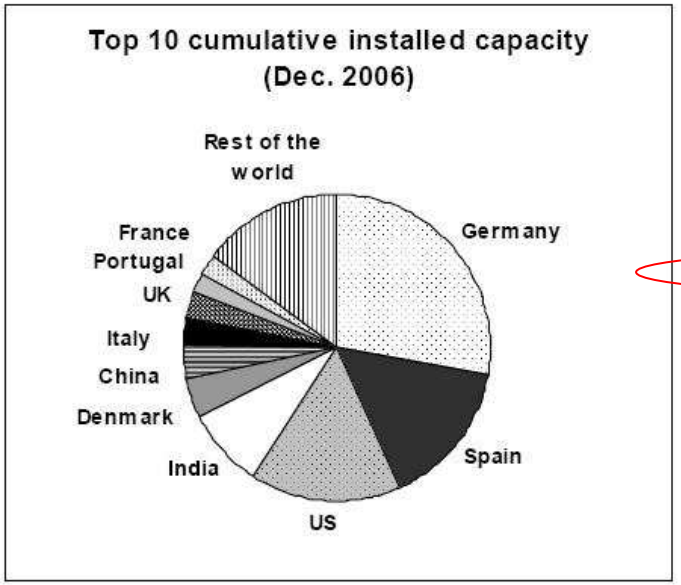
  高度重视发展独立创新能力和开发核心技术
- Set up fixed feed-in tariffs; 建立固定上网电价
- Innovative promotional policies based on carbon credits;

  基于碳信用额的激励政策
- Training of staff. 员工培训

Wind Power 风能

- Clean renewable energy without GHG emissions; 清洁无GHG排放的可再生能源
- Mature Technology; 成熟技术
- High potential in China: 在中国的巨大潜力
  - Onshore: 253 GW; 内陆
  - Offshore: 750 GW. 海上
- Renewable Energy Law since 1.1.2006; 可再生能源法从2006年1月1日开始实施
- Rapid development in recent years. 近年来快速发展

China's Wind Power capacity
中国风电的装机容量



Total capacity	MW	Market share
Germany	20,622	27.8%
Spain	11,615	15.6%
US	11,603	15.6%
India	6,270	8.4%
Denmark	3,136	4.2%
China	2,604	3.5%
Italy	2,123	2.9%
UK	1,963	2.6%
Portugal	1,716	2.3%
France	1,567	2.1%
Top 10 - Total	**63,217**	**85.2%**
Rest of the World	**11,004**	**14.8%**
World total	**74,221**	

- In 2007, 3,304 MW of new wind capacity was implemented, representing a market growth of **145%** over 2006; 2007年中国风电市场增长145%
- China now ranks **fifth** in total installed capacity - with 5,908 MW at the end of 2007.
  中国是世界第五大风电市场

Barriers 障碍

- Technical 技术
  - Advanced technology (>1.5 MW turbines have to be imported); 缺先进技术（ >1.5 MW 的风机需进口）
  - Lack of experienced staff and spare parts manufactures; 缺技术人才以及零部件供货商
  - Uncertain grid capacity in rural areas.
    边远地区的电网不稳定
- Financial 财政
  - Low feed-in-tariff combined with high investment costs; 上网电价低，投资成本高
  - Low IRR, therefore little incentive for equity investors and loan providers. 自有资本回报率低

Policies promoting wind power
促进风电发展的政策

- Feed-in-tariff 上网电价
  - Renewable Energy Law (2006); 可再生能源法（2006）
  - Tentative management measures for price and sharing of expenses for renewable electricity generation (2007).
    可再生能源发电费用分摊管理试行办法（2007）
- Grid connection 风电并网
  - Renewable Energy Law (2006). 可再生能源法
- Investment promotion policies
  投资激励政策
  - Renewable Energy Law (2006) 可再生能源法（2006）

Recommendations 建议

- More investment in Research and Development activities; 加强研发能力建设
- Promotion of domestic suppliers (gearbox, generator, blades…), decreasing the unit costs;
  促进主要零部件的本土化，降低单位成本
- Training of staff; 人员培训
- Set up a fixed countrywide feed-in-tariff for each wind farm.
  建立全国统一的风场上网电价

Demand Side Management 需求侧管理

- Set of promotional tools and practices to influence the amount and timing of costumer's energy demand in order to use energy more efficiently. 通过采取激励措施，引导用电户改变用电方式（电量和时间），提高最终用电效率。
- Benefits: 优势
  - Decrease of fuel consumption; 降低燃料消耗
  - Reduction of GHG emissions and acid rain; 减少温室气体排放和酸雨
  - Effective way to address power shortages. 应对能源短缺的有效手段

Measures of DSM DSM方法

Increased investment in 加强投资

- End-use energy efficiency 终端用能的能效提高
  - Encouraging the use of efficient equipment such as energy saving lamps and high-efficiency transformers.
    促进高能效设备的使用：节能灯、高效变压器
- Load Management: 负荷管理
  - Price discrimination: Time of use power pricing with large differences between peak and off peak prices; 差别电价体系
  - Tariffs that compensate consumers for voluntary demand reductions during peak periods;
    对高峰期自愿放弃用电的用户进行补偿
  - Large customers shift their production schedule away from peak hours.用电大户调整生产时间以避开用电高峰期
- Energy conservation 节约能源
  - Changing thermostat settings; 改变恒温设置
  - Reducing hours of operation. 减少运行时间

Barriers 障碍

- Lack of an adequate and stable DSM funding mechanism which is critical; DSM 缺少足够的资金
- Tariff setting methods discourage grid utilities from investing in DSM (energy efficiency measures decrease the consumption of energy and therefore their revenues);
  由于能效提高导致电网公司收益下降，目前电力定价体系不利于电力公司投资DSM措施
- Much of China's industry is in transition and therefore facing enormous changes and uncertainty, making it harder to commit to energy efficiency programmes;
  中国工业面临巨大改革，使企业应用高能效技术的不确定性增大
- Shortage of specialized professionals trained in DSM matters. 缺少DSM人才

China's existing Policies on DSM
中国现有的DSM政策

- Energy Saving Law (1997), update in 2007
  节约能源法1997年制定，2007修订
  - Energy Saving Standard System, Certification of Energy Efficient Products, Energy Saving Service Institutions
    节能标准体系、能源效率标识管理、节能产品认证 、节能服务机构
  - Government subsidies, tax incentives, government purchase programmes
    节能专项资金、财政补贴、税收优惠政策、政府采购
- State Grid Corporation Electricity Demand Side Management Implementation Measure (2005)
  国家电网公司电力需求侧管理实施办法（2005）

China's existing Policies on DSM
中国现有的DSM政策

- Energy Saving Management Measures (2000)
  节约用电管理办法（2000）
  - Load Management : Economic policy promoting end-users using energy during valley hours 负荷管理：经济激励政策引导用户移峰填谷
    - Price discrimination during peak/valley hours, price discrimination for hydropower during dry/rainy season, other seasonal power tariffs, price discrimination for stable/non-stable electricity providers
      峰谷分时电价、水电丰枯期电价、季节性电价、两部制电价、可中断负荷和高可靠性电价政策
    - Load Shift Measures, such as Energy Storage
      蓄能等负荷转移措施
  - Energy Saving Management 节能管理
    - Energy efficient products and Energy Efficiency Standards
      节能技术产品、能源效率标准

Recommendations 建议

- Make DSM a priority policy; 视DSM为优先政策
- Create stable and adequate DSM funding;
  保证稳定和足够资金
- Remove financial disincentives to grid utilities investing in DSM 消除不利于电网公司发展DSM的经济因素
  - Costs of effective DSM investments should be treated like any other utility cost; 有效地DSM投资应被视为公司运行的正常成本
  - Create incentives to the grid utility to implement DSM measures. 鼓励电网公司实施DSM措施
- Further pricing reforms 其他价格改革
  - Critical peak prices for large industrial consumers;
    大型工业用户：提高高峰电价
  - Price reductions for consumers that reduce electricity use.
    节约用电用户：降低电价

Potential for International Cooperation

国际合作机会

Areas for international cooperation
国际合作机会

- Technology transfer 技术转让
  - IGCC-CCS (main components)
  - Wind (gearbox, blades, generator)
- Financial Assistance 财政支持
  - IGCC-CCS (high initial costs)
  - Wind (feed-in tariff)
- Capacity Building / Training and Education
  能力建设、培训和教育
  - DSM
  - IGCC
  - Wind

Conclusion

总结

Conclusions 结论

- China's electricity sector is a large GHG emitter worldwide with high mitigation potential;
  中国电力行业产生较大的温室气体排放，并有很大的减排潜力
- There are several mitigation options with different mitigation effects and costs;
  一些减排技术有不同的减排成本和减排效应
- The most representative options are 最具有代表性的技术是
  - IGCC-CCS; 整体煤气化联合循环发电技术和碳捕捉与封存技术
  - Wind power; 风能
  - DSM. 需求侧管理

  Each of these technologies has high mitigation potential; however, they face implementation barriers.
  每项技术都有较大的减排潜力，但也面临着实施阻碍
- The main areas for international cooperation are technology transfer, financial assistance and capacity building. 主要的国际合作领域有：技术转让、财政支持以及能力建设。

Thank you!

谢谢！