Looking Past Kyoto
National University of Singapore
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Stanford Program in Energy and Sustainable Development

Main Points

- Framing the Climate Problem
- The Kyoto Structure
- Post-Kyoto Positions
- Dilemmas
- Breaking the Frame

Orthodox frames

- Common pool resources and inclusive governance
- Optimization
  - Stern report and cost-benefit analysis
- Regulatory mandates
  - Cap & trade or taxes
- General institutions and rules
  - Property rights
  - Hard law
  - Global carbon markets

Kyoto Protocol Structure	Industrial Countries	Emerging Markets	Least Developed Countries
Short Term (Energy Efficiency)	Uniform Low Price Signal	CDM	CDM; ODA
Medium Term (Fuel Switching)	Increasing Price Signal	Graduation Targets	CDM; ODA
Long Term (Innovation)	Distant High Price Signal	Graduated, Global Trading	Tech Transfer; ODA

Post-Kyoto Positions	Industrial Countries	Emerging Markets	Least Developed Countries
Short Term (Energy Efficiency)	Uniform Low Price Signal	Differentiated Commitments + Wider CDM	Wider CDM (forestry); ODA
Medium Term (Fuel Switching)	Increasing Price Signal	Graduation Targets	CDM; ODA
Long Term (Innovation)	Distant High Price Signal	Graduated, Global Trading	Tech Transfer; ODA

Dilemmas

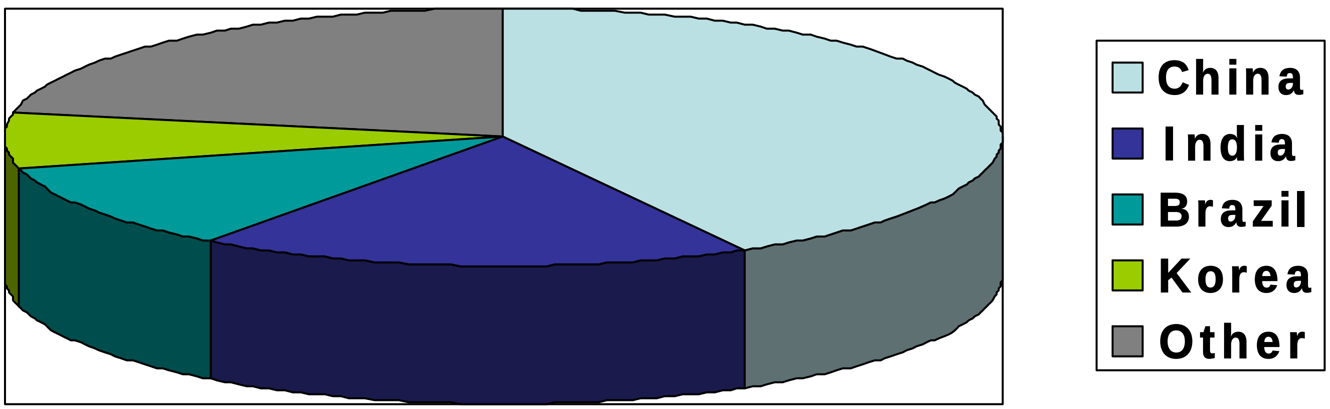
- Some don’t play: U.S., China outside
  - Trade sanctions
    - EU vs. US.
    - Lieberman-Warner vs. China
  - Headroom
    - G-77 solidarity and selective transfers
    - Cost of general transfers
    - Incidence as a tax on labor
    - Unconditional ODA and Chinese donees
- Kyoto mechanisms critique
- Risk of negotiation failure

Kyoto Mechanisms Critique: First Round CDM

- **Inappropriate baselines**
  - **Tropical "hot air": (endogenous?) currency devaluation**
  - **Low incentives for long term investment in technology**
- **Inefficient (over)subsidization**
- **Inadequate implementation**
  - **Climate M&V?**
  - **Other sustainable development (surplus biomass in fuels)**
- **Leakage and project boundaries**
  - **Biofuels and deforestation**
- **Commercial replication**
  - **Delhi CNG vehicles and GAIL gas subsidies**
- **Subjective additionality determination**
  - **Investment additionality**
  - **Barriers analysis**
  - **No regrets and additionality**
- **Moral hazard, property rights and offsets (avoided deforestation)**

Buyers and Sellers

- Buyers: the EU and Japan
- Sellers: China, India, Brazil, Korea

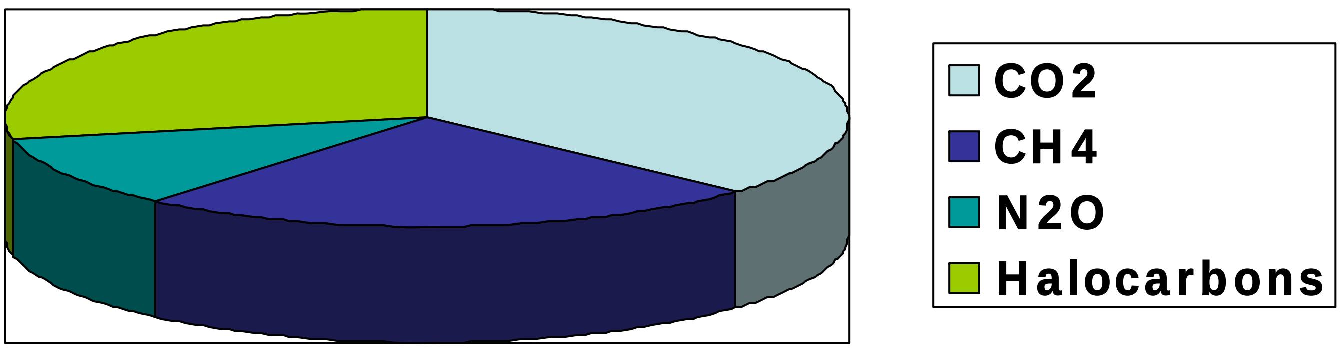


Total Supply = 278 Million t CO_2e/y

1700 Million t CO_2e to 2012

Buyers and Sellers

- Buyers (mostly) substitute CDM for CO_2 reductions
- Sellers are (mostly) not selling CO_2 reductions



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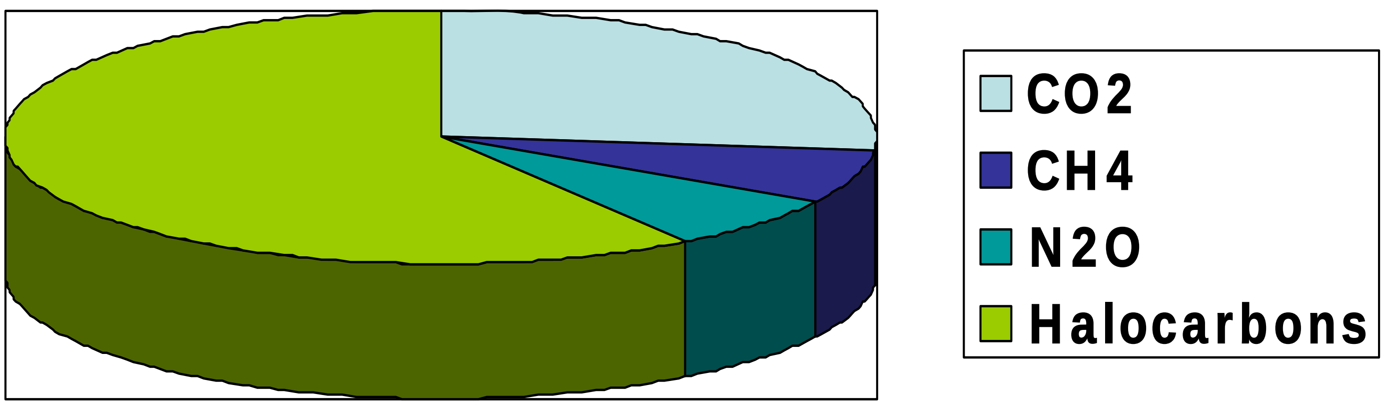


Kyoto Mechanisms Critique: First Round CDM

- HFC23: industrial processes gases
- CH_4: land fills; flaring
  - Rising natural gas prices
  - Local environmental controls
- Adiptic acid and voluntary industry controls
- Renewable Portfolio standards withdrawal
- NOx: Animal wastes and fertilizers
  - Rice seeds and low fertilizer

Market distortions

The Case of HFC-23 Projects

- Byproduct of HCFC-22 (refrigerant) manufacture.
- The GWP of HFC-23 = 11700.
- Accounts for ~30% of CDM market.
- Current projects in CDM account for ~75% of developing world HCFC-22 production.
- No new plants allowed.
- Voluntary capture and destruction by Annex-1 industry.

Market distortions

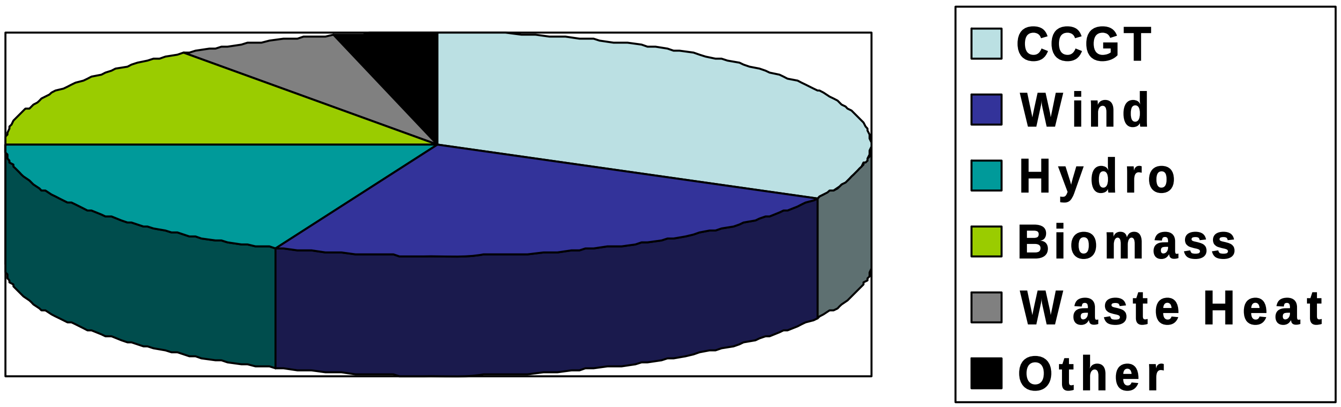
Consider 1kg of HCFC-22

- 1 kg of HCFC-22 -> 0.0275 kg HFC-23
- 0.0275 kg HFC-23 * 11700 = 0.32175 $tCO2_e$
- Current CER market price = €9 /t $CO2_e$
- Cost of abatement = €0.10 / t $CO2_e$
- CER value of 1 kg of HCFC-22 = €2.90 - 0.03 = €2.87
- Current HCFC-22 market price = €1.60

- HCFC-22 Revenue:CER Revenue = 1:1.8
- Chinese projects - 65% tax - 1:0.6
  - €15 CER price is 1:1 for Chinese projects.

Energy

How much is the CDM doing for energy development?



~1400 Projects, ~35,000 MW nameplate capacity

Second round CDM

- 22^{nd} EB session perverse incentives correction
  - Reversal of policy prohibited
  - Upgrade of policy post-2001 does not change baseline
- Energy cases
  - Combined cycle gas plants
  - Clean coal plants: IGCC; USC
  - Large–scale hydro and nuclear?
- Problem resolution?
  - Loss of dynamics in energy markets (frozen baseline)
  - Disjunctive (political) markets and baseline
  - Proliferation of credits without market transform

Third round (Program) CDM?

- COP-11 aggregated projects rule as partial acceptance of program (policy) change
  - Energy efficiency
  - Transport
  - Forests
- Regulatory uncertainty and critique
  - Subjectivity
  - Policy baseline
  - Credit period and amounts
  - Commercial replication (market trasnform) with project by project subsidies

Breaking the frame: Inclusion?

- Non-cooperative solutions
  - National self-interest with asymmetric power
  - Mini-lateral agreements and international regimes
    - European Union a a model
    - WTO
  - Wider collective action at the margins of non-cooperative positions
  - Lessons learned: International regimes
    - Mandatory rules around non-cooperation
    - International contracts with limited range

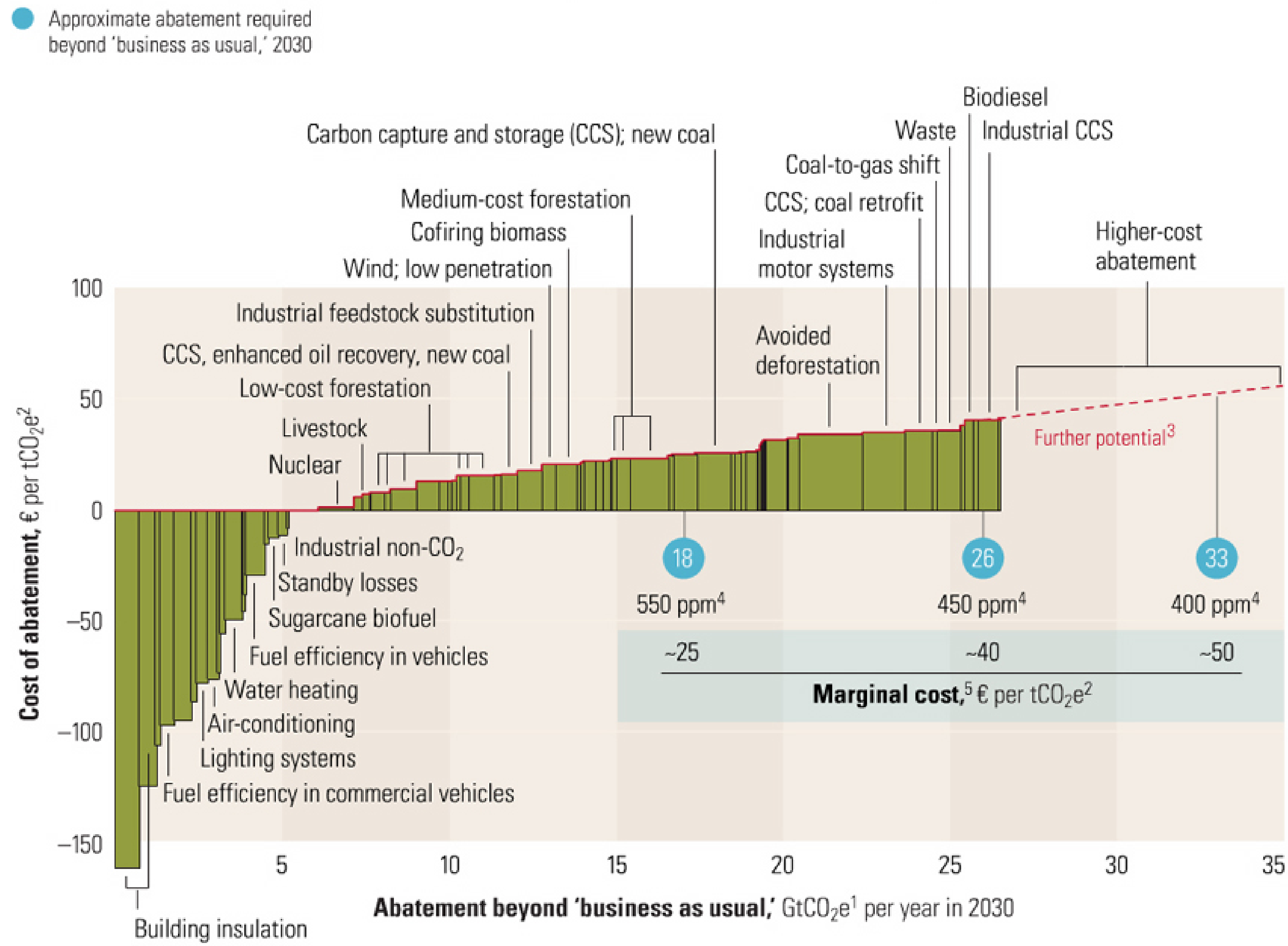
Breaking the Frame: Optimization?

- Gravitational forces and energy profiles
  - Security, local environment, industrial policy, competition
  - Regulation and rents
- Political Economy at the national or local level
  - Relative prices are not the exclusive drivers of national emissions trajectories
  - National carbon regulation as a rent driven regime

Regulation’s margins

- Climate, sectoral and indirect policies
  - U.S. climate policy
  - China’s national climate plan
  - Chinese emissions
- Three specific margins
  - Negative costs
  - Close to market
  - Non-commercial

Global cost curve for greenhouse gas abatement measures beyond 'business as usual'; greenhouse gases measured in G tCO_2e[1]



[1] $GtCO_2e$ = gigaton of carbon dioxide equivalent; "business as usual" based on emissions growth driven mainly by increasing demand for energy and transport around the world and by tropical deforestation.

[2] tCO_2e = ton of carbon dioxide equivalent.

[3] Measures costing more than €40 a ton were not the focus of this study.

[4] Atmospheric concentration of all greenhouse gases recalculated into CO_2 equivalents; ppm = parts per million.

[5] Marginal cost of avoiding emissions of 1 ton of CO_2 equivalents in each abatement demand scenario.

Gravitation Models: Mitigation at 20 Euros/tonne?

- Energy efficiency
  - Collective good at international level?
- Transportation
  - Biofuels and agricultural policies
  - Composite Materials (fleet turnover)
  - Hybrid plug-ins and off-peak power
    - Shift to power sector emissions
- Power Sector
  - Renewable Portfolio Standards
  - Fuel switching and market development: Relative prices, supplies and political premiums
  - Technology development and commercialization price gap

Gravitational Forces: IEA 2006

- Oil price remains high
- Return to coal
- Re-carbonization of earlier declining trend to de-carbonization
- China overtakes US in CO_2 emissions by 2010
- Energy security emerges as core issue
- Energy intensity increases in developing countries understated by IEA

Breaking the Frame: General Institutions

- WTO as the operative model: deals at the margins
  – Political economy and with whom can you deal?
- Market transformations
  – Beyond the regulatory frontier (the limits of political will)
  – Making money as the driver of social change
- Multiple strategic interventions
  – Targeted and particular mechanisms
  – The collective costs of new markets

State Centered Change

- Normative result
  - Global or national
- State mandate, instruments and enforcement
- Barriers
- Political Will
- Policy shocks?

Business Centered Change

- Define market opportunities
  - Pricing
  - Market share
  - Timing of income flows
- Joint venture associates
- Financing plan
- Contractual structure (risk assignment)
- Competitive response
- Supplier and distribution networks
- Manage regulatory and political risk (taxes)

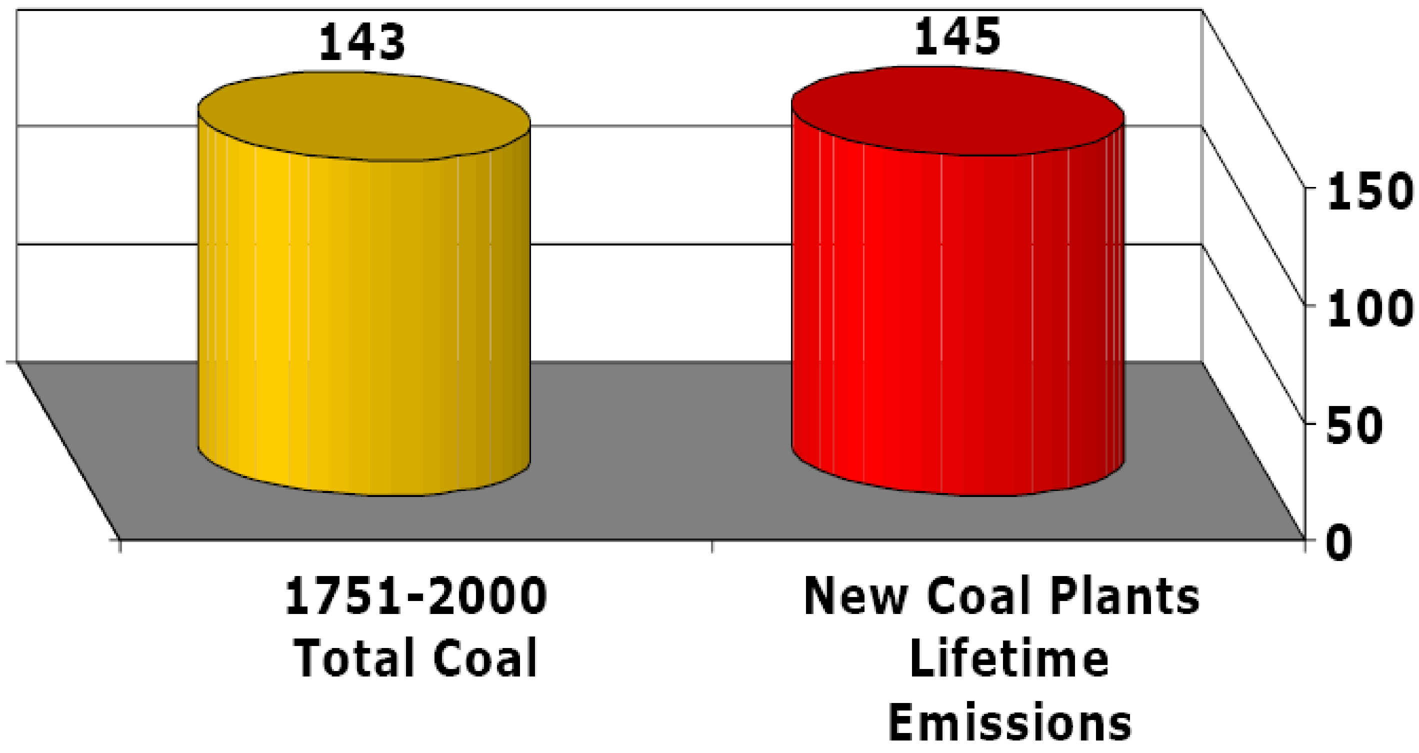
A Simplified Story Line (1)

- Power dominates transport given current fuel prices and technology development
  - Fleet turnover time is determinative
- A low level carbon tax (equivalent) is a non-cooperative climate solution among OECD countries
- Energy efficiency gains are in theory non-cooperative solutions among emerging economies, but are puzzling in practice
  - If substantial, policy needed is information rather than international coordination or targets (IRP and DSM)
  - Domestic issues shift from economic to political economic

A Simplified Story line (2)

- **Emerging economies have local potential for market transformation (e.g. fuel switching) in well-diffused commercial power technologies**
- **Speeding commercial diffusion of new technologies in power generation and distribution is the ultimate key to climate mitigation**
- **Policies to affect market transformations and technology innovation are likely to be more indirect and downstream than direct and upstream**
- ***Coal is the central story: economics and politics***

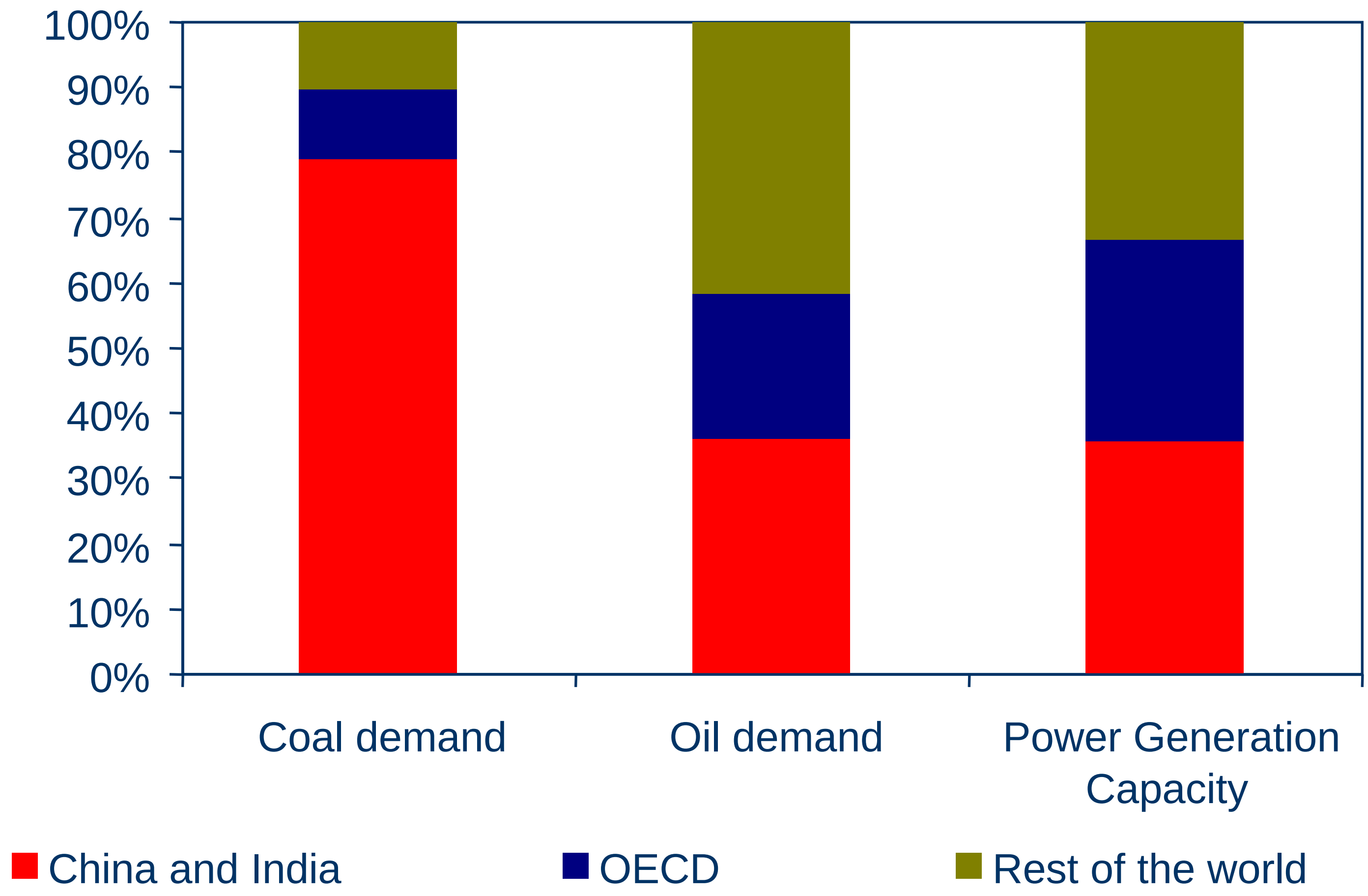
The problem with coal: new coal plant emissions = all historic coal emissions



*Billion tonnes carbon

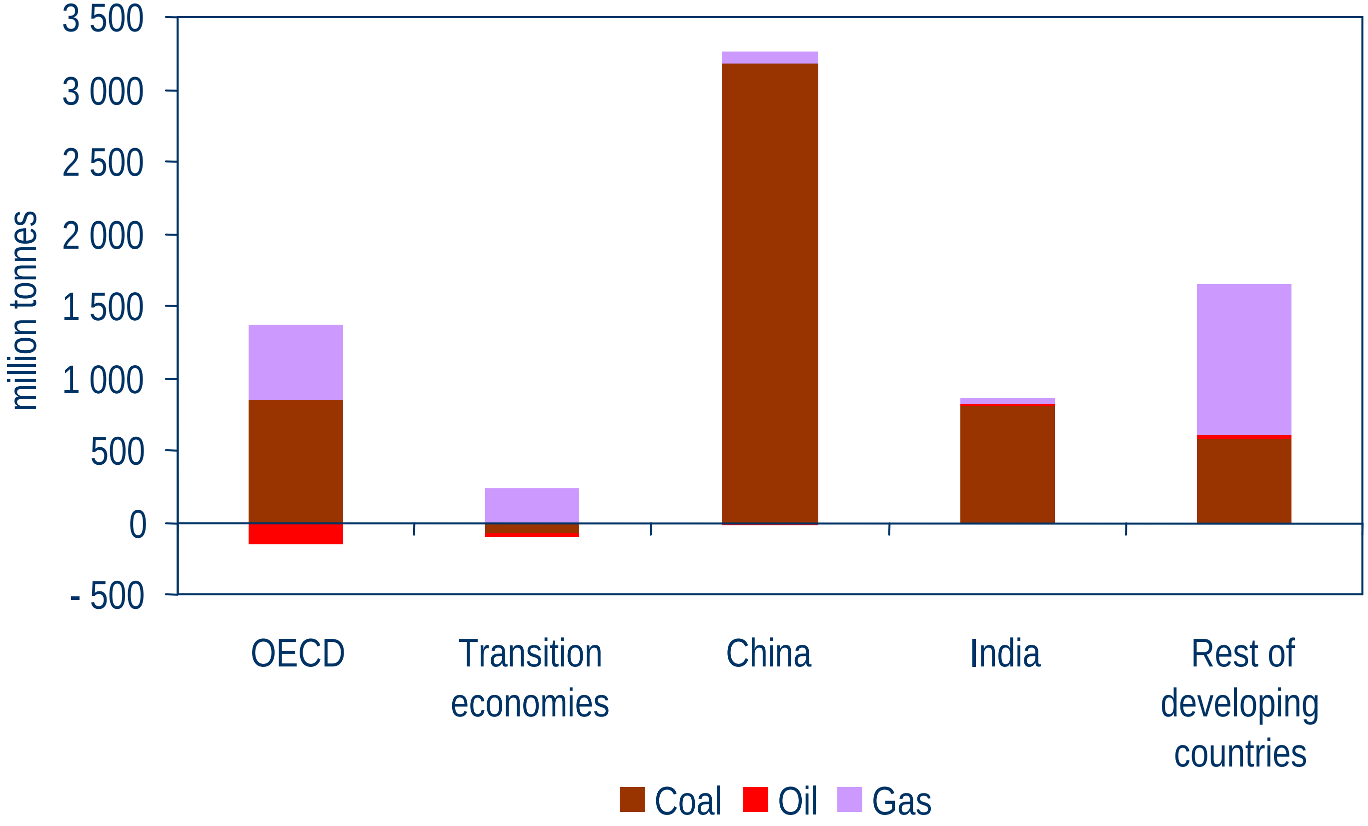
Source: Hawkins, IEA, WEO, ORNL, CDIAC 2004

Reference Scenario:
Share of China and India in the Global Coal, Oil and Power Capacity Growth, 2004-2030



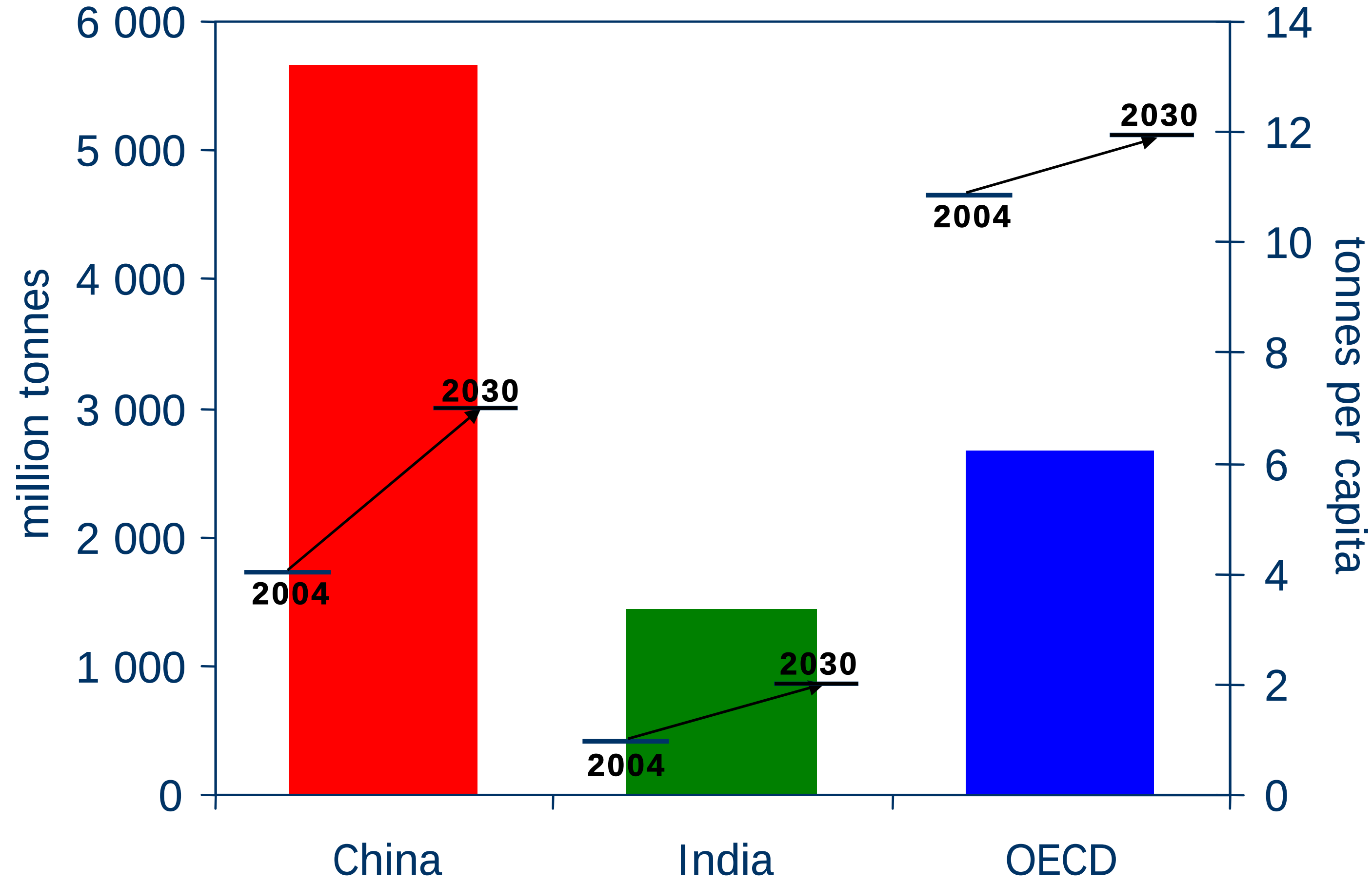
China and India account for a significant part of the growth in the global fuel demand and power generation capacity

Reference Scenario: Increase in Power Sector CO_2 Emissions by Fuel, 2004-2030



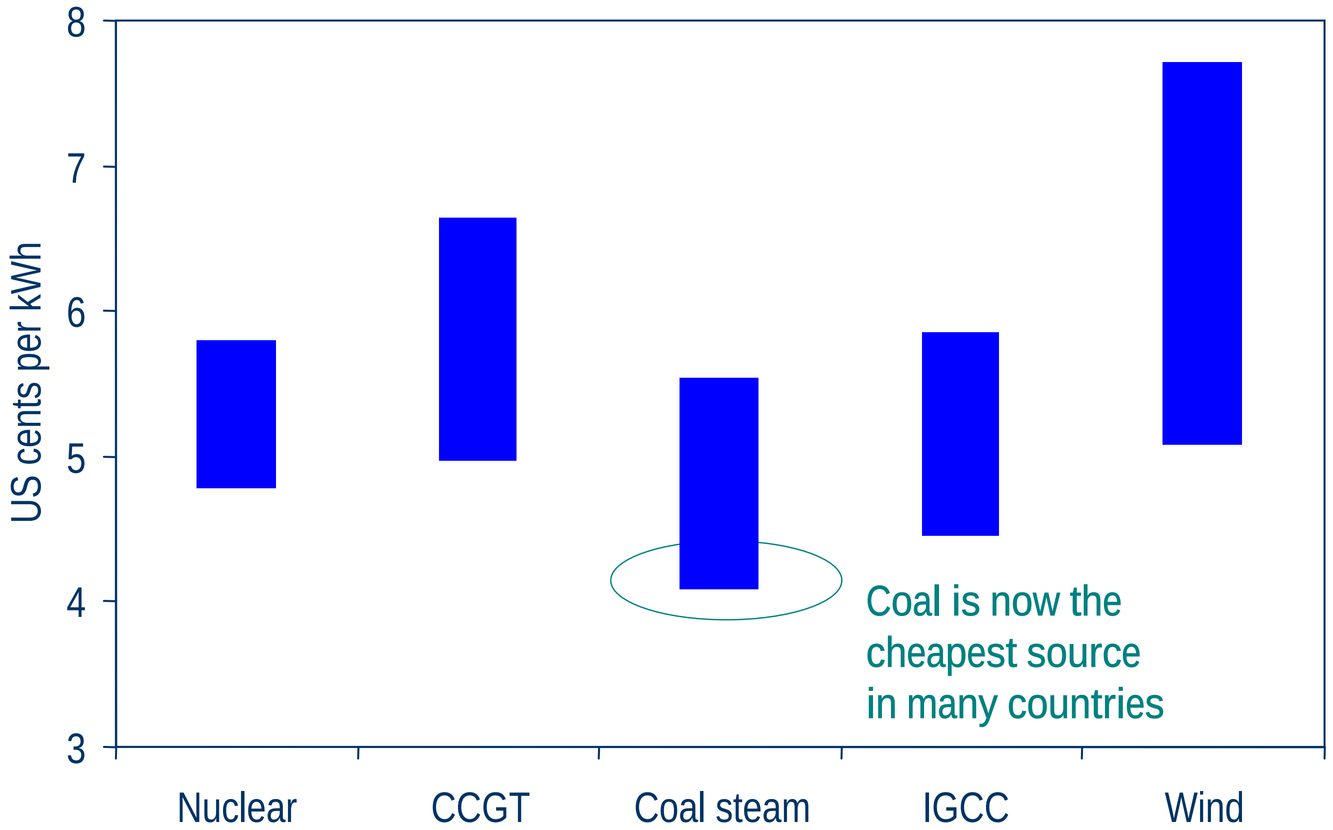
China and India account for 58% of the increase in power sector CO_2 emissions to 2030

CO_2 Emissions Growth 2004-2030



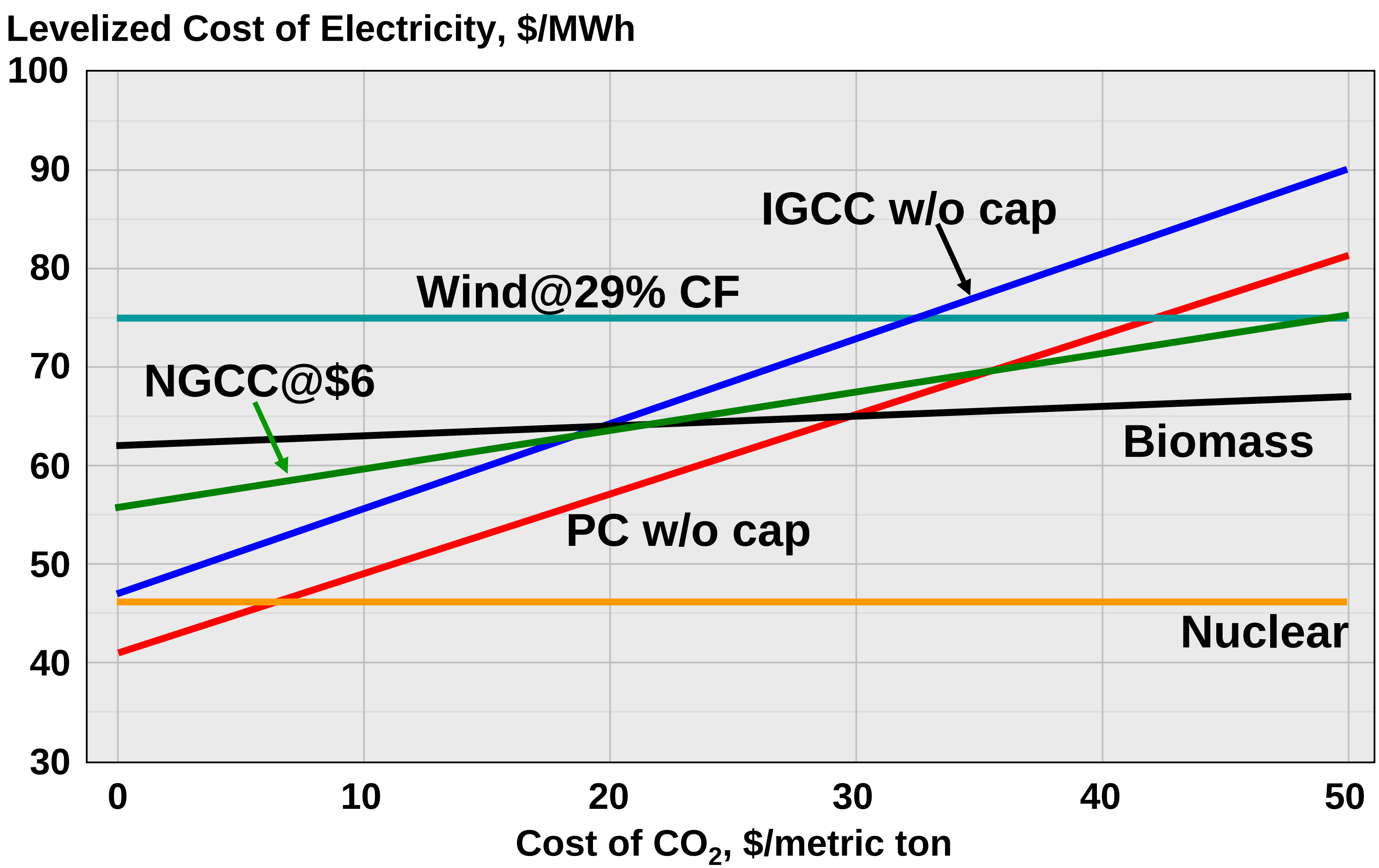
Emissions growth in China is twice as large as in the OECD, but in 2030 per capita emissions will still be lower than current OECD ones

Electricity Generating Cost Ranges Main Technologies

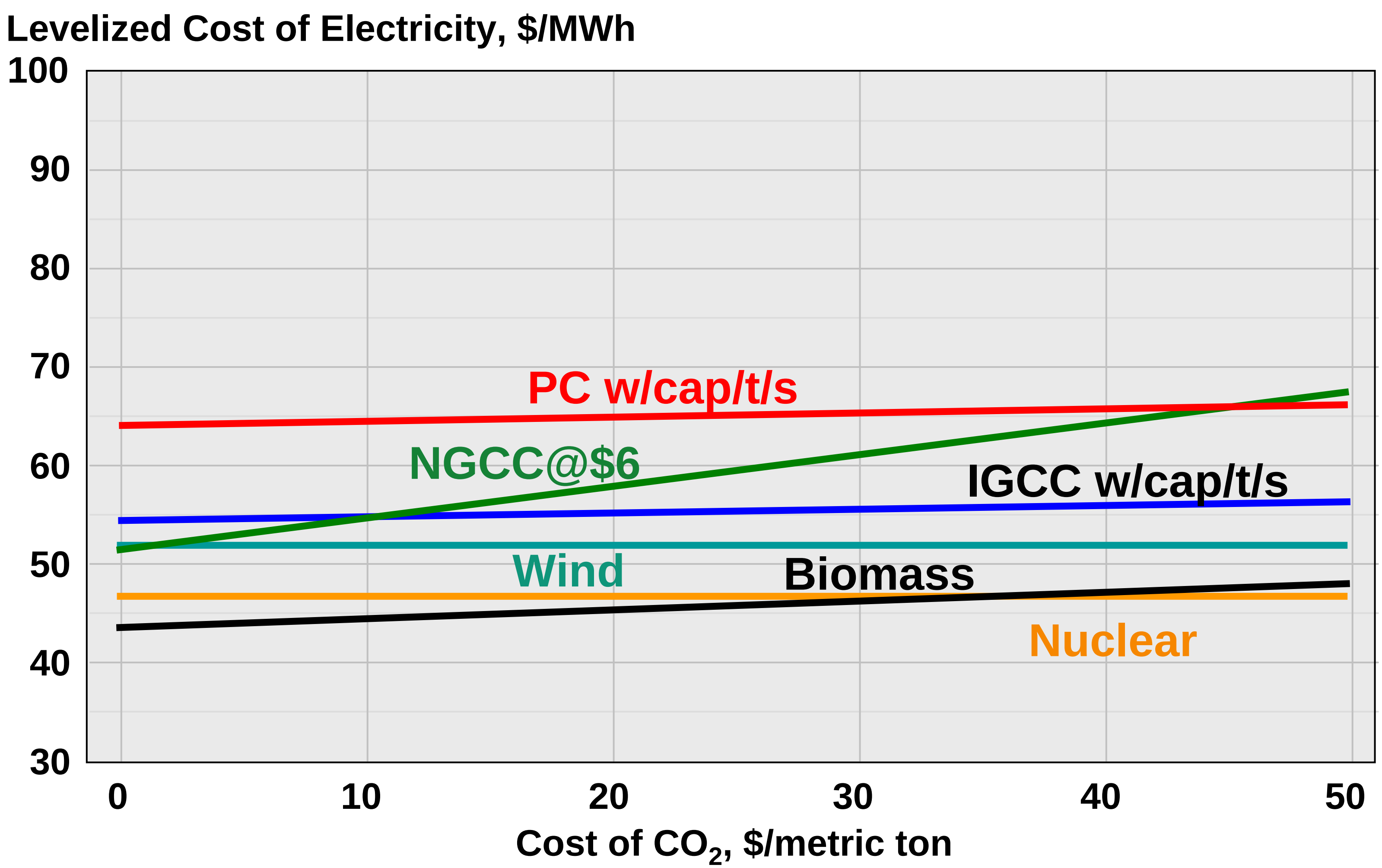


Gas-fired electricity is no longer the cheapest form of generation; prices assumed to remain between $6 and $7 per MBtu

Comparative Costs in 2010



Comparative Costs in 2020



Limiting Chinese Coal Growth

- **The Structure of the Growth Model**
- **Reducing Demand through Energy Efficiency**
  - **Global collective good?**
  - **Incentives for Implementation**
- **Fuel switching at the margin: Natural Gas**
  - **Decentralization of energy portfolio and security**
  - **Global market development**
  - **Local environmental side effects**
- **Clean Coal with sequestration**
  - **Ultra-critical**
  - **Carbon capture and sequestration**
  - **Upstream choices and downstream development**

Engaging Developing Nations

- Development first
- Specific problems with political salience close to market; not general systems
- Political economy is local and hybrid
- Business development model of change
- Markets (latent) are not private or uniform goods
- Public-private (Asian?) models for exploring market organization
- International support for market organization

Hybrid Political Economies

- National collective institutions sporadically and selectively penetrate
- Local political/industrial complex driven by competitive expansions
- Financing at varied rates of rationed capital and high opportunity costs for retained earnings
- Role of state bureaus vs. more complex set of public and private institutions for public goods (policy) like market shifts
- Policy is often endogenous to hybrid firms

China case: Political Economy

- **The positive capacity of the central state is sporadic; its negative capacity is substantial**
- **In periods of high growth, major decisions about economic policy are decentralized to provincial authorities**
- **After the division of corporate and ministerial organization in the 1990s, concentrated areas of political and market power lie with leading state corporations**
- **Successful examples of economic development are rapidly copied by other local authorities**

Thought experiment: Gas Deal in China

- **Best estimates new generation capacity at least 50 GW in 2004 and 60-70 GW in 2005**
  - **Rising production of 14.9% between 2004 and 2005**
  - **Energy intensity exceeds 1.0; electricity 1.4**
- **December 2006, total installed capacity exceeded 600 GW**
  - **More than 90 GW of newly installed capacity placed in service in 2006**
  - **New capacity more than 80% coal fired**
  - **Approximately 250GW in new power station projects under construction**
  - **Approximately 25% planned new capacity supercritical coal**
- <u>**Imagine China replaces 50 GW of planned coal capacity with natural gas (baseload CCGT) by 2020**</u>
  - <u>**15% reduction over IEA's baseline for coal capacity in 2020**</u>

Plans and prices: Guangdong, 8/04

- Relative Electricity Costs:
  - ***Hydro***: 32-34 cents/kwh (fen in levelized costs);
  - ***Coal without FGD:*** 37 cents/kwh;
  - ***Coal with FGD***: 40 cents/kwh;
  - ***LNG*** (all in): 43 cents/kwh;
  - ***Nuclear***: 47-50 cents/kwh
  - $4/mmbtu gas = $65-70/ton coal (levelized costs with no premia)

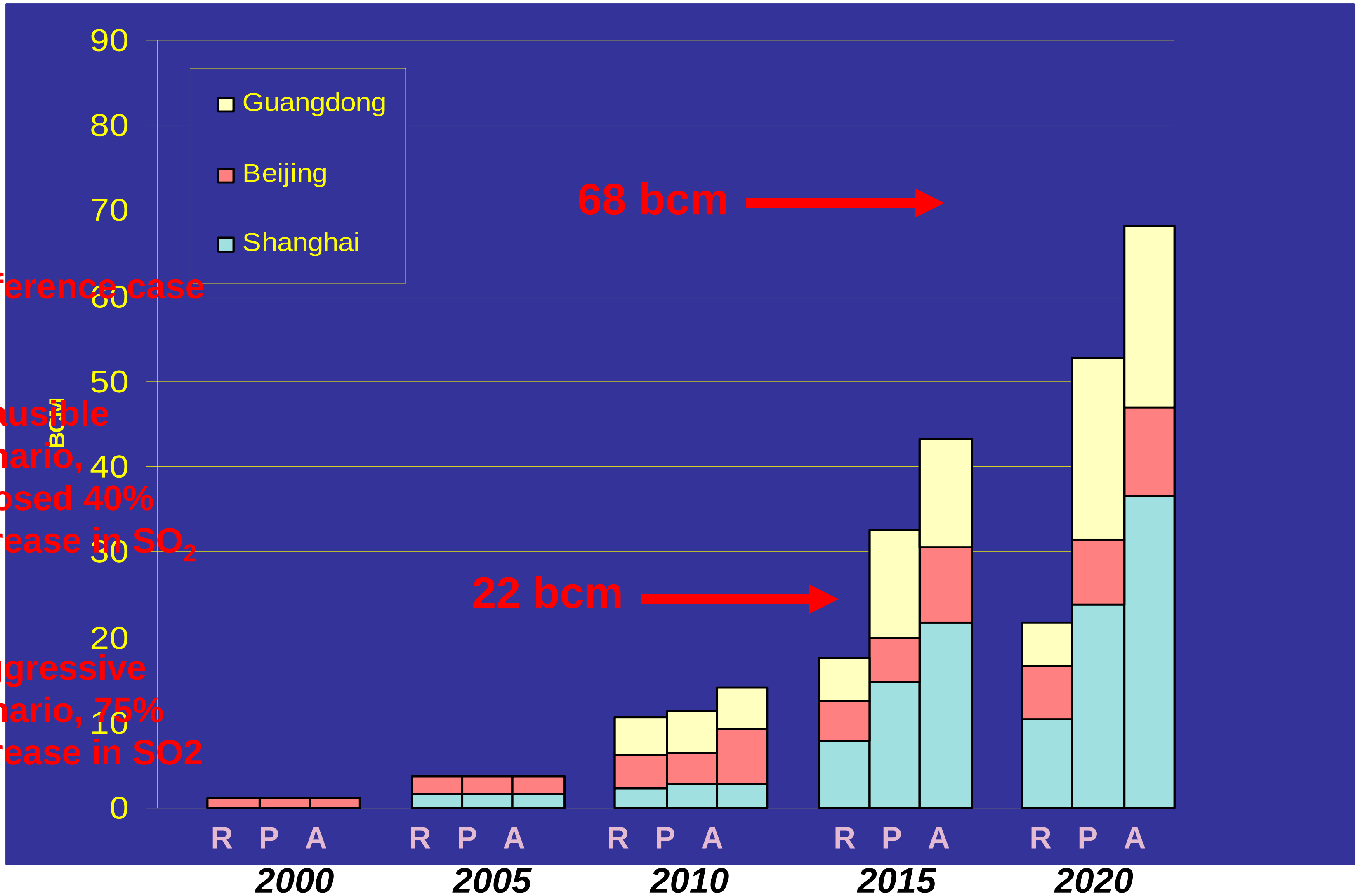
Gas Fuel price shifts- Oct. 2006

US$/ mmbtu	2000	2005	2010	2015	2020
Beijing	4.07	4.74	4.88	5.02	5.02
Guang -dong		5.98 (3.10)	5.98	5.98	5.98
Guang -dong			8.97	8.97	8.97
Shang hai	5.68	7.10 (10.15)	7.10	7.10	7.10

Non-price drivers of gas development in coastal cities (over project lives)

- **Local autonomy (federalism)**
- **Environmental concerns**
- **Peak load curve and tariff controls**
- **Afford market development subsidies**
- **Exchange rates**
- **Capital Market reforms**
- **Industrial development: reliability and distributed power**
- **Chinese oil majors**

Demand for natural gas in the three regions is highly sensitive to environmental constraint

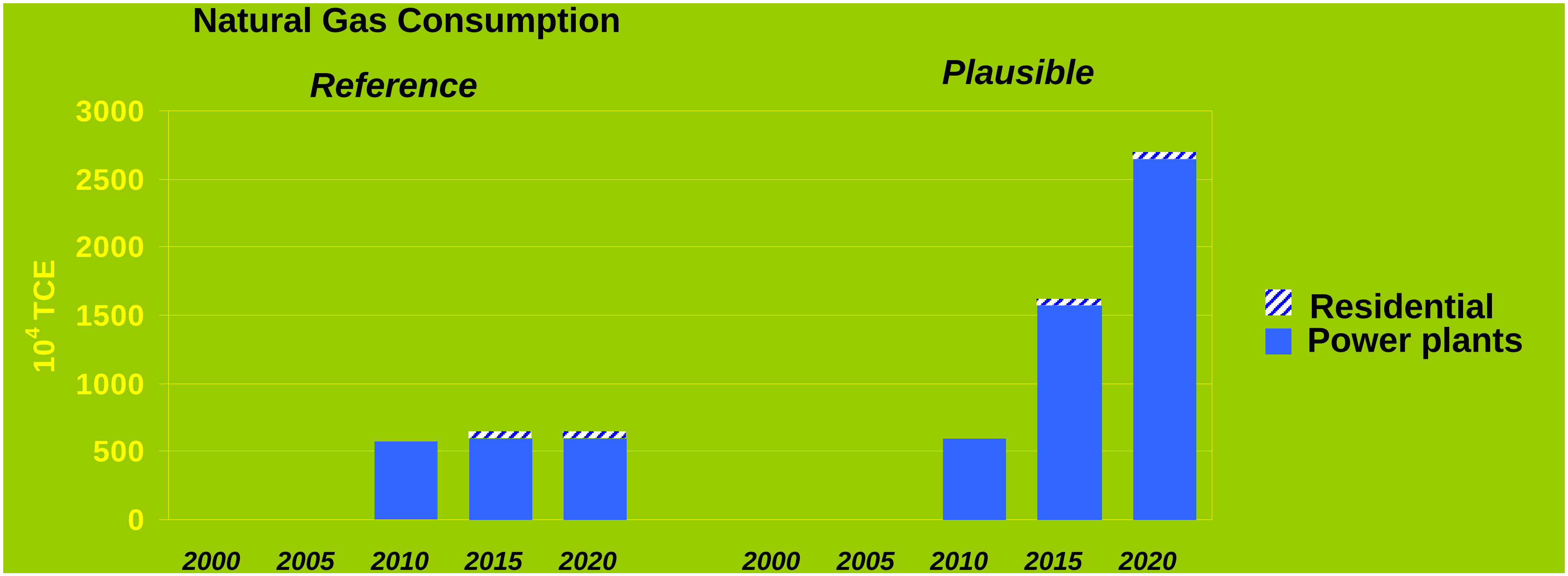


R= Reference case

P = Plausible scenario, imposed 40% decrease in SO_2

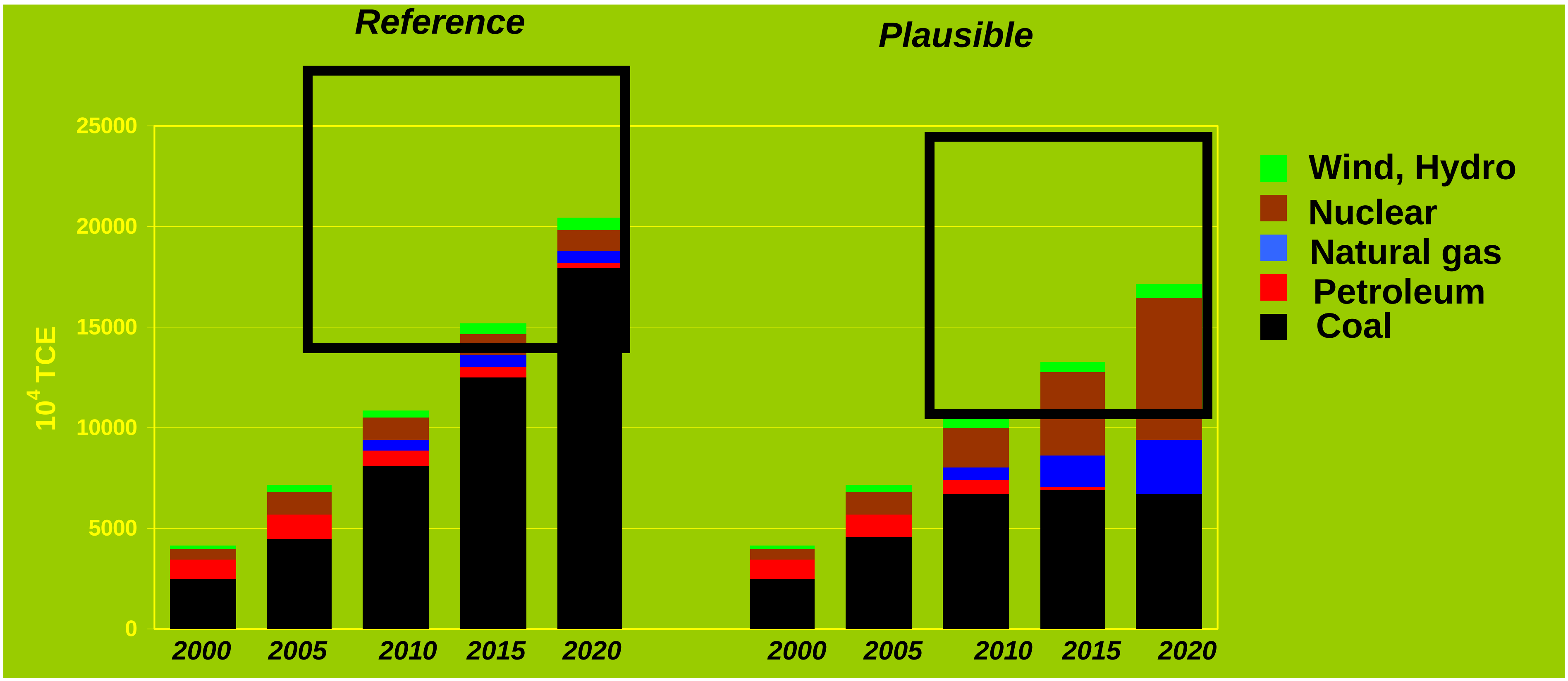
A = Aggressive scenario, 75% decrease in SO2

Guangdong: Demand for gas is in power plants

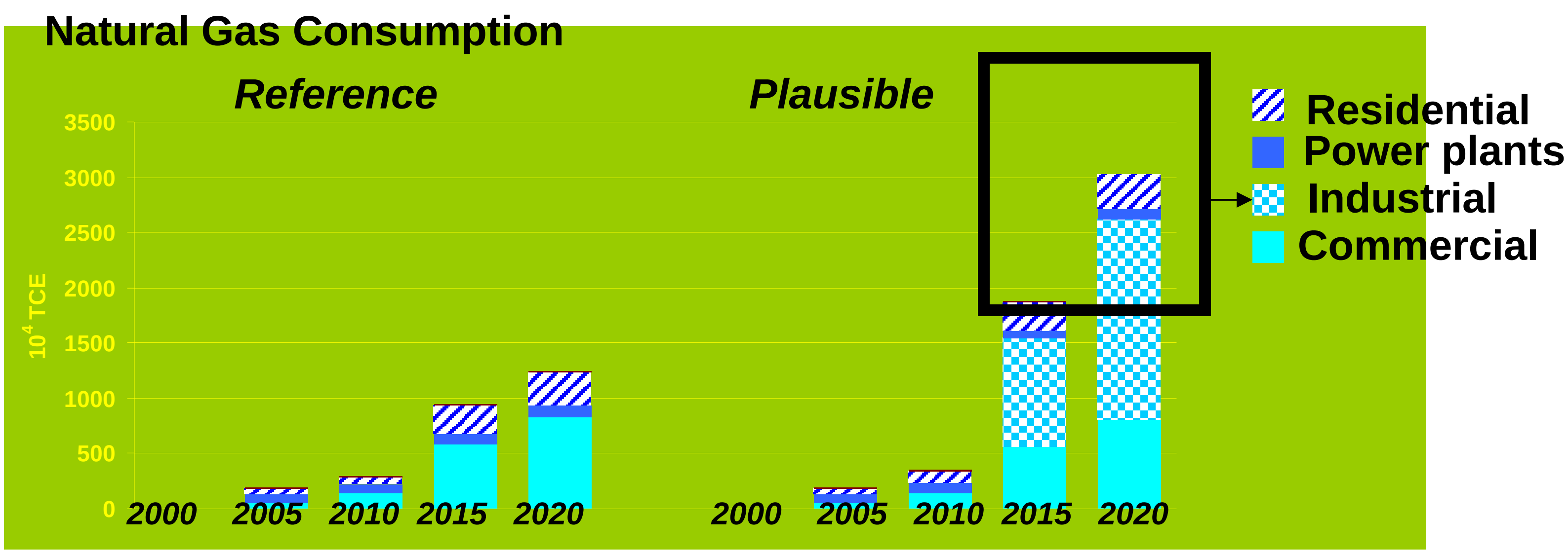


Guangdong: Nuclear plays big role

Power Sector Fuel Consumption

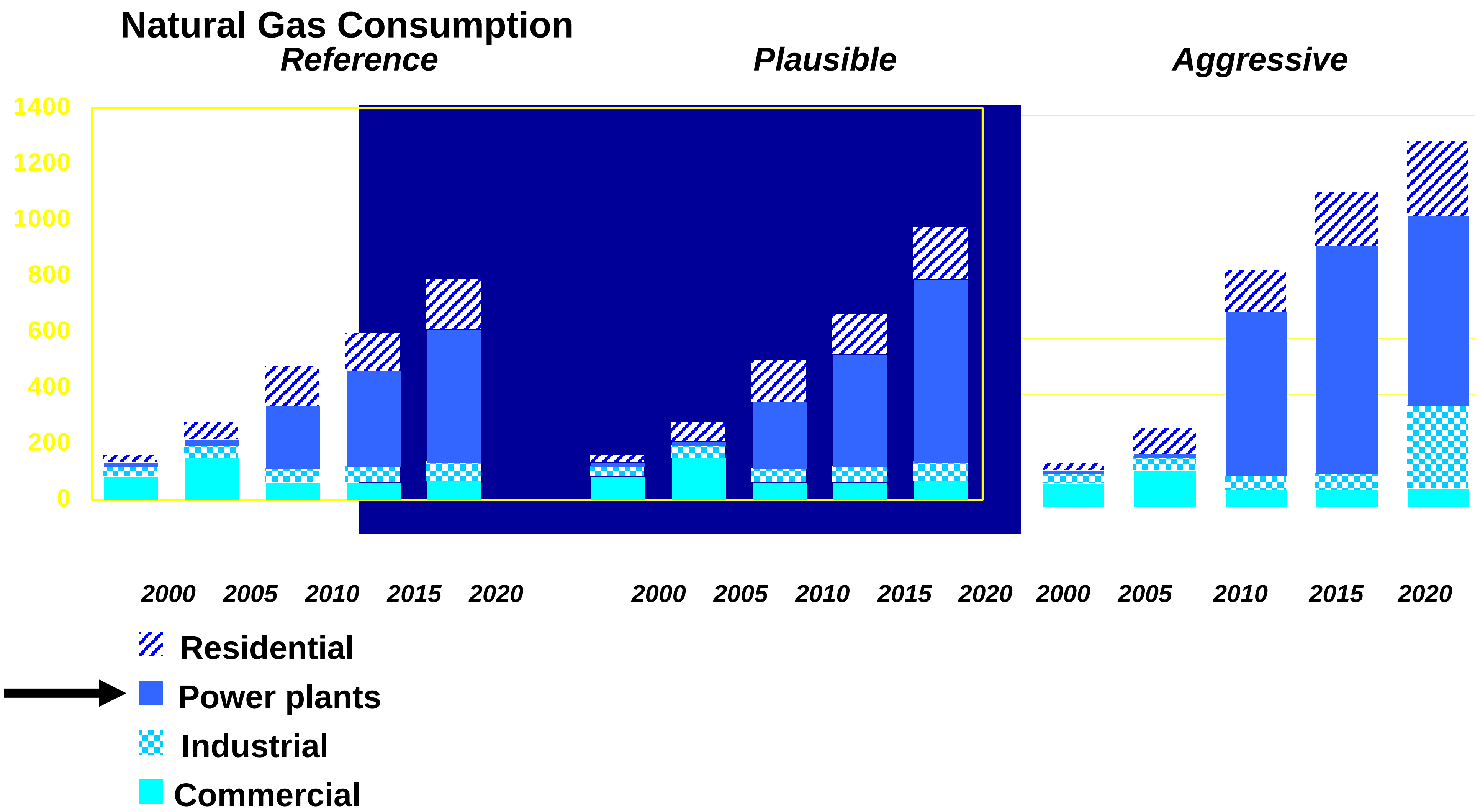


Shanghai: Demand for gas is in industrial sector

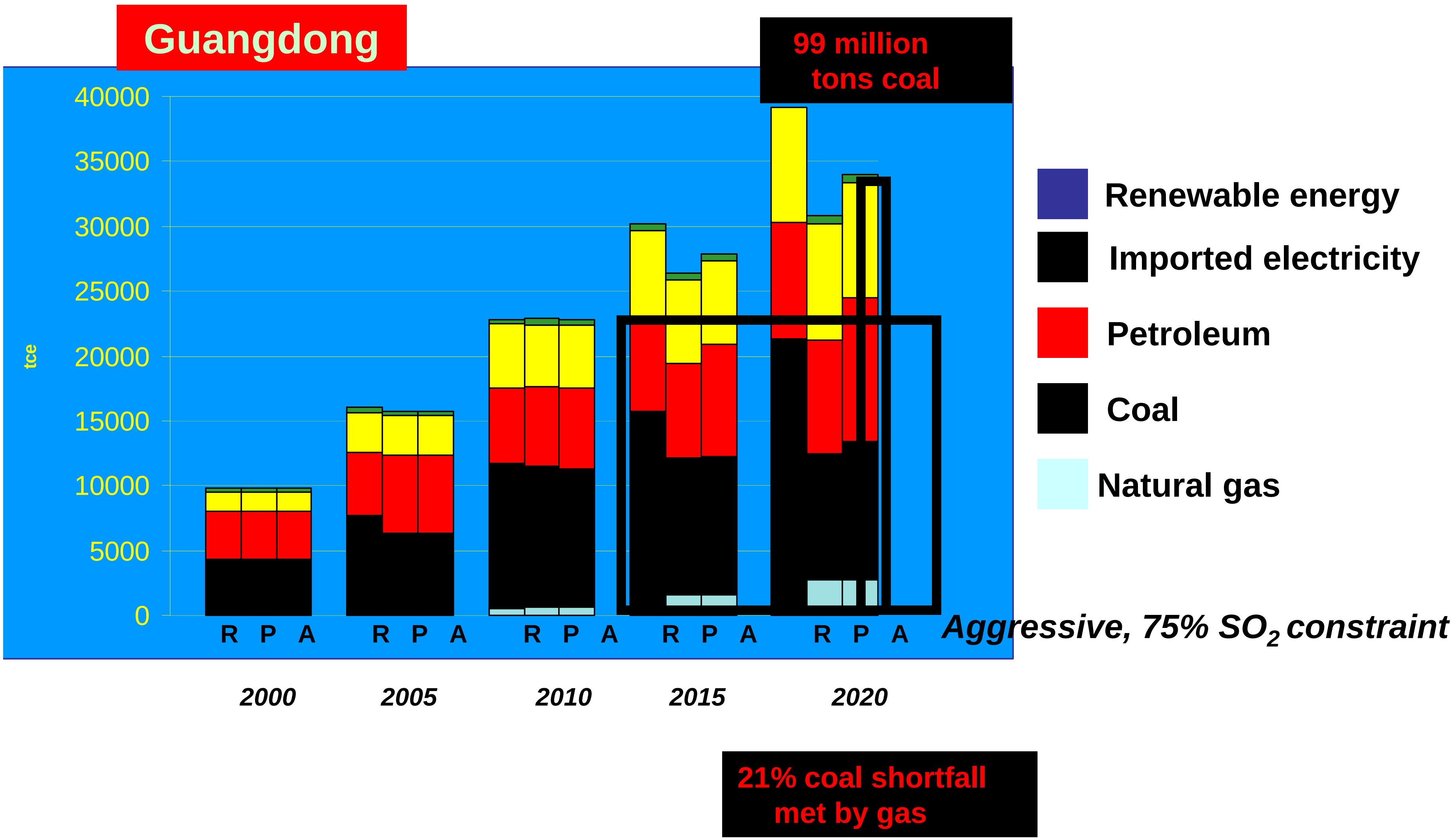


Fuel switch	*Affected industries*
Coal, oil → natural gas boilers	Petroleum and chemicals
	Process heat (metal prod, textile, manufacturing
	Steel and iron

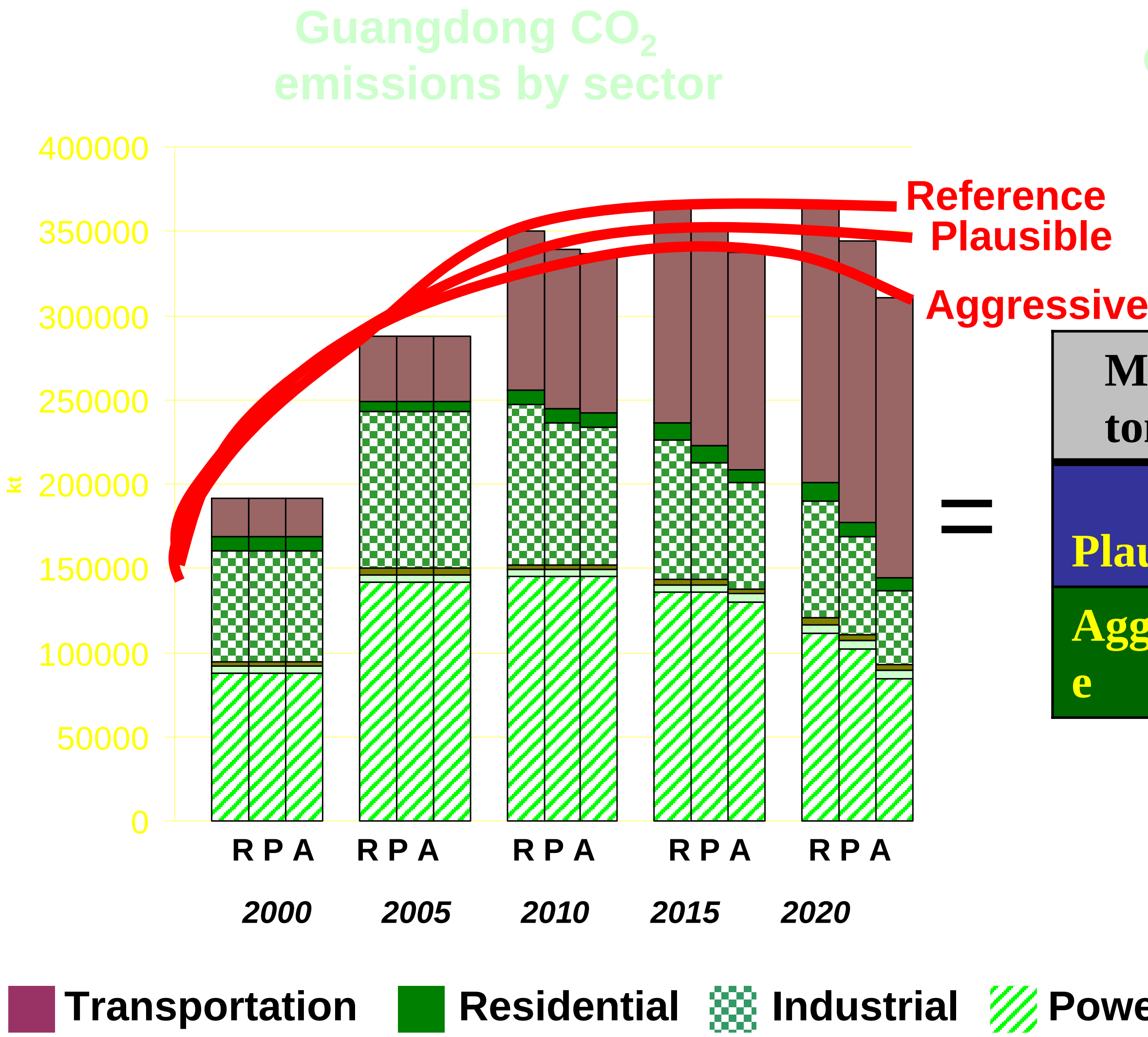
Beijing: Little change in fuel consumption without stringent environmental constraints



Implications for CO_2:
Do environmental controls displace coal?



Implications for CO_2: Do CO_2 emissions decrease?



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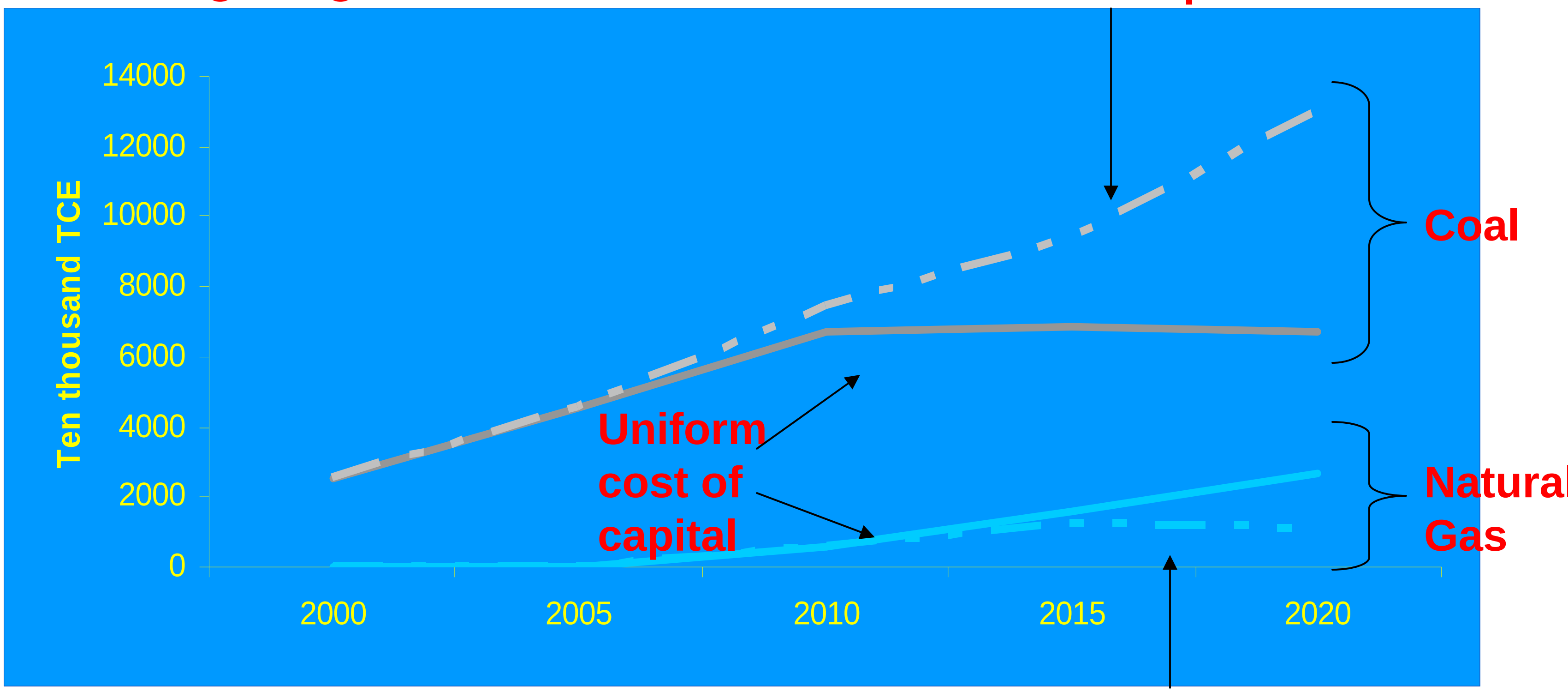
CO$_2$ emissions savings

Million tons	2010	2015	2020
Plausible	11	15	43
Aggressive	16	28	108

Low cost of capital for power plants spurs coal consumption

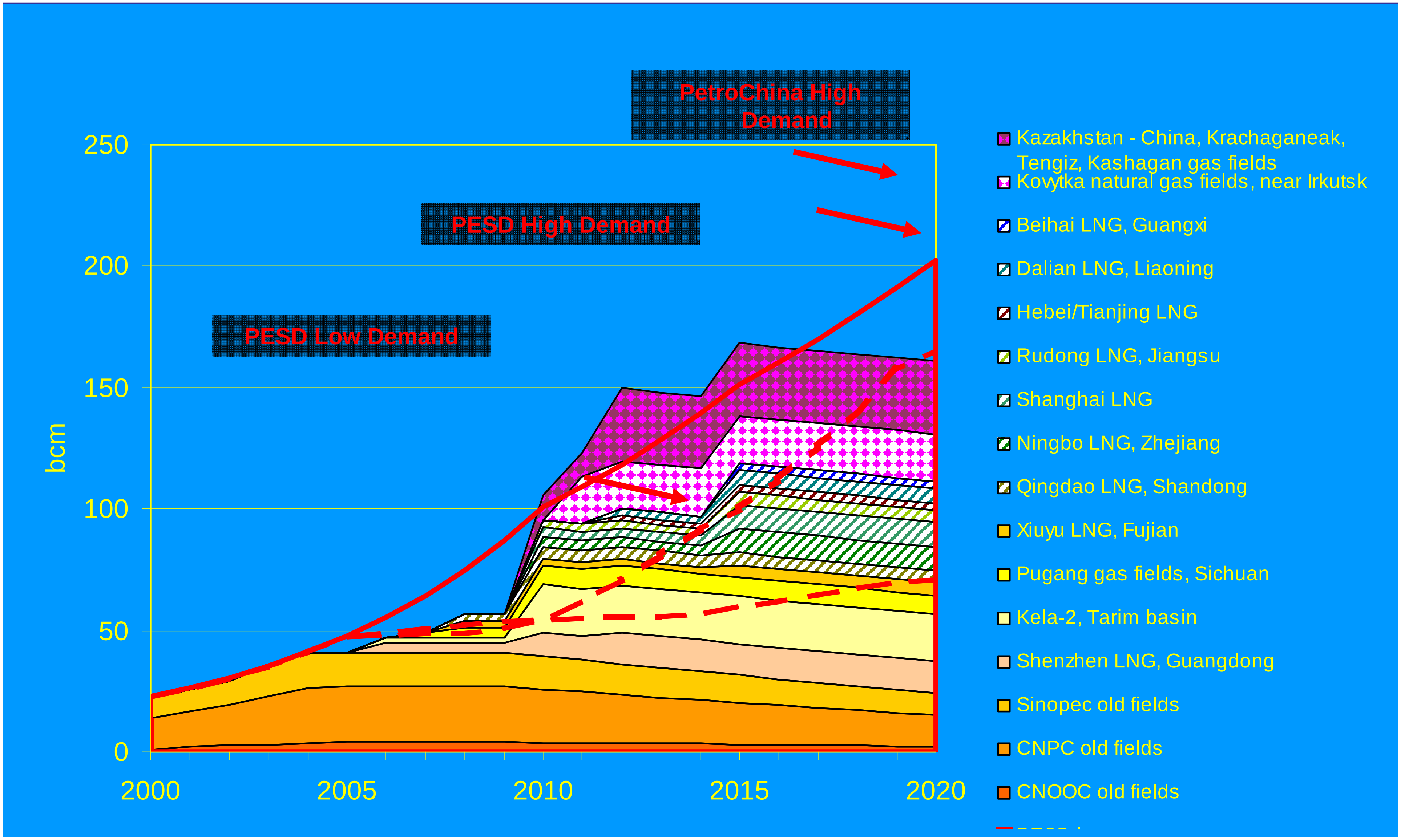
Guangdong

Differentiated costs of capital



Differentiated costs of capital

Natural gas sourcing could potentially be a challenge



Summary of Major Results

- Power plants are not always the most economically efficient source of fuel switching
- Financial reforms, such as differentiated cost of capital by sector could affect fuel consumption patterns
- Environmental and infrastructure policies could indirectly affect carbon dioxide emissions

Deals beyond CDM?

- Targeted development priorities
  - Multiple funds?
- Negotiated (policy) baselines
  - Sub-national entities
- Commercial replication
  - Baseline shifts
  - Market development
  - Downstream investments
    - Infrastructure
    - Policy
    - Risk organization
    - Supplies of Fuel

Development and climate

- Efficient subsidies
  - Competition, marginal prices, scale
  - Auctions with qualification and evaluation specialized expert panels (TEAP)
- Business centered change with complementary policies
  - Conditionality (policy shifts)
- Portfolio investment with negotiated credits tied to price cap?
- Sunsets
  - Tranche payouts, performance evaluation by TEAPs
  - Credibility (reputational) review

Investment Funds

- Objectives: Market Transformation
- Regulatory Quality
  - Regulatory capture and systematic oversupply
  - Ambiguity of interpretation of additionality standard
  - Technical capacity to narrow ambiguity in TEAPS
- Efficiency of Expenditure
  - Supply side
    - Marginal cost bids
    - Expert judgment on gravitational forces and emissions productivity
  - Demand side: price setting or (regulated) market clearing
    - Opportunity costs in domestic trading markets
    - Oversupply of offsets
    - Sub-optimal price with risk-averse actors