Beyond Climate Policy: Reconciling Climate Change and the “Coal Renaissance”

UT Energy Symposium

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Outline

1. The Fundamentals: Coal and Climate Change

2. The Markets: Rapid Growth and Financialization of Coal

3. The Epicenter: Chinese Coal Markets

4. Beyond Climate Policy: Addressing Coal in a Post-Kyoto World
Coal dominates global energy supply growth


- **Coal**: 3.9% (3rd highest growth rate)
- **Renewables**: 7.8%
- **Hydro**: 2.4%
- **Crude Oil**: 1.1%
- **Gas**: 2.1%
- **Nuclear**: 0.4%

Source: IEA
Coal has the greatest share of world energy since 1970

World Primary Energy Supply 2010

- Coal 30%
- Natural Gas 24%
- Oil 34%
- Nuclear Energy 5%
- Hydro electricity 6%
- Renewables 1%

Source: BP Statistical Review 2011
Coal is the single largest source of global CO$_2$
CO₂ from developing world coal is the biggest climate challenge

Source: IEA WEO 2010, current policies scenario.
## Fragmenting global climate policy not addressing this challenge

<table>
<thead>
<tr>
<th>Kyoto</th>
<th>EU</th>
<th>China</th>
<th>USA</th>
<th>AU/NZ</th>
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<tbody>
<tr>
<td>• No agreement to extend Kyoto</td>
<td>• EU carbon market (ETS) decarbonizing EU power generation, reducing coal build</td>
<td>• Target to reduce CO₂ intensity of GDP 40-45% (2005-2020)</td>
<td>• National cap-and-trade: stalled or dead</td>
<td>• NZ has nascent market</td>
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<td>• “legally binding global treaty” model likely dead</td>
<td>• But nuclear pullback likely to increase coal demand</td>
<td>• Target to improve energy efficiency per unit of GDP by 17% (12th FYP)</td>
<td>• RGGI imploding? NJ, NH pulling out</td>
<td>• AU attempting to pass cap and trade this year</td>
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<tr>
<td>• Fragmentation of climate policy is new norm</td>
<td>• But nuclear pullback likely to increase coal demand</td>
<td>• Target to increase “non-fossil” energy to 15% by 2020 (mostly hydro and nukes)</td>
<td>• AB32 under legal attack (present and future)</td>
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<td>• EPA regs could drive 10-75 GW of coal retirement</td>
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Globally traded coal markets were born from the oil crises

In 1979, after two oil crises, the world sought to diversify its power sectors away from oil. The global arbitrage was clear: swap cheap, abundant coal for expensive, cartel-controlled oil.

-“The uses of coal are limited only by our imagination as to how to transform this abundant resource into practical use.”

-“The concept of an international free-trading market in coal analogous to other major commodity markets must be present throughout the planning process. Such a market could ultimately develop in a fashion similar to today’s international oil market [. . .]”

-Ulf Lantzke, Executive Director of the International Energy Agency in 1979

Imagination became reality

Global Trade in Steam Coal Grew by Over 5x Since 1980

- **Land Trade (Steam and Coking)**
- **Maritime Coking**
- **Maritime Steam**

Global trade is connecting previously disconnected markets

- Prices in the world’s major domestic coal are increasingly becoming linked to the global trade
  - Efforts to export US PRB coal are the most recent dramatic example
  - China’s import behavior since 2009 is another crucial factor
Coal is going the way of oil – becoming a financial asset

- Markets evolved from long-term contracts to spot markets with liquid, global price benchmarks; allows arbitrage to connect markets
- Derivatives volume now estimated to be 3x the size of the physical trade
- But, that process is just beginning….and significant bilateral/OTC trading persists
Looking ahead: can shale gas challenge coal’s dominance?

The Global Expansion of Shale Gas Could Redraw the Gas-Coal Relationship

• US gas is now cheaper than globally traded coal
New EIA global shale gas study identifies global shale deposits

- Newly identified shale gas increases global technically recoverable gas reserves by 40%
Drilling down: early signs of the next global energy arbitrage(s)?

**Too Early to Say: Key Spreads to Watch**

- Brent (oil)
- Henry Hub (gas)
- NBP (gas)
- PRB minemouth (coal)
- FOB Newcastle (coal)
- FOB Qinhuangdao (coal)

$ / mmbtu


- Is 20 year BG-Cheniere US LNG export deal a sign of the next global energy arbitrage?

Note: These spreads, of course, do not show required infrastructure investment, transport, or environmental costs incurred to realize the arbitrage.
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   - Power sector reform: diversifying away from coal
   - Coal sector reform: making coal cheaper

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China coal production more than doubled since 2000

Chinese Coal Production

Billion Tonnes

Source: China NBS, BP.
Expansion of China’s power sector drives coal demand

Source: China NBS, CEC.
Uneven reform of coal and power sectors drives new energy policies

Gradual Liberalization

Central Planning


Tvh, mt

Coal

Power


Central Planning

TVE private mines allowed
Two-tier price system introduced
SOE price controls relaxed
Ministry of Coal Industry abolished – ending central planning of production
Electricity coal price controls relaxed

Power Generation

State power corporation dissolved

Coal negotiation Conference ends in 2009

Power prices still tightly capped


Tvh, mt

Coal Production

Gradual Liberalization

Central Planning

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China’s power market can’t bear the cost of coal

Coal is often worth more than electricity in China

- Latest NDRC price “cap” on contract coal announced April 2011
- Summer 2011 peak shortages of ~50 GW expected to continue

Source: Reuters, Shanghai DRC. Note: Coal price is Qinhuangdao 5800 kcal/kg material. Freight from QHD to Shanghai is $5/ton. Heat rate is average for China: 2775 kcal/kwh.
Power sector heavy losses create pressure for Beijing to diversify fuel exposure

- “The Big 5” accounted for 54% of installed capacity in 2010

Source: 2008 data is from China Electricity Council. 2010 data and 2011 estimate from former Datang president Zhai Ruoyu and other sources as reported by China Coal Times.
Diversification is **slowly** eroding coal’s share of new capacity

- Non-fossil target 15% by 2020: nuclear and hydro will be the largest coal substitutes
- Wind growth is making a small dent
- But it takes 2 GW of wind to replace 1 GW of coal generation; solar is 2.5-3x out of the money against coal without subsidies (feed in tariff) on China’s grid
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Chinese coal prices highest in the world

Qinhuangdao Benchmark Coal Prices

Source: Reuters
Transport bottlenecks dramatically increase costs

- Current railway expansions will add equivalent of 50% of current coal transport capacity by 2015
Beijing’s solution: coal-power bases

14. Xinjiang
Key coal-power base policy objectives

“Large energy enterprise groups are nurtured with the integrative and comprehensive development of coal, power, railways, ports, chemical, and other related industries so as to toughen the government’s influence and control on energy.” – Zhang Guobao, head of National Energy Bureau, 2008

| Consolidation            | • Promote integrated development of coal, power, and chemicals sectors by large state-owned firms  
                          | • Consolidate coal sector |
|--------------------------|-----------------------------------------------------------------------------------------------|
| Control                  | • Reassert government control over energy sector through SOEs  
                          | • Promote vertical integration of coal and power firms |
| Cost Reduction           | • Reduce coal costs for power through internal transfer pricing (result: new two tiered pricing in the coal market?)  
                          | • Reduce rail bottleneck and high transport costs through mine-mouth power and coal-by-wire (30-60% of delivered coal cost) |
Key coal-power base targets

Coal production reforms and transport expansions aim to make Chinese coal cheaper, which would enable faster demand growth.

- Bring 90% of all coal production under coal-power bases by end of the 12th FYP
- Establish 10 large SOEs with production capacity over 100 mt each
- Establish 10 medium SOEs with production capacity over 50 mt each
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Emissions mitigation options for coal in the development context

Key Criteria: Must be able to provide reliable, secure base load power

Two Mitigation Strategies

1. **Substitution**: utilize less carbon-intensive, base load alternatives to low-efficiency coal

2. **Decoupling**: utilize coal technologies that decouple coal consumption growth from coal emissions growth
Substitution (1): Currently available baseload substitutes for subcritical coal

Cost and Emissions Profiles of Baseload Alternatives to Subcritical PC

- **Gas** makes sense “where you can get it” domestically
- **IGCC** makes sense “where you want a CCS call option”
- **Nukes** make sense “where you can pay for it and secure it”

Decoupling (1): CCS might decouple coal consumption from coal emissions

CCS is a climate silver bullet, but faces high obstacles

- High costs / need for public support
- Regulatory and legal framework for storage lacking
- Artificially capped power in developing countries prevents cost pass-through
- CCS energy penalty harms energy security

Source: Global Carbon Capture and Storage Institute, 2010.
Decoupling (2): Efficiency improvements offer immediate reductions

Coal plant efficiency gains may offer higher near-term potential for emission reductions than renewables

- 21% less CO₂ (Average worldwide)
- 16% less CO₂ (EU)
- 10% less CO₂ (State-of-the-art technology)
- 40% less CO₂ (CCS technology)

Source: IEA Clean Coal Centre
Decoupling (3): Underground coal gasification

- Increases world recoverable coal reserves by 300-400%
- Leaves ash underground
- Reduces NOx, SOx, mercury particulates
- Possible integration with CCS and EOR
- Syngas product can be used for diverse inputs (power, transport, chem)
- Early estimates of cheap costs: 2-3$ / mmbtu (without CCS)
- Risk: groundwater contamination

Image courtesy of UCG Association.
UCG: Old technology, new wave of investment

UCG: Old technology, new wave of investment

UK:
13 UCG licences awarded (BCG Energy, CCL, Riverside, Europa Oil & Gas, B9 Coal and others) promoting a demonstration UCG-CCS project onshore and 500MW power station.

Ireland:
1 UCG licence awarded in Dublin Bay - VP Power.

Belgium:
EU trial at Thuin.

Canada:

USA:
Major trials in the 1950s. Substantial interest & new project activity planned in Wyoming, Montana, North Dakota, Cook Inlet, Alaska & other states. Linde, CCL & Laurus.

Spain:
EU trial at El Tremedal.

Colombia:
UCG project planned.

Chile:
UCG project announced by Carbon Energy.

Brazil:
Demonstration project planned.

Slovenia:
UCG under review.

South Africa:
Eskom in 2nd stage of UCG project. Others reviewing.

Uzbekistan:
Oldest UCG plant in the World (50yrs) in Angren.

Pakistan:
Substantial activity planned in Sindh Province.

Turkey:
CCL project in Amastra with Hema.

Kazakhstan:
UCG trial site identified.

Russia:
Long history of UCG activity. Promgas-Gasprom active.

Japan:
Research activity.

China:
History of Pilots. Academic training of many UCG PhDs. New projects planned - Cougar & CCL. The Ulanchap, Inner Mongolia project is in its 3rd year. Other projects in this region in planning stage with other operators including CGE, Cougar & Gulfside.

Bangladesh:
UCG activity planned.

Vietnam:
2 projects Red River Delta in planning stage - Linde & CCL.

Indonesia:
MOU signed by CCL.

Australia:

New Zealand:
Solid Energy UCG project.

India:
Substantial activity planned with 13 companies bidding for leases.
Conclusions

1. Coal is the world’s fastest growing fossil fuel and largest contributor to new global energy supplies
2. World coal markets are developing along a path similar to oil markets and are connecting regional markets
3. Chinese coal markets are central to climate change and are now undergoing a radical restructuring
4. Coal should be understood as both the leading cause of climate change – and the leading mitigation opportunity
5. Yet climate policy is not adequately equipped to deal with the coal challenge – new approaches are required
6. An portfolio of existing and emerging approaches – that are aligned with developing country goals – can be used to address the problem at scale, now
Thank You

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Wildcards and game changers

• **Unconventional gas:** can the unconventional gas boom be exported and used to displace coal generation?
  – US/China Shale Gas Resource Initiative
  – ~50% of China’s gas resources are unconventional (CBM) (not including shale)

• **Coal to Liquids / Coal to Gas:** is coal conversion investment a looming emissions explosion?
  – China has over 50 BCM of annual CTG capacity by 2015 on the drawing board (~25% of expected gas supply)

• **CCS:** Can CCS overcome cost and sequestration impediments to become viable?
  – Will non-geological sequestration technologies improve prospects for CCS?

Source: China CTG estimates from Michael Parker, based on announcements of planned capacity additions in China. NDRC approval pending.
Xinjiang Declared 14\textsuperscript{th} Coal-Power Base

- Xinjiang added 250 Bt of proved coal reserves from 2006-2010
- Total estimated resources as of 2011 are 2.19 trillion tons
- Peabody recently declared Xinjiang was the “Middle East of coal”

Coal markets are undergoing rapid “financialization” similar to oil’s development

**Financial Evolution of the International Coal Trade**

- **1997**: TFS sets up a coal desk
- **1998**: Enron launches SECA, 1st standard physical coal contract; TFS launches API 2 CIFARA index, API 4 FOB RB, API 3 NEWC7
- **1999**: Global Coal launches the SCOTA standardized physical contract, electronic trading platform; NYMEX introduces 1st US coal futures
- **2000**: EU Electricity Deregulation
- **2001**: TFS launches API 1, the 1st physical coal index; the first indexed floating physical coal trade occurs; TFS brokers 1st financially settled coal swap
- **2002**: Enron declares bankruptcy
- **2003**: Global Coal and ICE launch 1st Rotterdam futures
- **2004**: Global financial crisis begins
- **2005**: Platts launches 1st India CFR benchmark; McCloskey launches 1st Indonesian benchmark; 1st Indonesian swap trades; CME Singapore Exchange, ICE offer Indonesia swaps
- **2006**: Global Coal and ICE launch 1st Newcastle futures; ASX launches 1st physically settled Newcastle futures (contract later withdrawn)
- **2007**: McCloskey launches 1st CBF South China index; ICE launches coal options and 3 US coal futures contracts, 1st Indonesian coal futures contract; brokers offer 1st China coal swaps

**Spot Markets**

**Global Benchmarks**

**Derivatives**

Coal derivatives markets are now estimated to be 3x larger than physically traded international coal markets
Wildcard: CBM Will Likely Come Online Before Shale

*Shell Signs Pact with China Xinjiang Government on CBM Development* – Platts, 9 March 2011.

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<th>Exploration</th>
<th>Shell signed a “Strategic Cooperation Framework Agreement” to explore and develop CBM with the Xinjiang government</th>
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<td>Projections</td>
<td>WoodMac estimates CBM will contribute 14% of China’s total gas domestic supply by 2030</td>
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<tr>
<td>Pricing</td>
<td>CBM downstream prices currently not capped by Beijing</td>
</tr>
<tr>
<td>Impediments</td>
<td>But pipeline access for CBM producers has been an impediment</td>
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Global energy supply growth: 2010 update

- Coal now highest share of world energy since 1970: 29.6%
- Renewable power gen grew 15.5%, but all renewables are only 1.8% of global energy supply

Chinese Coal Imports and Exports

Million Metric Tonnes

Imports
Exports

Jan-02 May-02 Sep-02 Jan-03 May-03 Sep-03 Jan-04 May-04 Sep-04 Jan-05 May-05 Sep-05 Jan-06 May-06 Sep-06 Jan-07 May-07 Sep-07 Jan-08 May-08 Sep-08 Jan-09 May-09 Sep-09 Jan-10 May-10 Sep-10 Jan-11 May-11
Substitution (2): Can China replicate the US shale gas boom?

China’s Major Shale Gas Basins and Pipeline System

Tarim: recoverable reserves estimated at 583 tcf (16.5 tcm)

No production YET. Production estimated 10 years out.