Coal Use in India and China: Supply, Demand, and Generation

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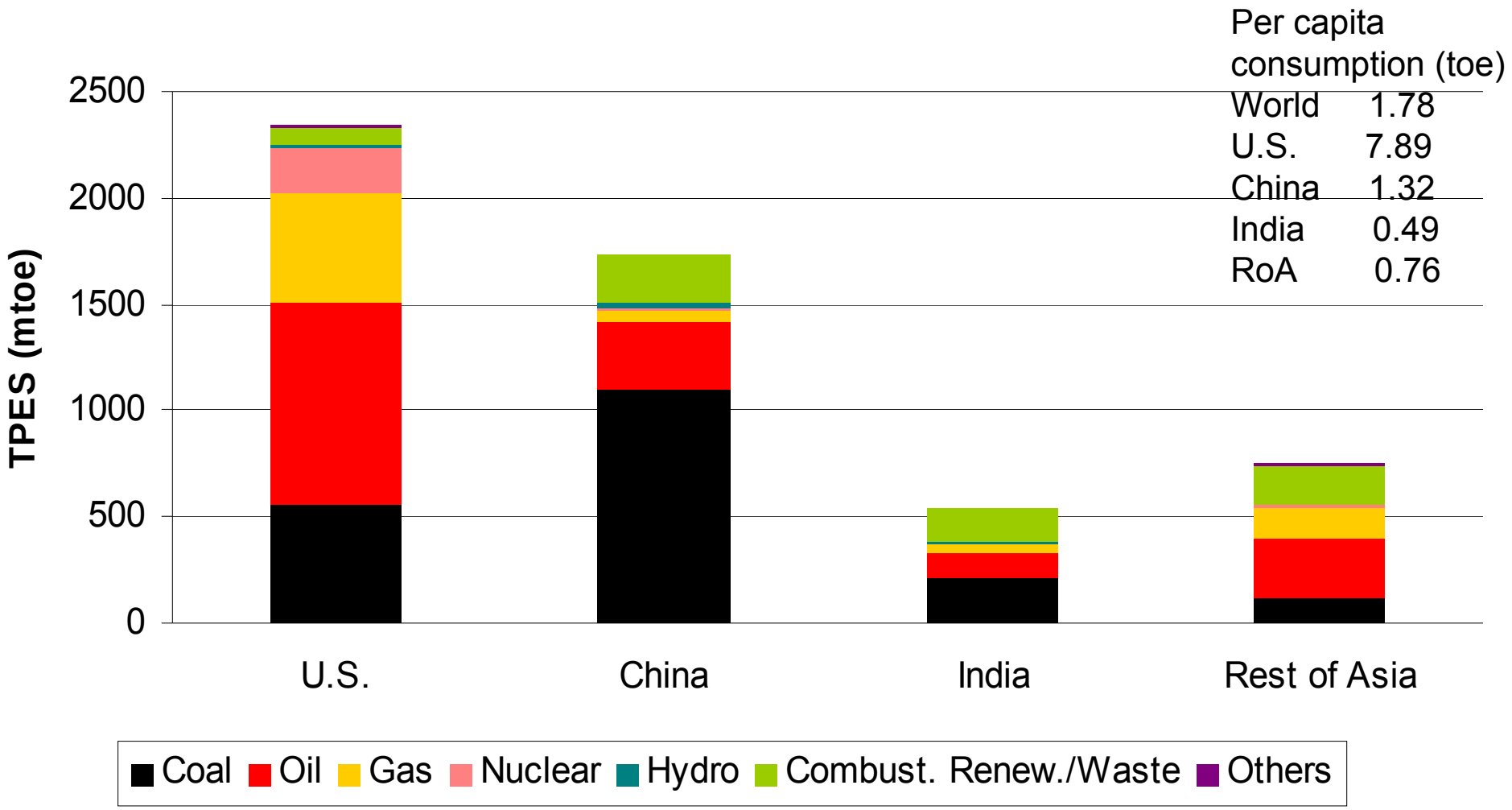
Outline

1. Key Energy Challenges
2. Electricity and Coal Scenario
3. Challenges in the Coal/Coal Power Sectors
4. Coal Resource/Reserves
5. Displacement
6. Coal Power Technologies
7. Key Takeaways

1.0 Key Energy Challenges in Asia

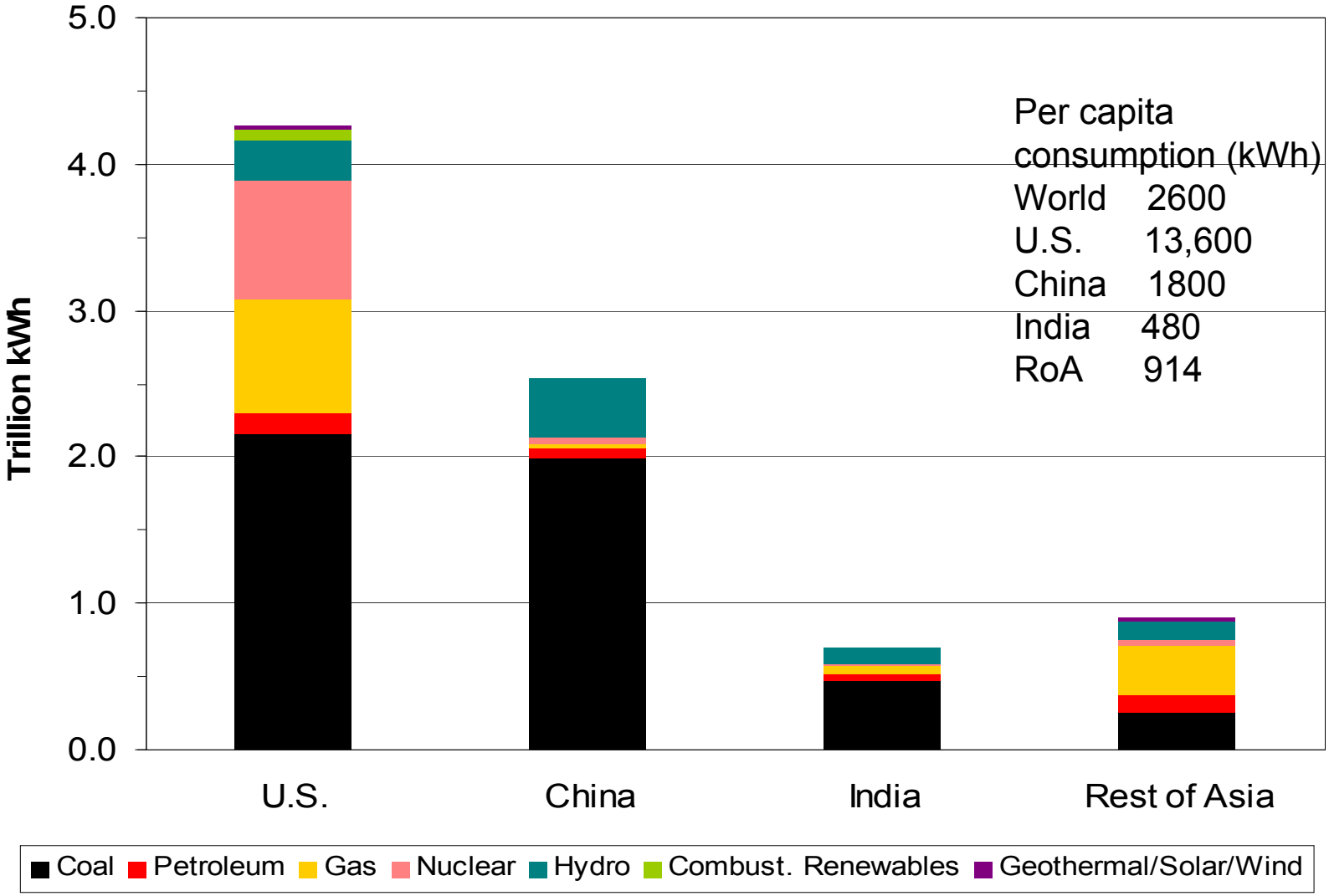
- Promoting sustainable energy infrastructure development
  - Energy consumption will increase with greater economic development
  - Timescales are important (lock-in)
  - Institutional changes towards market orientation
- Providing basic amenities and energy services to all citizens
  - Key for poverty reduction (MDG)
- Energy security, access to energy resources, affordability
  - Limited domestic resources of oil and gas
  - Significant domestic coal resources
  - Cooking fuels and stable electricity supply
- Local environmental protection
  - Pollution control and land-use changes
- Global Climate Change (“envelope” challenge)
  - Significant impacts on water, agriculture, and coastal areas
  - Need to prepare for mitigation

2.0 Total Primary Energy Supply



Source: IEA 2007; 2005 data

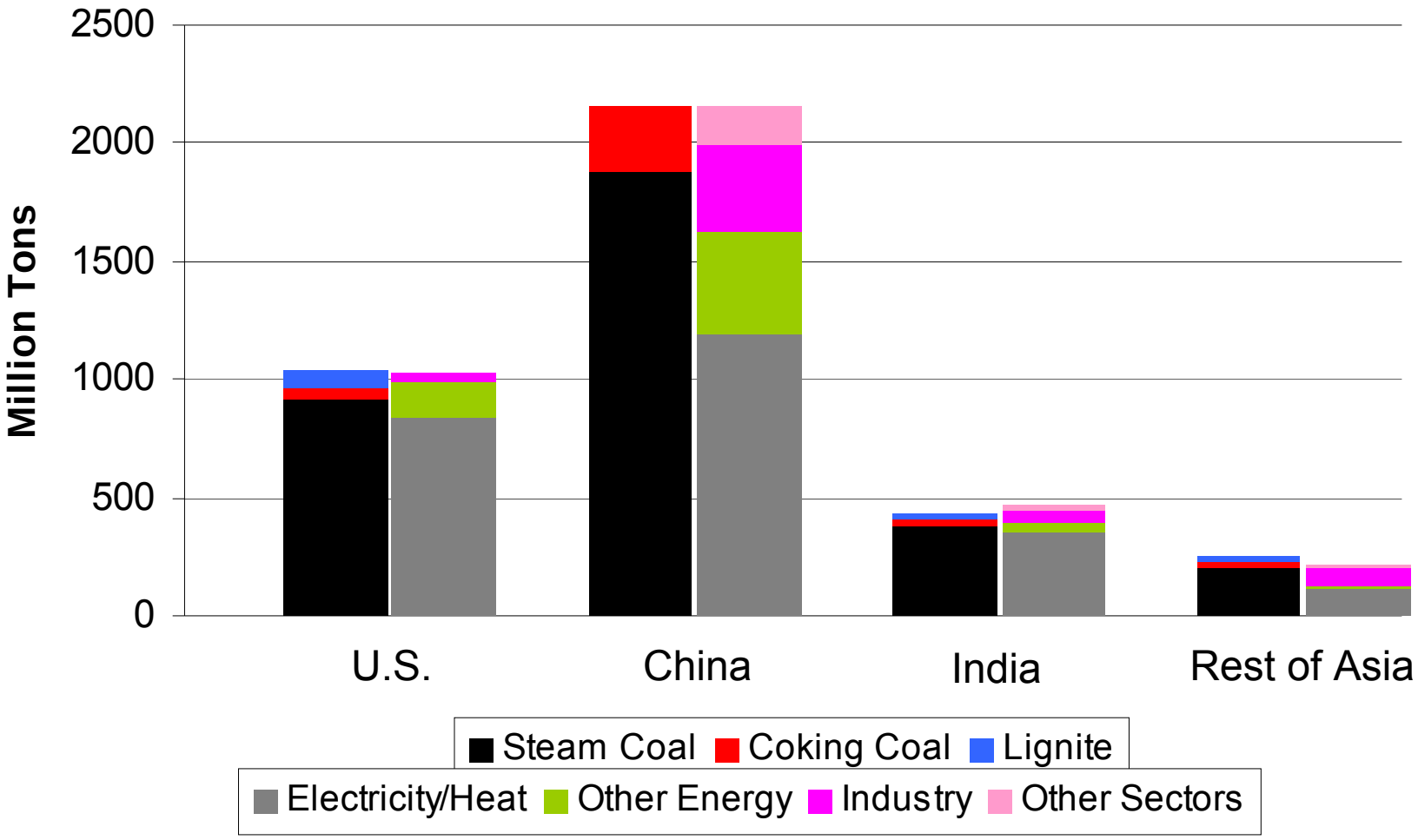
2.1 Electricity Generation



Source: IEA 2007; 2005 data

Electricity generation dominated by coal

2.2 Coal consumption/production

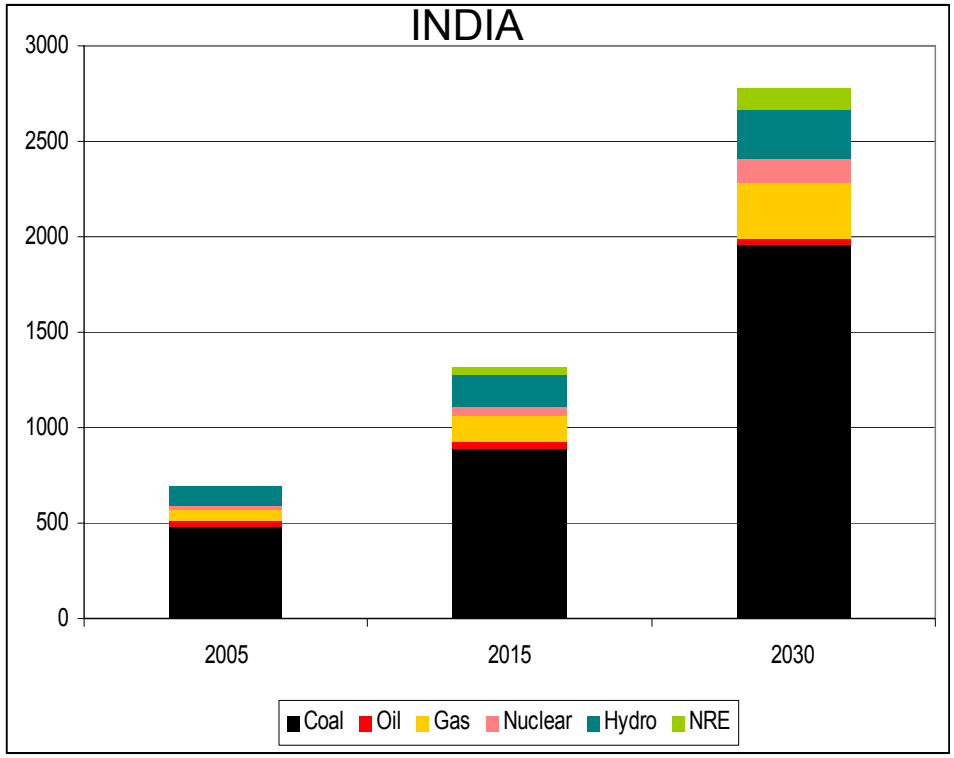


Source: IEA 2007; 2005 data

Most of domestic coal production is for electricity generation

2.3 Future electricity demand

- Electricity consumption/supply bound to increase dramatically
  - India: 600 TWh in 2004-05 → 3600-4500 TWh by 2030



2.3 Future electricity demand

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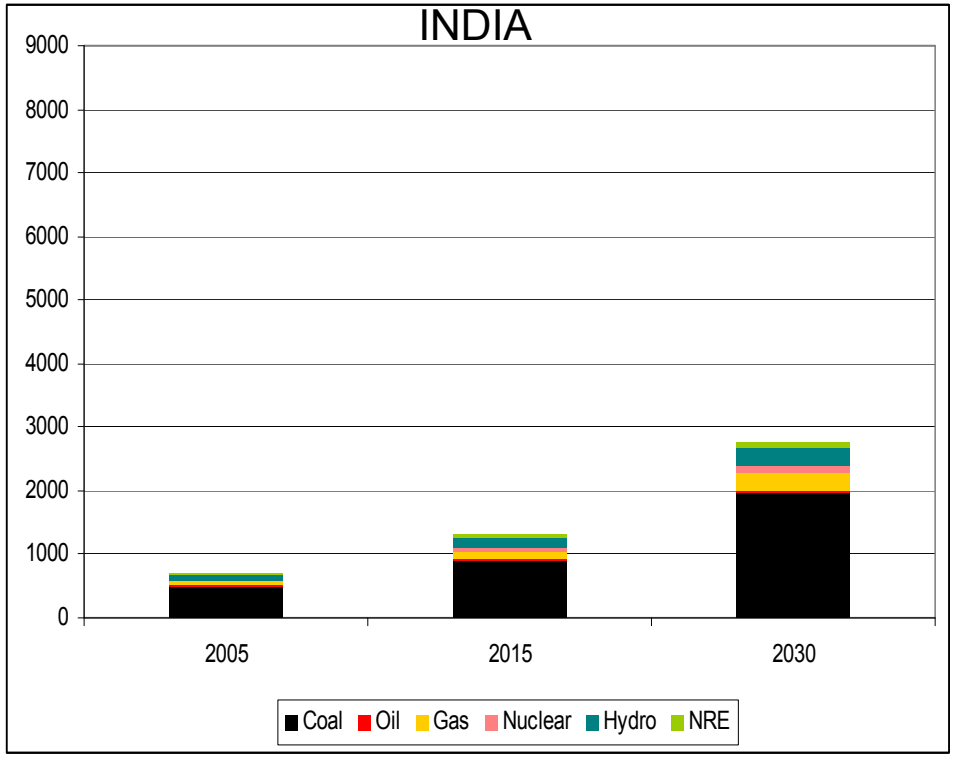
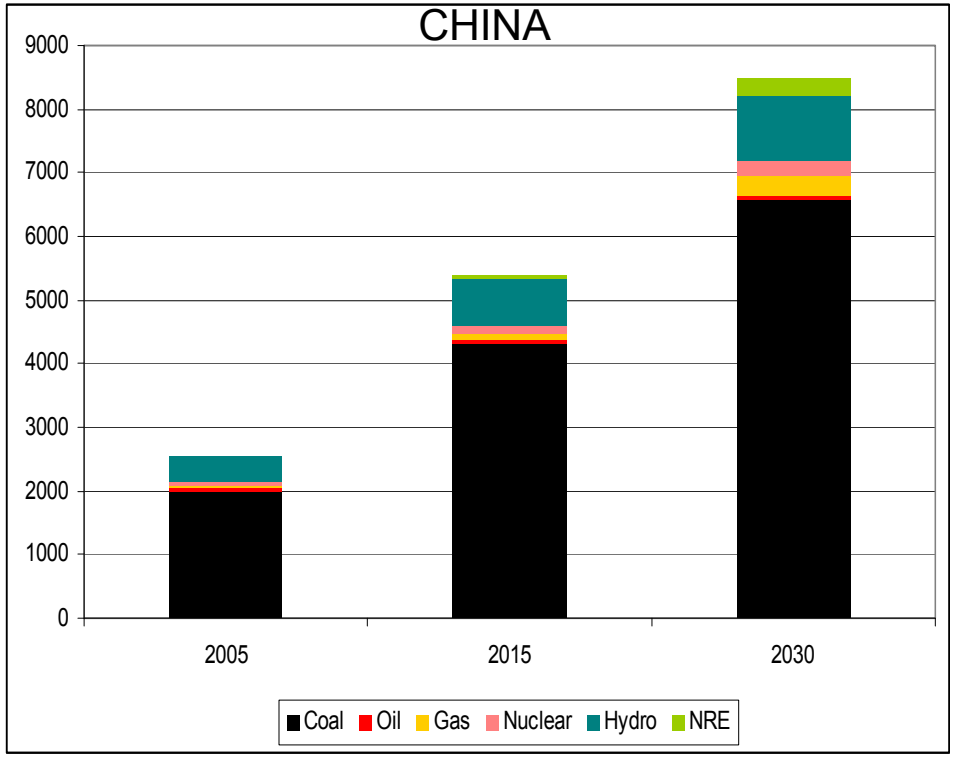
  - India: 600 TWh in 2004-05 → 3600-4500 TWh by 2030
  - China: 2500 TWh in 2005 → 7200-9800 TWh by 2030





Coal Power growth rate (2005-2015): India 5.8%; China 8.3%

2.3 Future electricity demand

- Electricity consumption/supply bound to increase
  - India: 600 TWh in 2004-05 → 3600-4500 TWh by 2030
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- Short term plans

India

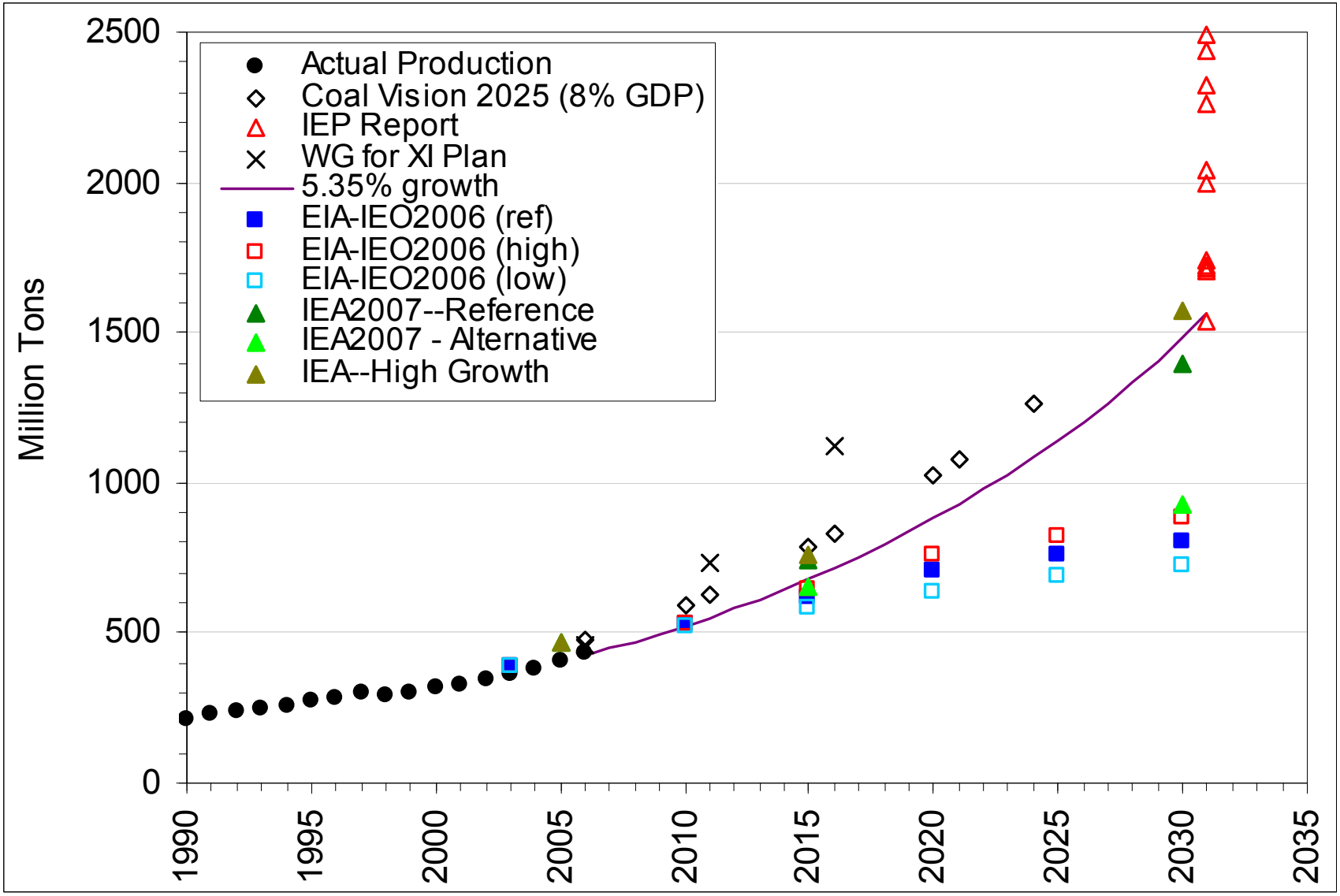
  - 10 GW of coal-power installed 2002-2007 (Planned: 20 GW)
  - 45 GW of coal-power planned for 2007-2012

China

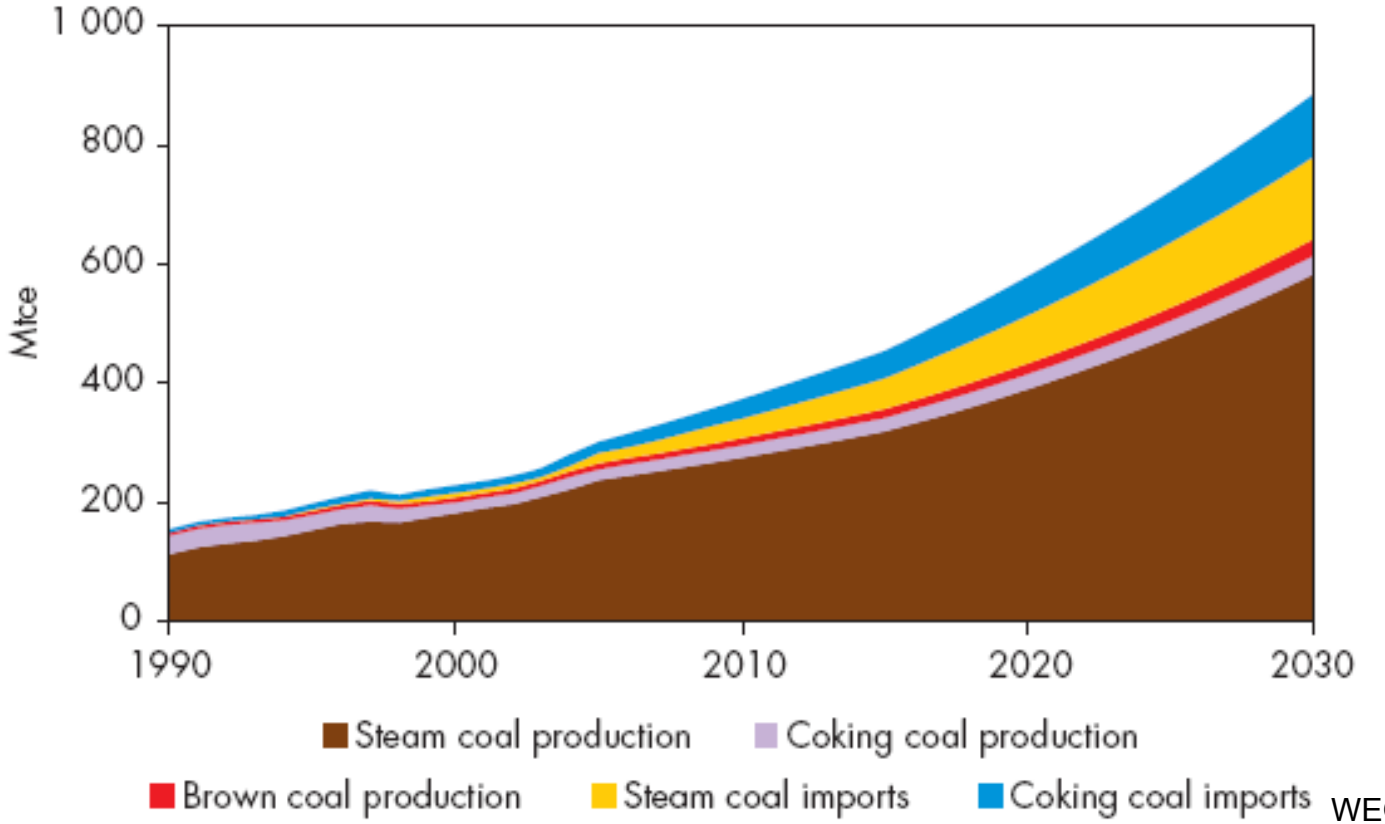
  - 135 GW of coal power 2002-2005
  - 220 GW planned for 2006-2010; 170 GW already installed by 2007

India is not the same as China

2.4 Future Coal Demand – India



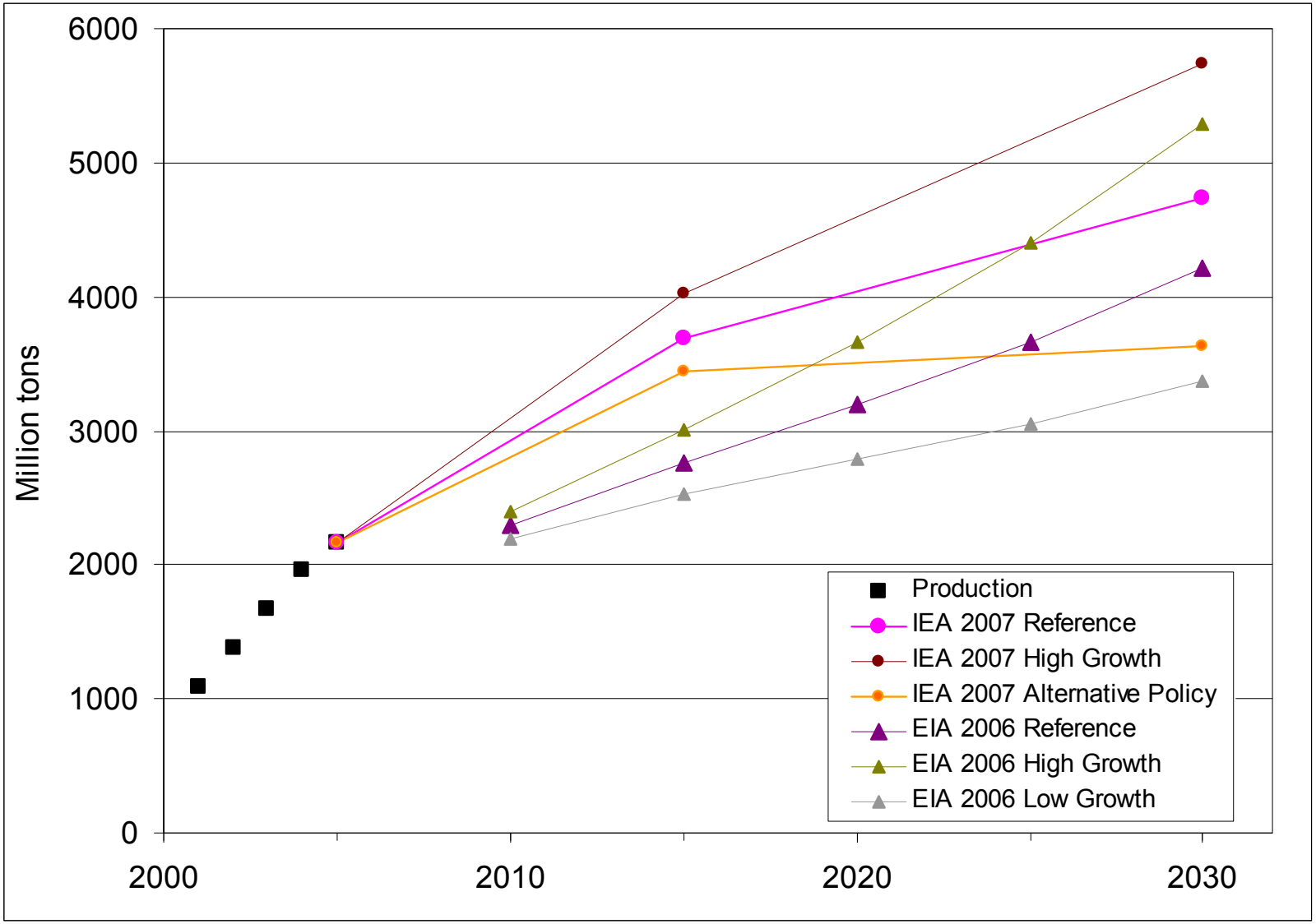
2.5 Coal Imports -- India



WEO2007

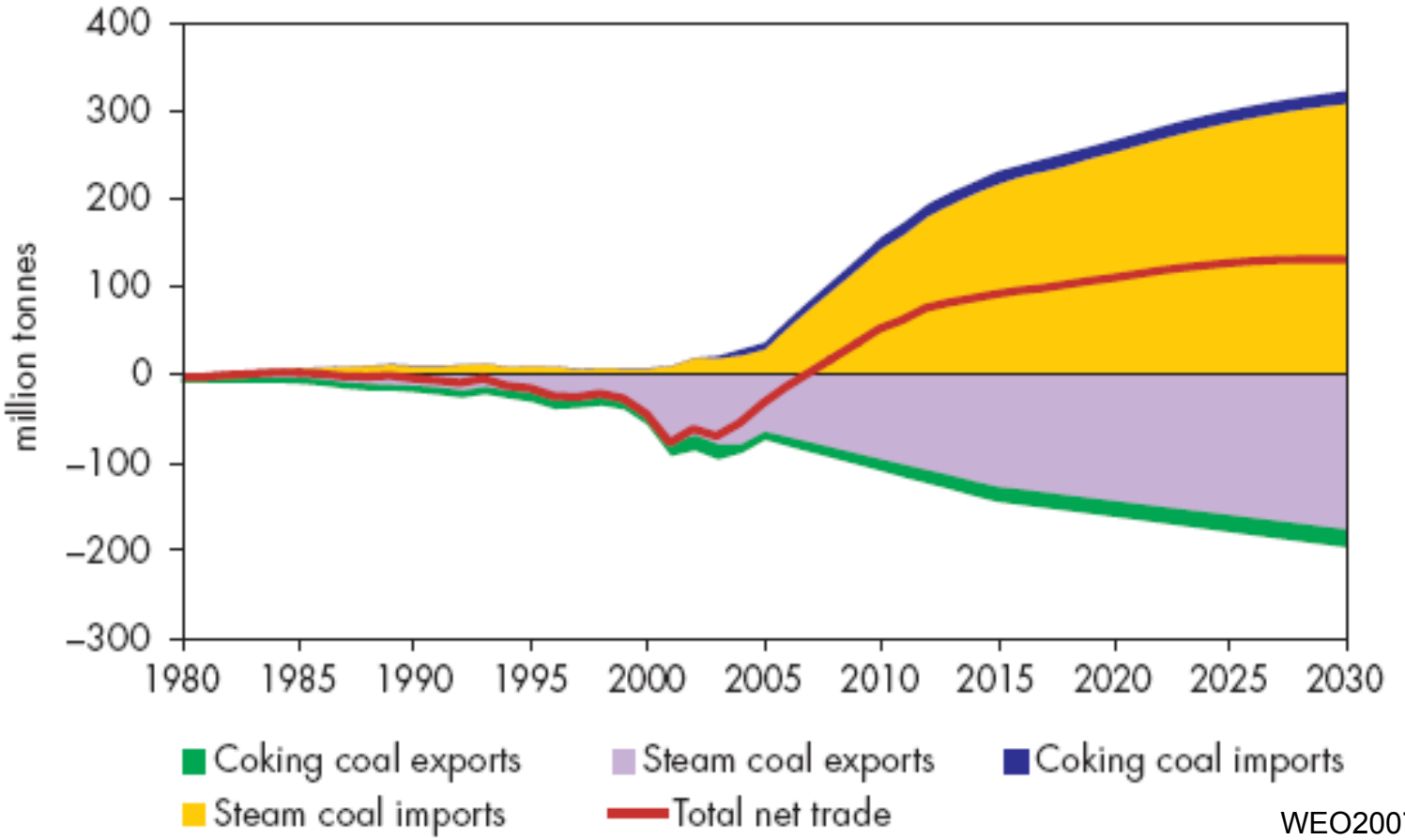
- Expected domestic production: ~1.4 BT by 2030
- Higher level of imports than present
  - Domestic coal companies buying/mining coal in other countries (Indonesia)
  - Indian projections: 11%-45% of demand by 2030 (IEA: 30%)
- Port infrastructure can be a key limitation
- Key countries: Australia, Indonesia, South Africa

2.6 Future Coal Demand -- China



In contrast to EIA, some IEA projections indicate slow down in growth of coal consumption by 2030

2.7 Coal Imports - China



WEO2007

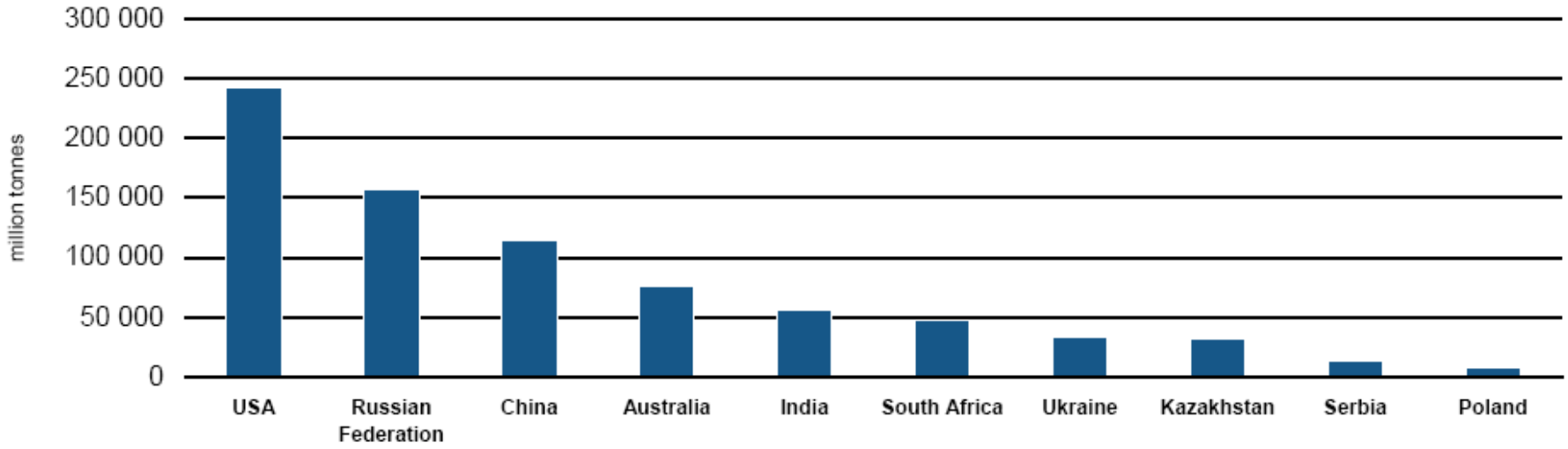
China becoming a net coal importer

- High level of steam coal imports by 2030 to meet coastal coal demand
- Import from Indonesia, Australia, South Africa, Vietnam
- Export only to Japan, Taiwan, Korea

3.0 Key Challenges

- Meet the rising demand
  - Increase pace of exploration & better reserve assessment
  - Upgrade technologies to access deeper reserves
  - Reduce bottlenecks in coal transport
- Reduce and manage social issues
  - Resettlement and rehabilitation (big issue for India)
- Limit and manage environmental impacts
  - Balance between environment and mining
  - Deploy advanced technologies
- Introduce institutional and pricing reforms
- Increase human resources and capacity building

4.0 Coal Reserves



- Coal resources widely distributed compared to oil/gas
  - Asia: Dominated by India, China; Indonesia/Australia—big exporters

A New Way To Look At The World

Coal

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THIS MAP SHOWS

Countries resized relative to:

Coal Reserves
(number of tons)

WORLD TOTAL

847.5 billion

Data © World Energy Council

RANKING

United States	242.7 billion
Russian Federation	157.0 billion
China	114.5 billion
Australia	76.6 billion
India	56.5 billion
South Africa	48.0 billion
Ukraine	33.9 billion
Kazakhstan	31.3 billion

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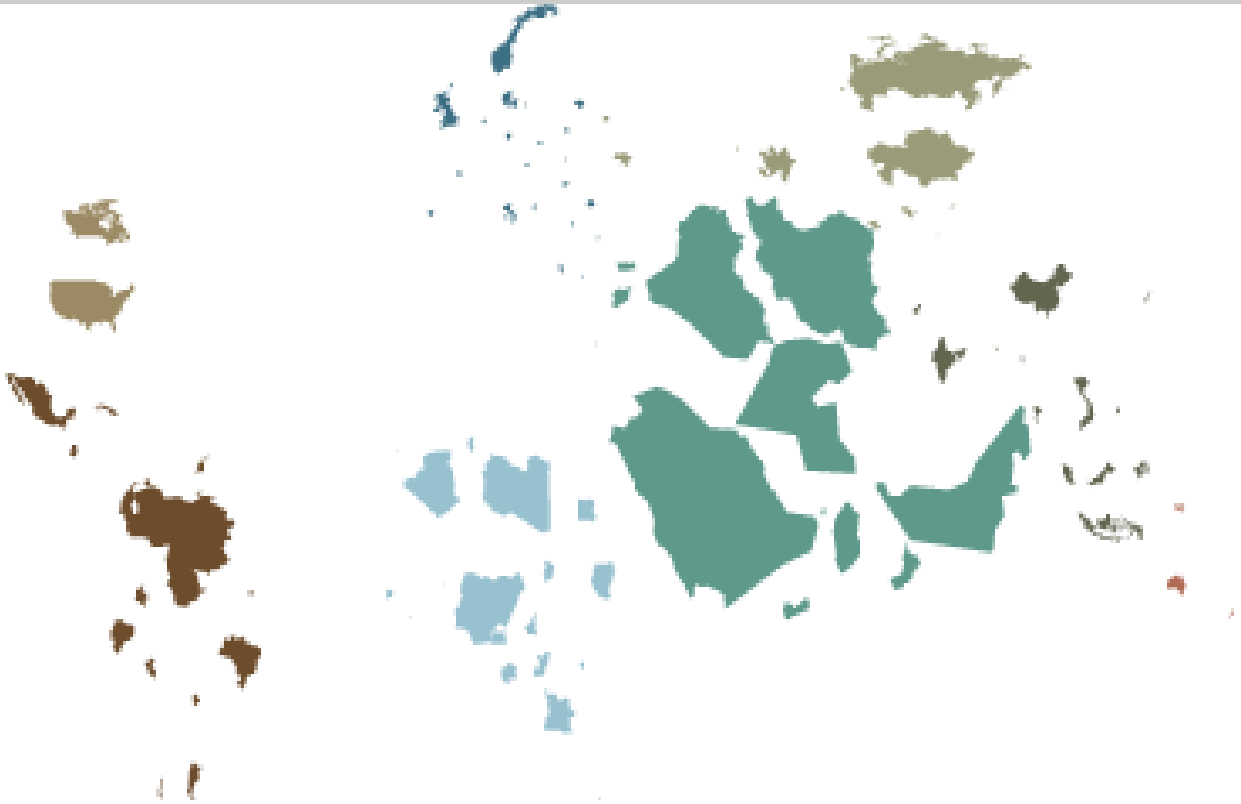
A New Way To Look At The World



Oil

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THIS MAP SHOWS

Countries resized relative to:

Oil Reserves
(number of barrels)

WORLD TOTAL

1 215 billion

Data © World Energy Council

RANKING

Saudi Arabia	264.3 billion
Iran, Islamic Rep.	137.5 billion
Iraq	115.0 billion
Kuwait	101.5 billion
United Arab Emirates	97.8 billion
Venezuela, RB	80.0 billion
Russian Federation	74.4 billion
Libya	41.5 billion

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A New Way To Look At The World

Gas

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THIS MAP SHOWS

Countries resized relative to:

Natural Gas Reserves (number of cubic meters)

WORLD TOTAL

176 462 billion

Data © World Energy Council

RANKING

Russian Federation	47 820 billion
Iran, Islamic Rep.	26 740 billion
Qatar	25 633 billion
Saudi Arabia	6 848 billion
United Arab Emirates	6 071 billion
United States	5 866 billion
Nigeria	5 150 billion
Algeria	4 504 billion

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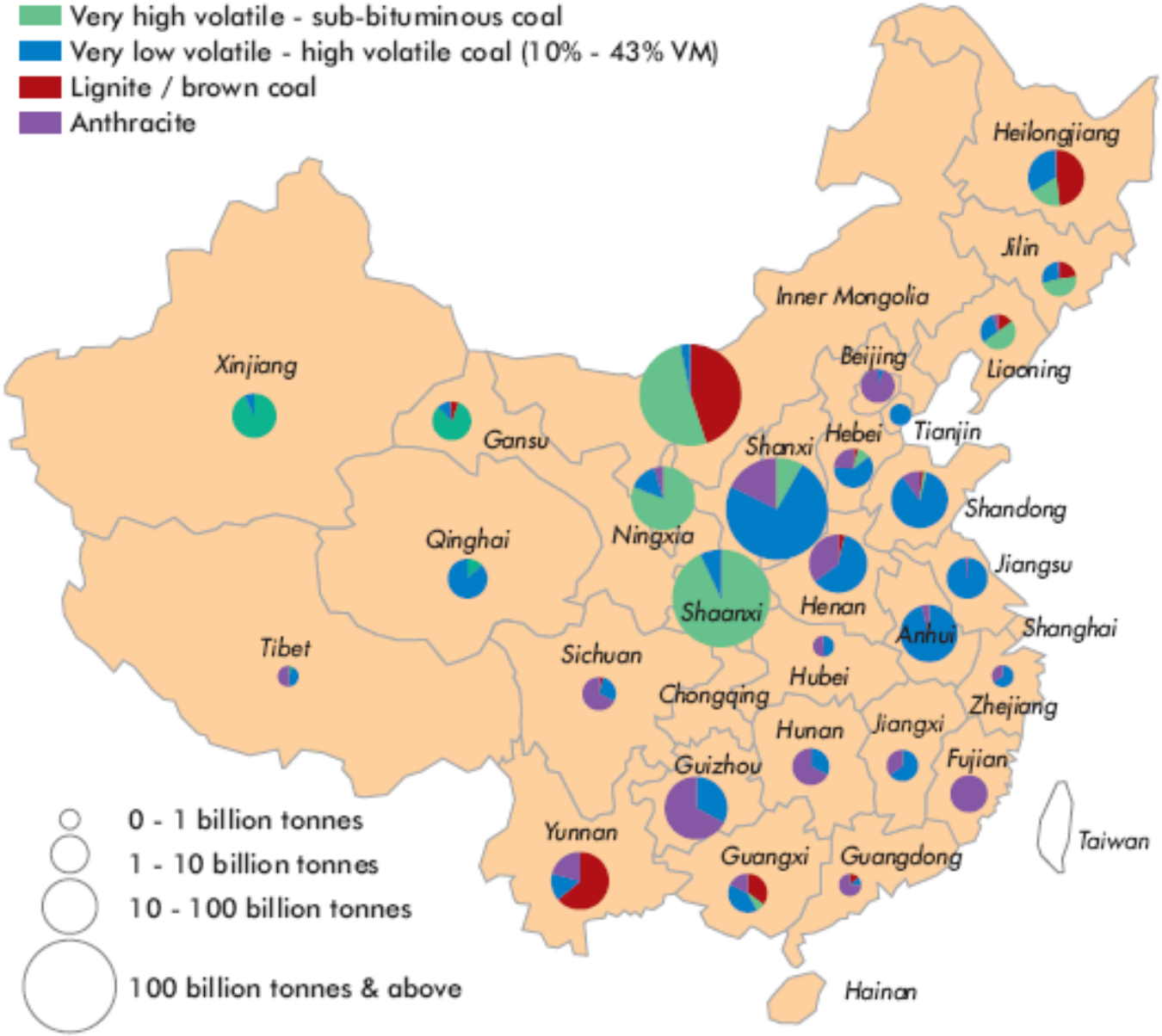
4.1 Indian Coal Resources

4.2 China Coal Resources



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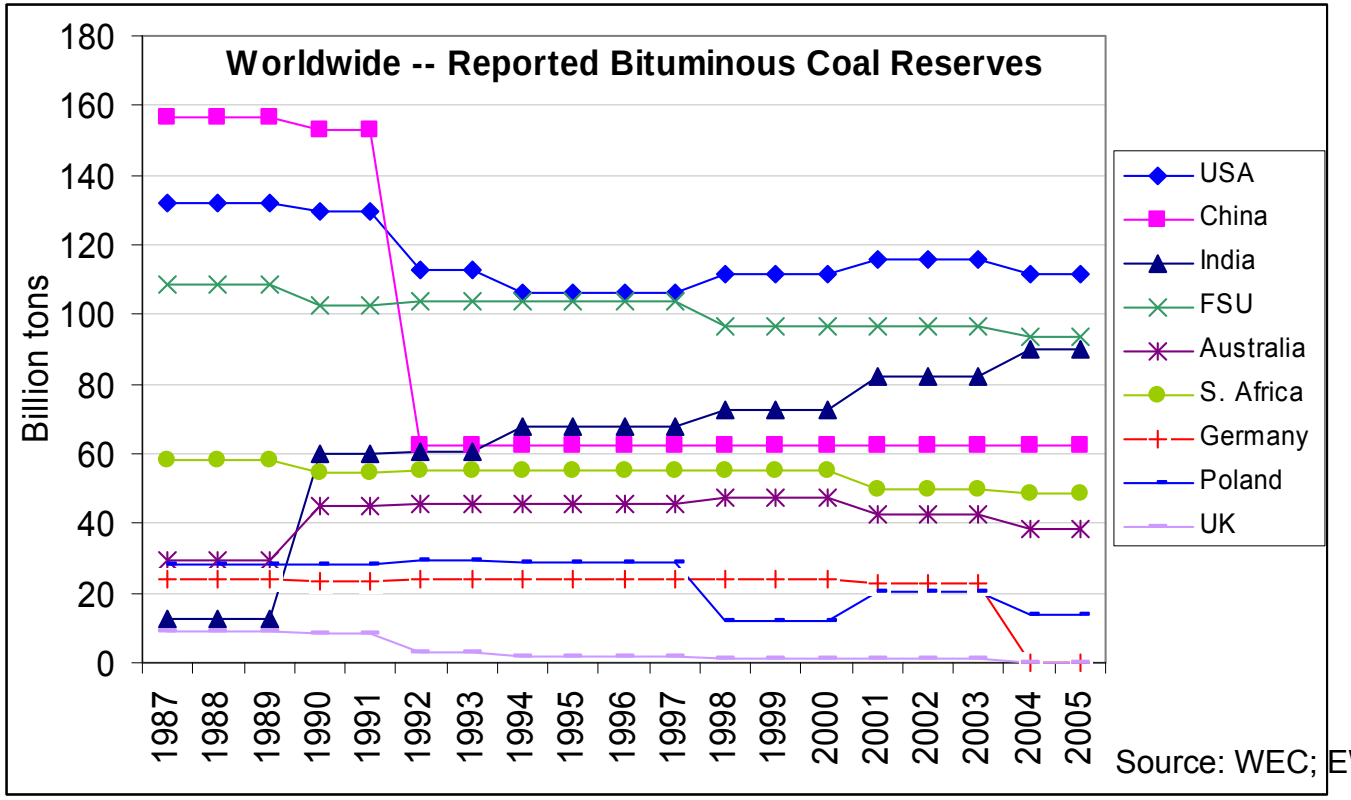
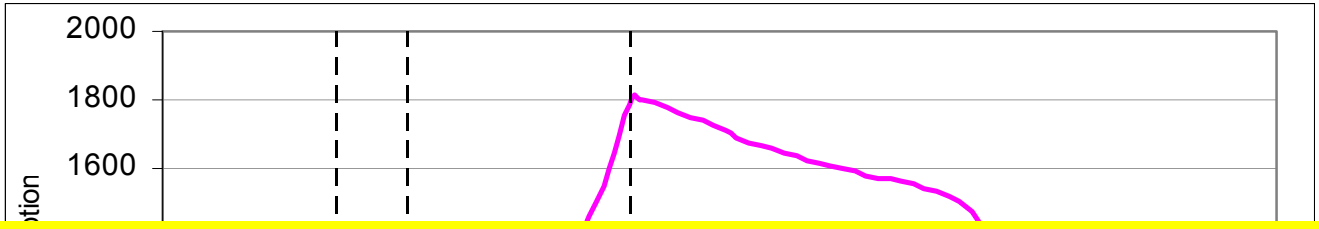
4.3 Coal Reserves



- Reserve data on coal is uncertain and not as well maintained as oil/gas
- Depletion not taken into account
- Data based on fairly old geological information
- Definitions of “reserves” not uniform across countries
- Issue of “Peak Coal” – does it matter?

4.4 Lifetime coal consumption
(Indian power plants)



BAU: Sa
type dist
11th Plan
(all using
coal)

Reserves matter for individual countries and their (perceived) energy security, but not globally

"Local Peak Coal" matters for long term energy policies of Asian countries, but not necessarily for coal-company decision making

Great impact on global coal trade

Upgrading of geological data is critical

	Existing Plants	11th Plan BAU	6% GDP	8% GDP
Electricity Growth		11%	4.8%	6.4%
Lifetime Coal consumption (BT)	12.2	24.7	68	91
Peak coal consumption (MT)	327.3	573.6	1353	1805

Beyond existing reserve base

5.0 Displacement—Key Social Issue (India)

- Displacement of people due to coal mining is inevitable and is of enormous magnitude
  - 170,000 families or 850,000 displacees to be rehabilitated by 2025
  - Land requirement to double from current 147,000 ha to 292 500 ha
- Very limited data and socio-economic information on PAPs
  - Fernandes: about 5 million (DP and PAP) for all mining (mostly coal) *(disputed)*
  - 75% of displaced people's lives worsened due to displacement
  - Detailed socio-economic data needs to be monitored, collected, and authenticated on a routine basis for all projects
- Coal projects are being held up because of social protests against mining
  - Little/no information on abandoned mines; reclamation and mine closure problems
- Rehabilitation and Resettlement (R&R) should make sure that people are better off than before
  - R&R should include creation of social assets and benefit sharing
  - Need for coal companies to be progressive and pro-active in dealing with their past
- PAPs need to be part of the decision-making process

6.0 Coal power technology policies

- Most of the focus over the last couple of decades has been on institutional and regulatory reforms
  - Breaking up of government monopolies
  - Privatization
  - Introduction of independent regulation
  - Pricing reforms / reduction of subsidies
- Climate change mitigation
  - Requires a major reorientation of the energy sector in a short timeframe
  - Technologies play an important role
- Policies for technology development & deployment
  - Energy technologies last a long time and have high investment costs
  - Need for government support for faster deployment and scale-up of technologies that meet future challenges
  - China is much better track-record than India

6.1 Current Technologies – India

Technologies constrained by quality of Indian coal (high ash and low calorific value)

- Full-scale domestic manufacturing started in late 60s-early 70s
  - Technologies licensed from foreign manufacturers
- Subcritical Pulverized Coal (PC)
  - Little domestic innovation for advanced PC technologies.
- Circulating Fluidized Bed Combustion (only for lignite)
- Supercritical (SC) PC
  - Two plants under construction using Korean/Russian technologies
  - Ultra Mega Power Plant scheme
- Main focus on particulate control; only one FGD in operation
- Efficiency has improved slightly, but not significantly
  - 1-2 percentage point improvement possible in all power plants
- Integrated Gasification Combined Cycle (IGCC) – pilot scale plant

6.2 Current Technologies -- China

- Domestic manufacturing started in early 80s
  - Built up a strong domestic manufacturing with innovation capability
- Dominated by subcritical PC, but now focused on supercritical PC
- Ultra-Supercritical (USC) PC
  - Seven 1-GW and three 600-MW units in operation (all indigenous)
- Efficiency has improved significantly
  - Shutting down of old and smaller power plants
  - Increasing use of SC and USC boilers
- Pollution control
  - FGD capacity 270 GW – over 50% of total capacity
  - Cess on sulfur emissions
- Gasification
  - Three IGCC and two oil-electricity co-production demonstration plants under construction
  - Developed indigenous technologies

6.3 Advanced Cleaner Coal Tech.

- Advanced Combustion
  - Supercritical and Ultra-supercritical PC
    - Well tested and commercial technology; China is already heavily invested
    - Coal quality (high ash) is an issue; requires washing
  - Oxyfuel combustion
    - Use O_2 instead of air and recycle flue gas
    - High CO_2 concentration in flue gas—helpful for carbon capture
  - Fluidized bed combustion
    - Combination with supercritical steam might be relevant for Indian coals
- Gasification (IGCC)
  - Carbon capture is more economic with IGCC
  - Current focus is on better environmental characteristics of IGCC
  - Entrained flow slagging gasification (GE/Shell) does not work for Indian coals → Need for fluidized bed gasifier (BHEL/Sasol/Southern)
  - China has developed its own gasifiers and is testing them → Focus on chemicals production

6.4 Carbon Capture and Storage

- **Followers not Leaders—U.S., Europe need to deploy CCS first (and "prove" it can be done)**
- **Price on carbon is critical for deploying CCS in India/China**
  - Nature and timing of international climate treaty and domestic carbon policy
  - Financial and technical support from developed countries
- **Technologies**
  - Post-combustion (PC): amine scrubbing; multi-pollutant capture
  - Precombustion (IGCC): water-gas shift reactor + Selexol
- **Economic carbon capture requires:**
  - High power plant efficiency; Low pollutant levels in flue gas
- **Deterrents: high aux. consumption (lowered cap.), efficiency loss, high cost**
  - Efficiency loss for retrofitting is about 30% for 210 MW units. (Sonde, 2005)
  - Capture cost of \$33-38/tCO_2 – doubles the price of power
  - More coal use with addition of CCS (dilemma)

- **High potential for storage sites in both India and China**
- **Critical need for detailed geological assessments**

6.5 Short-term "no-regret" policies

- Improve efficiency of existing system
  - Gives the time and breathing space to enact changes
  - Generation
  - T&D loss reduction (especially in India)
  - Demand management and end-use efficiency

- Deploy high-efficiency combustion technologies in the near term (SC and USC PC/CFBC)

- Long-term approach for emerging technologies
  - China already has much better planning than India
  - Strategic RD^3 for advancing emerging technologies—technology roadmapping
  - Need for different RD^3 strategies for each technology
  - Need for flexibility in technology choices (gasification vs. combustion)

6.6 Policies for CCS

- Position power plants for economic CCS in the future
  - Only install high efficiency plants
  - Enforce and tighten environmental pollution controls (market-based approaches, incentives)
  - Build capacity to monitor emissions from all power plants
  - Leave space for installing capture plants (retrofitting)
  - Research on capture technologies based on specific coal properties
- Invest in detailed geological storage assessments
  - Storage locations, capacity, and sealing mechanisms
  - Plan for monitoring and verification and resolve liability issues
  - Plan ahead for regulations (institutional and technical)
  - Government support for early demonstration projects
  - Leverage international and bilateral geological assessment activities
  - Siting of new power plants to consider storage locations

7.0 Key Takeaways…

- Coal will remain dominant in India and China
- Coal demand to dramatically increase in Asia
- But, India ≠ China
- Coal imports (and trade) will increase rapidly
- Need for better coal resource & reserve estimates
- Need to better manage social consequences of mining
- Focus on long-term tech. planning for coal power
- CCS will be deployed, but not first in India or China
- Need to position India/China towards future CCS
- Geological mapping for CO_2 is critical; needs to get underway now

Acknowledgements

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