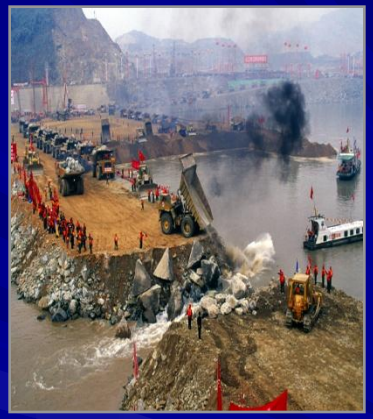
Achieving Lower Energy Intensity in China – Works in Progress



Carter Brandon

World Bank Beijing Office – September 10, 2009

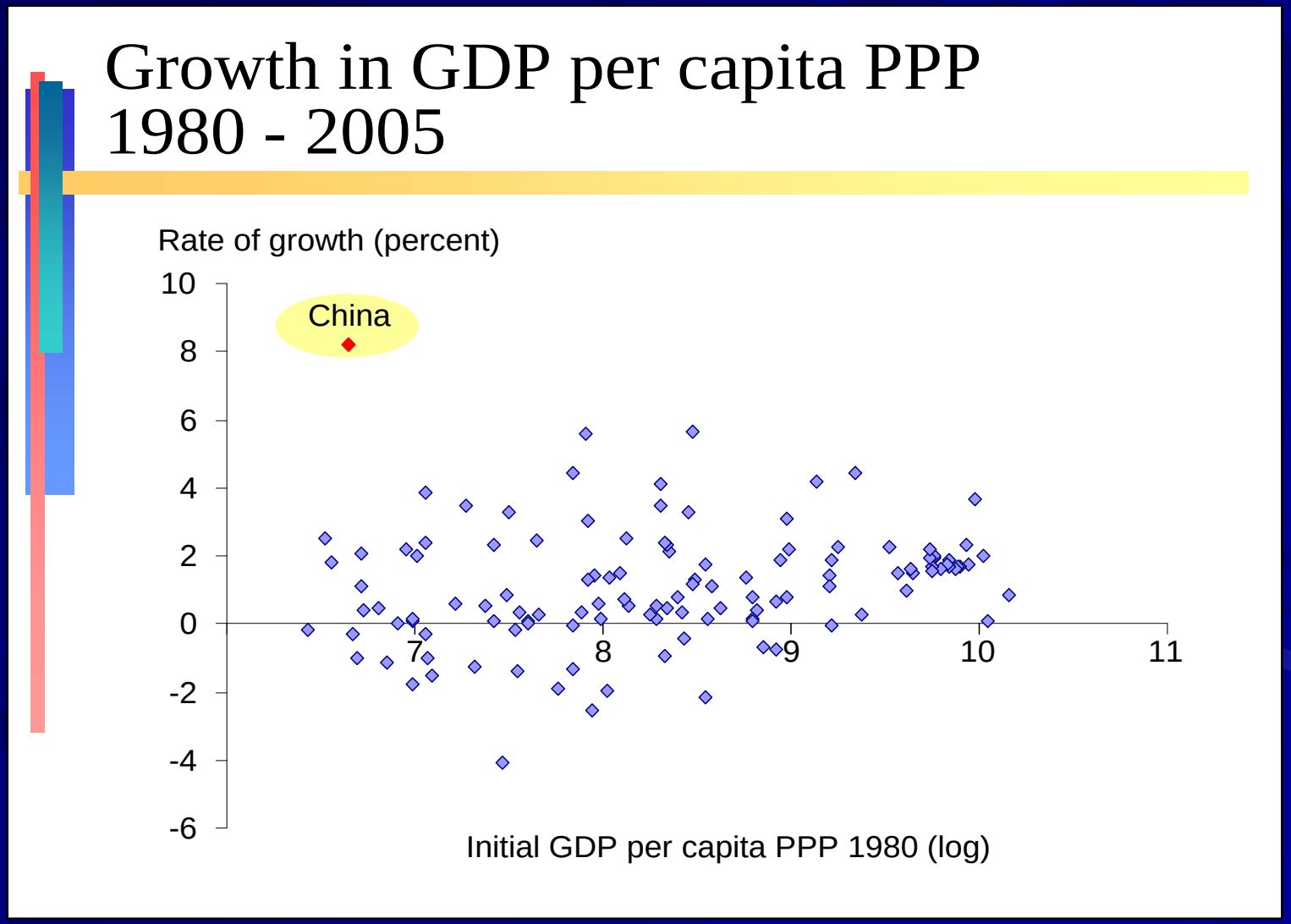
Introduction

- This presentation is not comprehensive: in 2008, China did not request World Bank support to an economy-wide or sector-wide analysis of low carbon options (as did Mexico and other countries).
- Rather, it requested three specific policy notes under the general theme of Low Energy Intensity. Today we have interesting building-blocks.
- China now appears more interested in the broader question of: “what are the impacts of a low-carbon path on the Chinese economy?” – and that is the next discussion.

Presentation Outline

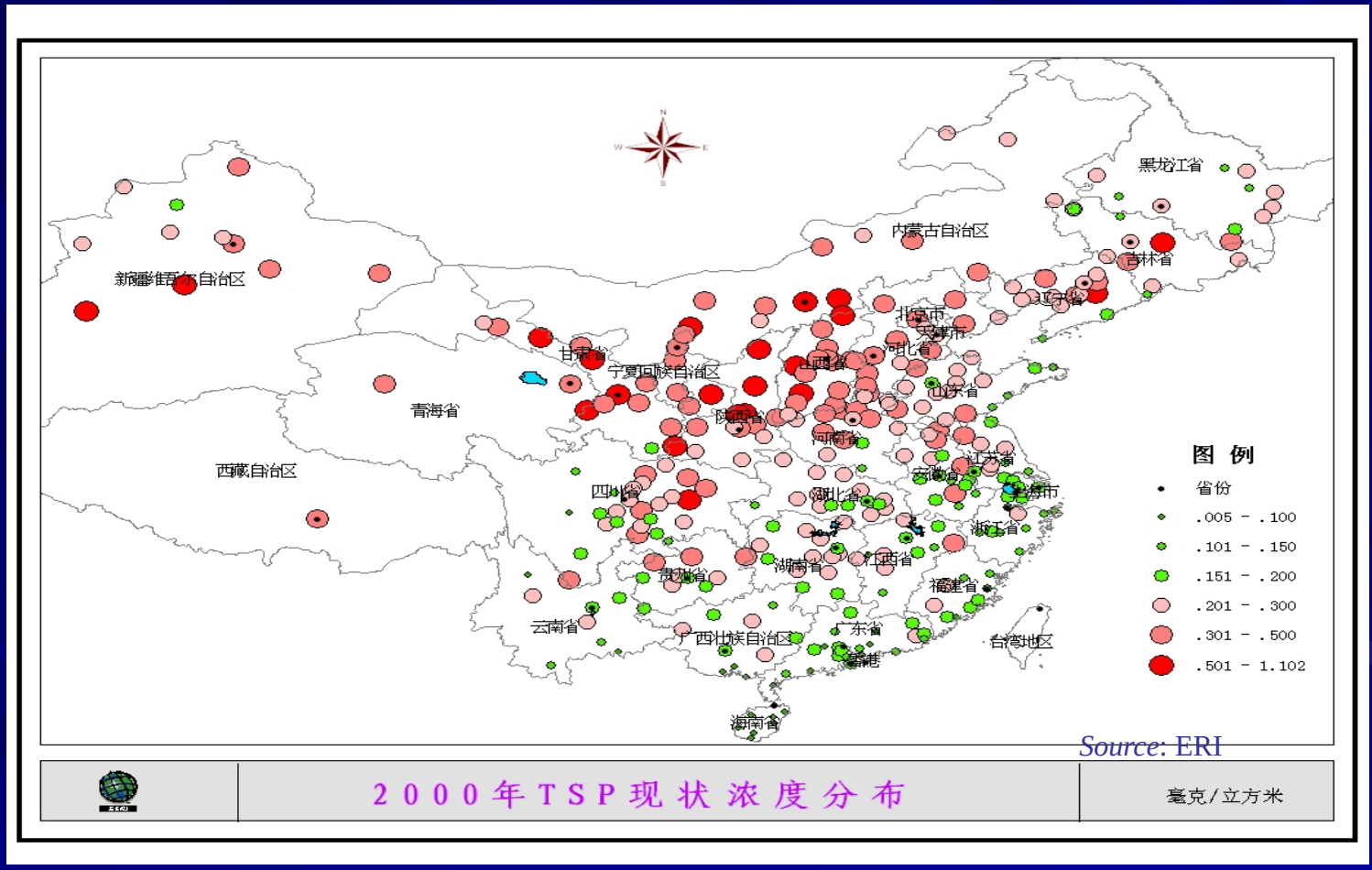
- The China context
- Three World Bank policy notes in preparation:
  - Renewable energy development
  - Energy efficiency through improved power dispatching (in Fujian and Shandong provinces)
  - Energy efficiency opportunities in the cement industry (in Shandong province)
- Conclusions and what next

China is the most successful developing country in the past 25 years



Local challenges – severe air pollution, particularly in the coal belt…

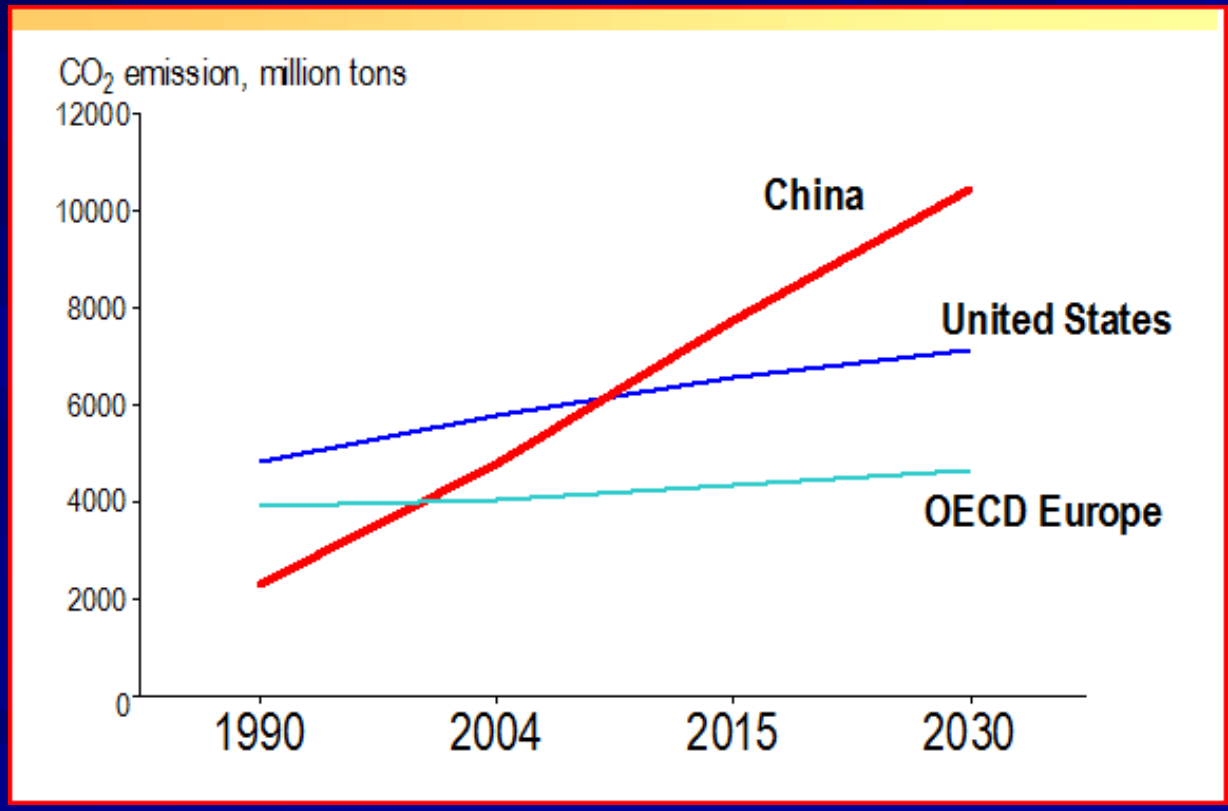
PM Concentrations (ug/m^3)



Of the 30 most air-polluted cities in the world, 20 are in China

Global Challenges—Climate Change

- CO_2 emissions have been increasing faster (by 10-15% annually) than anywhere else in the world
- Climate change impacts are already being felt in China

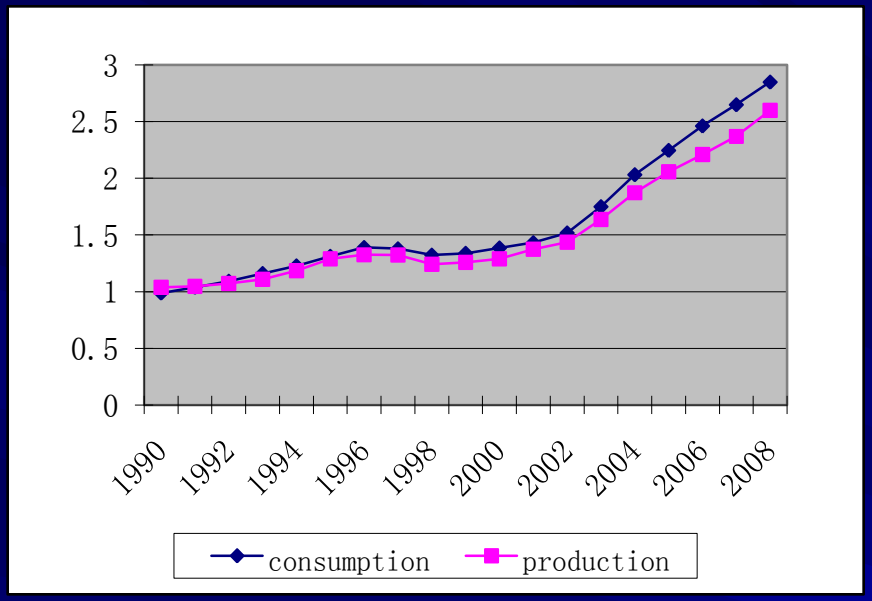


Government Energy Priorities

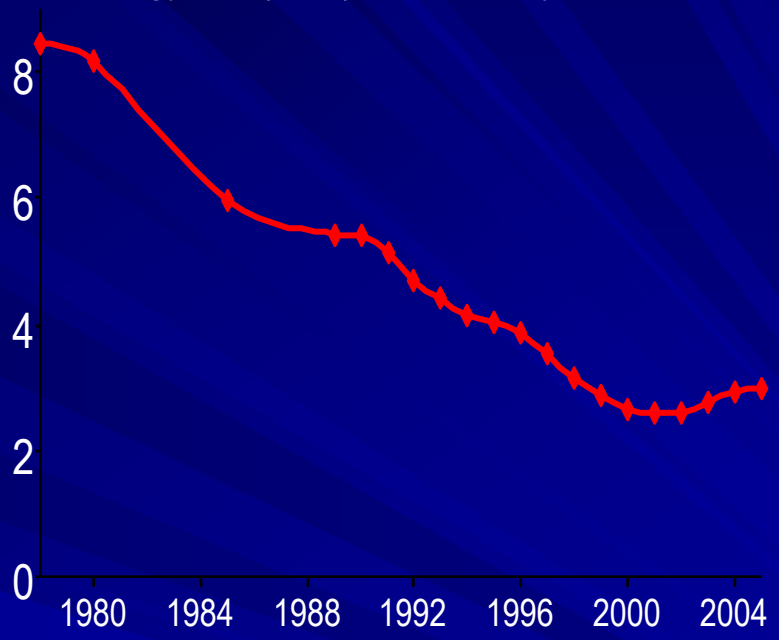
- Reduce energy intensity by 20% from 2006-2010. An ambitious target – but taken very seriously by industry and government at all levels.
- Increase efficiency of thermal power sector – currently 20% lower than best practice (2006).
- Decommission about 60 GW of small coal power plants.
- Scale-up renewable energy (10% by 2010, 15% by 2020). The current level is about 8%.
- Rapidly expand nuclear power sources (a seven-fold increase by 2050, to 60GW)
- Secure overseas oil and gas supplies.

China's Energy Intensity

China's Primary Energy Production & Consumption

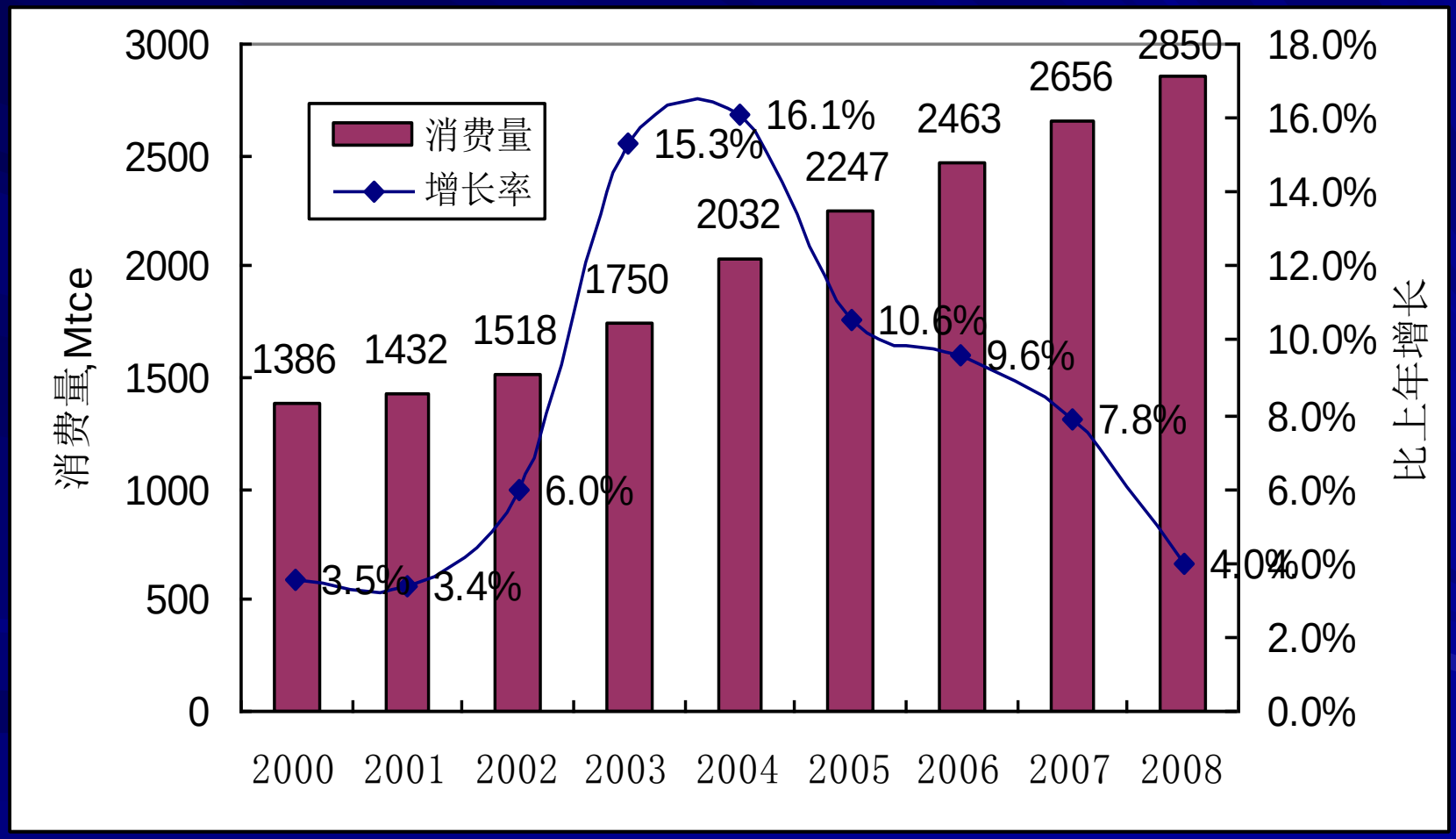


Energy use (SCE) per 10,000 yuan of GDP



- Energy intensity began to rise in 2002 after a long period of remarkable decline (between 1980-2000, GDP quadrupled while energy consumption only doubled).
- The recent change reflects growing dominance of energy intensive industry, growing motorization and rise of an urban middle class.
- Energy efficiency targets are aligned with energy security concerns, i.e., less dependence on imports.

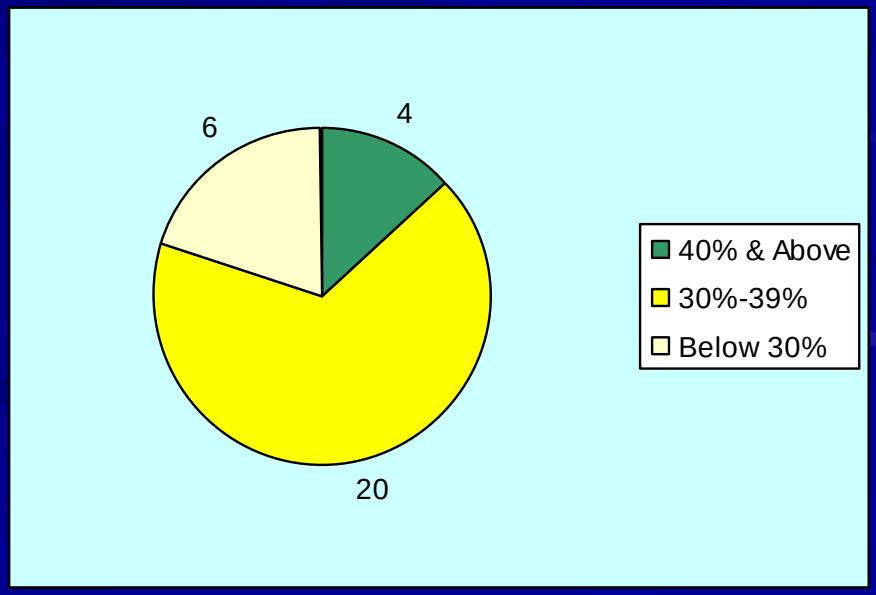
China’s energy consumption and growth rate



Energy Intensity Targets, 2006-present

- Actual achievements are below the target level of 4.4% annual average reduction (1.33% average in 2006, 3.66% average in 2007).
- Energy efficiency improvements are significant.
- The economic structure has not yet changed significantly, including that of industry.
- However, most policy measures started only in second half of 2006 and 2007 and the financial crisis impact will be seen through 2010.

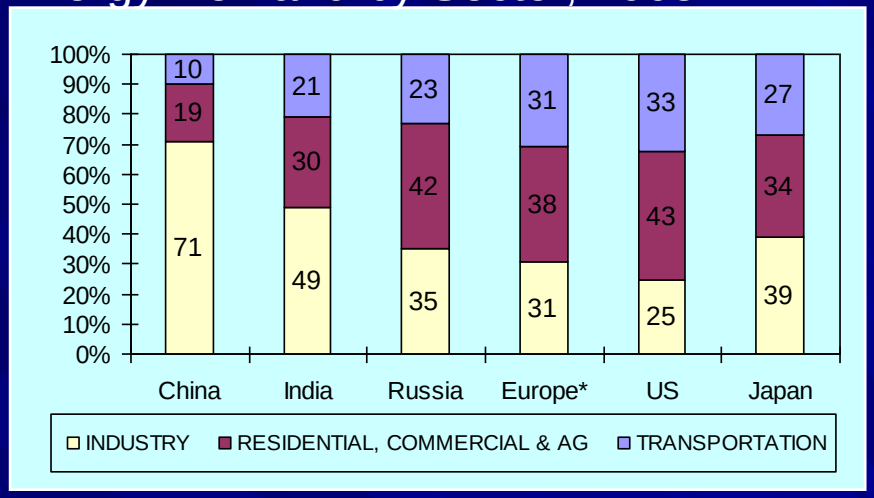
Energy Intensity Results, by # of Provinces and % of 2010 target achieved



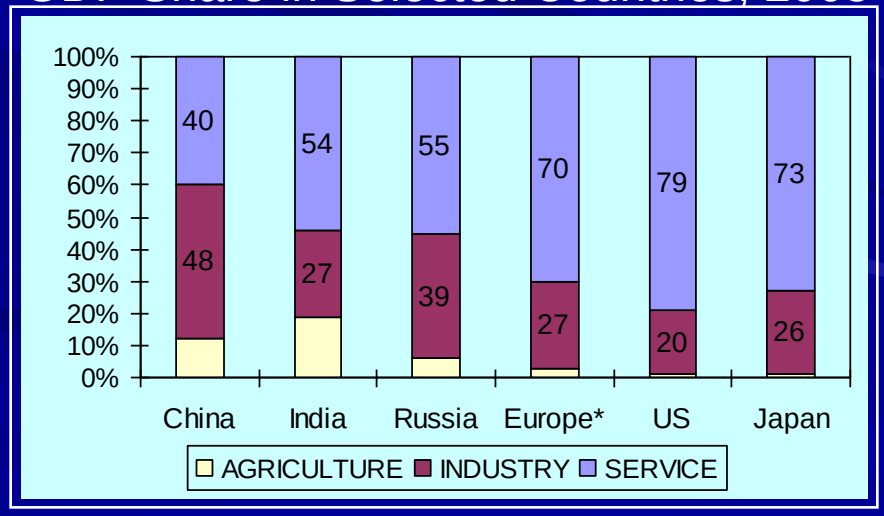
Energy Consumption Drivers

- Industry-led demand growth, i.e., shift to energy intensive heavy industry
- Emerging consumer class
- Dramatic increase in urban population (net increase of over 300 million urban residents 2000-2025)
- Cars doubling every 5 years
- Construction boom

Energy Demand by Sector, 2005



GDP Share in Selected Countries, 2005



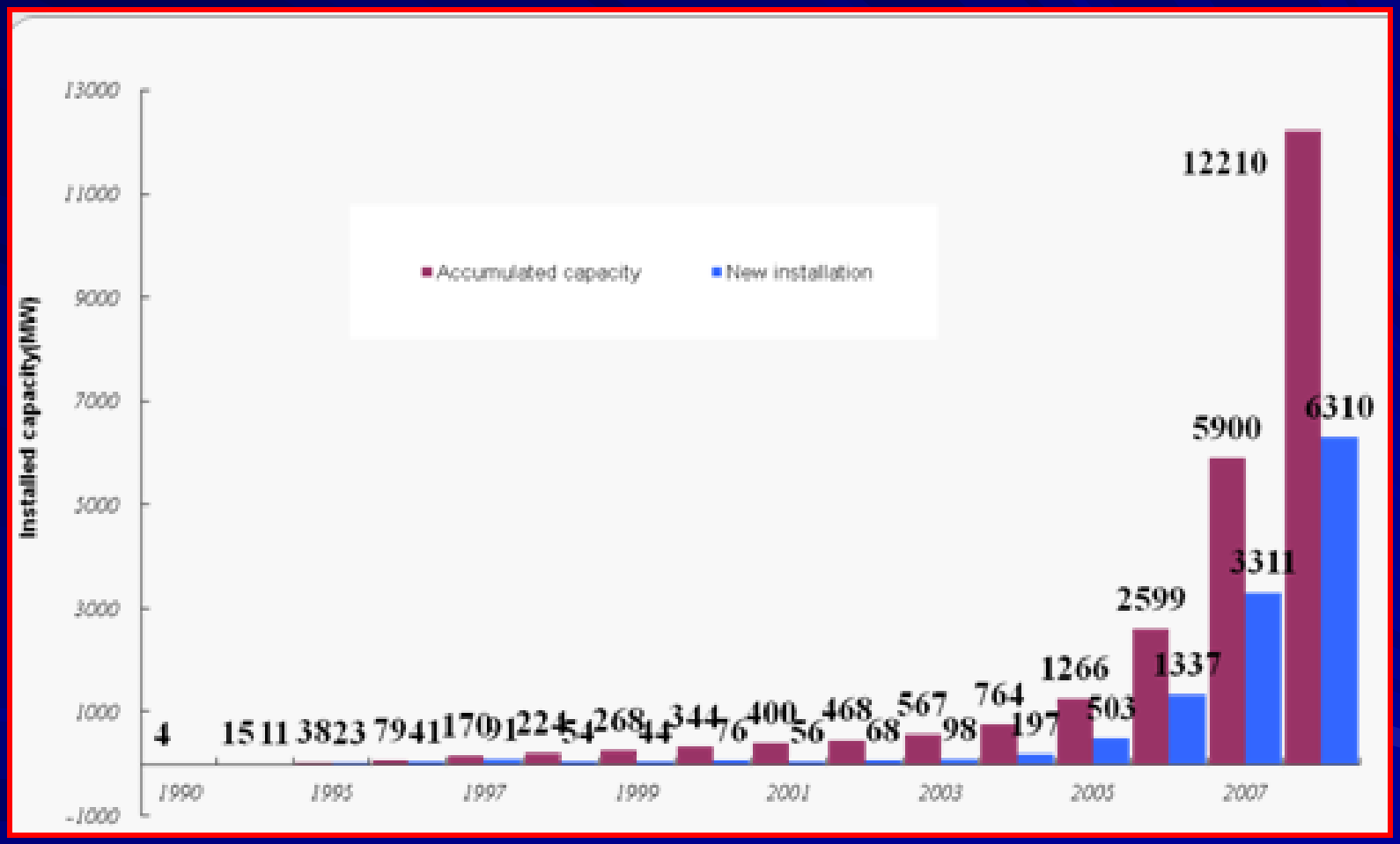
1st Policy Note: Renewable energy development

a. Renewables are currently 8% of total energy -- with renewables defined as wind, solar PV, solar heating, biomass, and small hydro (<50MW)
b. First task: analysis of the optimum economic level of electricity from renewable energy sources based on marginal financial and external costs in comparison with other production options.
c. Second task: analysis of the policy instruments required to reach the economic optimum and the financial impact on the various stakeholders involved.
d. Projections made (with World Bank support) in 2005 were very low compared with the ex post uptake of renewable energy, and the question is why.

China's Renewable Energy Plan (NDRC)

technology	Total Resource (estimated)	2008 Installation (2W)	Target 2010 (GW)	Target 2020 (GW)
Wind	300 GW	12.1	20	80 – 100 (recently raised from 30)
Small hydro (<50MW)	128 GW	50	50	75
Solar water heater	1700 billion tce	130 million m2	150 million m2	300 million m2
Solar PV	1700 billion tce	0.7	1	2
Bio energy (power)	350 million toe/year	3	5.5	21.5
Bio energy (fuel)	350 million toe/year	1.2 million ton bio ethanol	0.2 million ton bio diesel 2 million tone bio ethanol	1 million ton bio diesel 10 million tone bio ethanol

Growth in Wind Power



- By the end of 2008, the total installed capacity reached 12.1 GW.
- New installations grew 503 MW, 1.3 GW, 3.3 GW and 6.3 GW 2005-2008.

Policy Note 1, Preliminary Findings (1)

- The most economic renewable resource is small-scale hydro (the “forgotten” potential)… but its potential expanded capacity is “only” 25GW (or 30% of the recently upgraded wind target for 2020).
- The overall expansion of renewable energy is at lower cost than BAU (since small hydro has a higher NPV).
- No wind or solar PV technology is economically viable using a 12% discount rate, but wind is competitive at an 8% rate including externalities.
- Much technology can be developed for all renewable technologies, especially wind, small hydro, solar water heaters and solar PV… leading to massive exports.

Policy Note 1, Preliminary Findings (2)

- Mixed policy options work well, combining fixed feed-in prices for biomass and solar PV, and competitive bidding for wind concessions:
  - Prices paid are roughly 25-40% higher than coal-fired power prices for wind, and roughly 150% higher for solar PV.
  - There is a need for inter-provincial fiscal transfers to encourage eastern provinces to pay for renewable sources in the west (a balancing of demand and supply).
  - The certainty of revenues combined with a bidding system for wind power concessions has driven technology development, competitive prices, and expanding production and exports.
- Given continued growth in coal plants, the impact to date of renewables on air quality in the coal-affected cities is limited.

2nd Policy Note: Energy efficiency through improved power dispatching

- The dispatching function across many thermal and hydro power plants -- each with different fixed and variable cost structures, different levels of plant and grid efficiency, and different environmental impacts -- poses a challenging dispatching problem.
- The study seeks to optimize power dispatching in Fujian and Shandong provinces.

Policy Note 2. Preliminary Findings

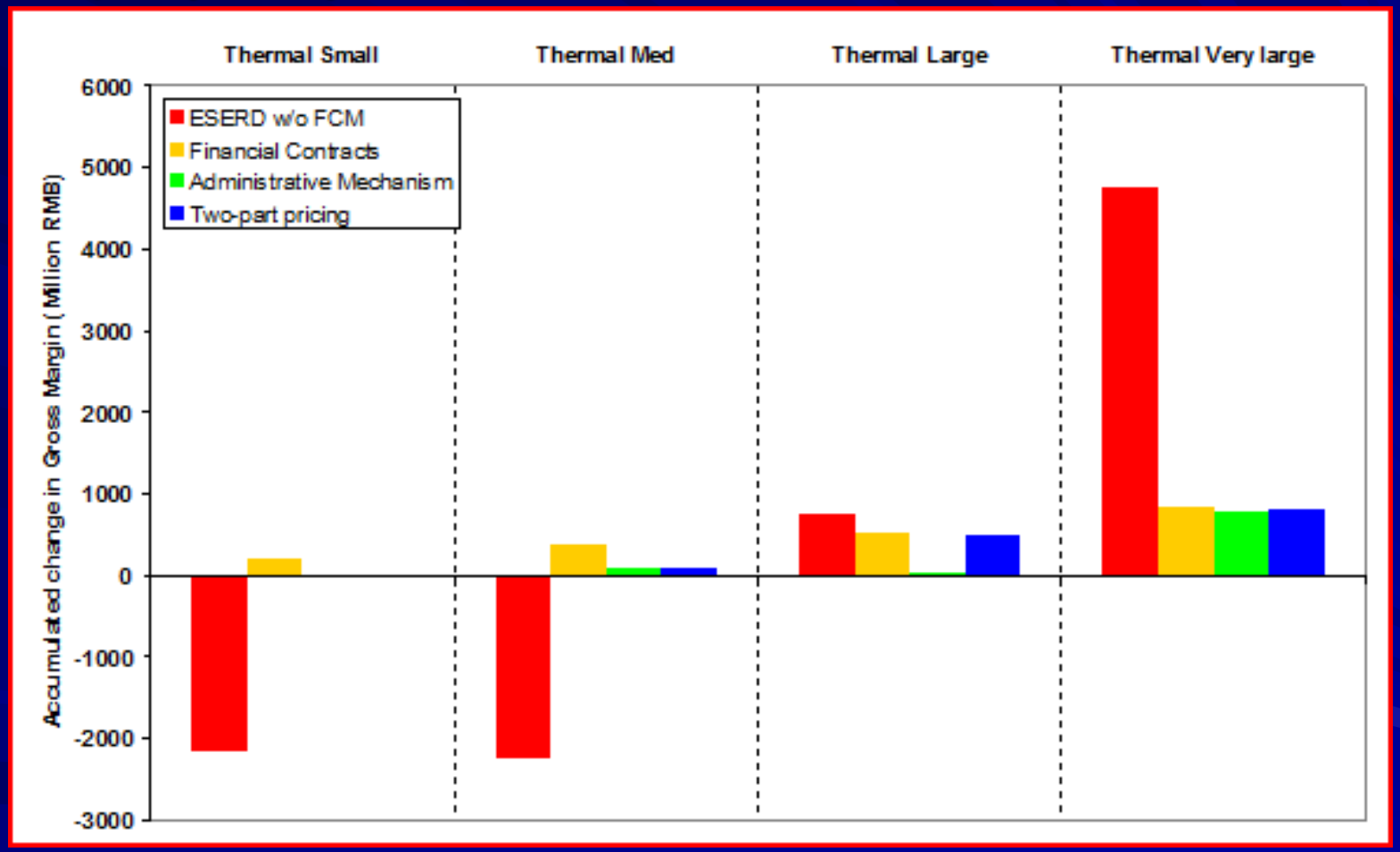
- Technical gains of 10% are possible, mainly by replacing dispatch of small and medium scale thermal by larger units, mainly large-scale thermal.
- Average reduction in small/medium unit operations was 3,500-5,000 hours per year (roughly half of capacity)
- Smaller units are still required for back-up and emergency reserve for supply security.
- The financial impact on small/medium unit operators was large, requiring compensation mechanisms – including to ensure the viability of small/medium units as reserves.
- Using three different policy models, the net savings in financial cost was less than 1% -- in spite of the significant reduction in the use of coal.

Overall Provincial Grid efficiency gains

		Difference with Baseline		
	CASE	**2008**	**2009**	**2010**
Fujian	**Baseline**			
	ESERD	**- 9.4**	**- 9.6**	**- 9.8**
Shandong	**Baseline**			
	ESERD	**- 10.3**	**- 8.5**	**- 9.5**

ESERD = Energy Saving Emissions Reduction Dispatch Model

Impact of financial compensation mechanisms on Gross Margin by class of generation unit and by Generation Company: Fujian Provincial Grid



Note on models: (1) no financial compensation mechanism; (2) financial contracts, (3) an administrative mechanism based on administrative prices for each thermal generation unit, and (4) a scheme based on two-part pricing per technology.

3rd Policy Note: Energy efficiency opportunities in the cement industry

- China produces close to half of the world cement output. In 2007, it was 1.36 billion tons.
- 40% is from relatively obsolete vertical shaft kiln (VSK) plants, the rest from more modern plants, including plants equipped with new suspension pre-heater and pre-calciner (NSP) kilns.
- This study focuses on Shandong Province, China's largest cement-producing province.
- It addresses (a) the energy efficiency aspects of NSP plants, and (b) the economic, social and fiscal aspects of shutting-down the VSK plants.
- The impacts of plant closings are evaluated against NSP production capacity expansion to get a clear picture of the *net* impacts of the cement sector restructuring policy.

Policy Note 3, Preliminary Findings (1)

- The impacts of 563 VSK plant closings on the cement sector and the economy in Shandong Province are economically small (<0.7% of provincial GDP).
- New NSP investments will offset about 60% of the closed VSK production.
- The national and provincial governments combined will provide $138 million in financial compensation to close down the inefficient VSK plants.
- However, the impacts are socially large. 45,000-68,000 jobs will be lost. The workers are typically older and unskilled.
- Few new jobs will be created by the new NSP investments. Older plants use 20 times the # of workers per unit of output.
- Safety net investments, including job training, extended health and/or retirement benefits, are therefore also required.

Policy Note 3, Preliminary Findings (2)

- A separate analysis was done of the energy efficiency of 16 NSP plants.
- The sample plants were less efficient than either domestic or international best practice. Energy savings of 14% and 31%, respectively, were found to be possible.
- Best practice can be reached by applying clearly identified electricity-and fuel-saving technologies and measures.
- Nearly all measures are cost-effective at current energy prices.
- The reasons these measure are not adopted include the age of the plant, staff technical knowledge, plant-specific operational conditions, investors preferences, and high initial capital costs.
- Better understanding of the barriers to EE up-take is required.

Cost-Effective Energy-Efficient Technologies and Measures Not Fully Adopted in the 16 Surveyed Cement Plants in Shandong Province

Electricity-Saving Technologies and Measures	Fuel-Saving Technologies and Measures
Motor and Fans	
Adjustable Speed Drives	Blended cement (Additives: fly ash, pozzolans, and blast furnace slag)
Adjustable speed drive for kiln fan	Limestone Portland cement
High efficiency motors	Kiln shell heat loss reduction (Improved refractories)
Variable Frequency Drive (VFD) in raw mill vent fan	Use of alternative fuels
Variable in cooler fan of grate cooler	Optimize heat recovery/upgrade clinker cooler
Installation of & replacement of coal mill bag dust collector's fan	Energy management and process control systems in clinker making
Replacement of Cement Mill vent fan with high efficiency fan	***Fuel Preparation***
High efficiency fan for raw mill vent fan with inverter	Efficient coal separator for fuel preparation
Replacement of Preheater fan with high efficiency fan	Efficient roller mills for coal grinding

Conclusions

- Achieving China's own energy intensity targets is an enormously complex task, requiring the combined forces of government, the private sector, and academia/research institutions.
- The political structures are aligned to meeting the targets of the current Five-Year Plan. The next one (the 12th FYP, 2011-2015) will be even tougher (incorporating any commitments arising from Copenhagen) -- but the political structure will also support.
- China is increasingly progressive in using price, fiscal, and market mechanisms to foster innovation, production, and exports of new "green" technologies.
- China appears ready to incorporate energy intensity targets into the 12th FYP, even if not emissions reduction targets.
- The World Bank is preparing to assist on the policy, financial, and economic dimensions – i.e., the impact of a low-carbon growth path on the economy -- of taking these actions.