Chinese power sector emission trading simulation

14th IEA-IETA-EPRI GHG workshop

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Christopher Guelff
Agenda

A. Context: China, IEA
B. The simulation
C. Results
D. Conclusions & implications
Context: electricity key to climate change efforts

- China world’s largest CO₂ emitter, power sector >40% of emissions
  - grew by 50% between 1990 and 2000, and doubled in the last decade
  - reached 7 billion tons of CO2 in 2010 (IEA)
Government taking action

- China has pledged to reduce carbon emissions per unit of GDP from 2005 levels by 40-45% by 2020

- Government in testing mode:
  - Exploring how an ETS could work in five city and two province pilots
  - Has committed to introduce national emissions trading scheme, including electricity generation, by 2016
IEA context: simulation next step from prior China electricity work

- Collaborative project with Chinese partners: ERI (NDRC) and China Electricity Council (CEC)
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What can a simulation achieve?

- Can/how will generators adapt to carbon constraint and trading opportunities in a Chinese context?
  - SOE power companies
  - Power production mandates
  - Preferential tariffs for cleaner fuels
  - Horizontal business relationships

- Test different rules and policies

- Insights for a national ETS

- Give generators experience
Participation of power companies key

- 32 participants from nine companies, representing half China’s installed capacity

- Good representation from four of China’s five major generators
Generators: Facing the ETS landscape

1. Provide mandated generation...

2. ...within a carbon constraint...

3. ...with trading opportunities to manage constraint...

4. ...while maximising profit...

5. and build new generation to meet increasing demand
Building a simulation

1. Build ‘realistic’ power companies

2. Provide growing generation obligation and carbon allowances

3. Setup renewable/fossil-fuel/nuclear power stations to own and build (calibration key)

4. Setup trading market
CBEEX setup carbon market

- CBEEX not a financial exchange so under Chinese regulations not allowed to have single market matching buyers and sellers

- Instead hosted separate buy and sell markets

- VPC places bid/offer in one market and other VPCs respond, triggering 24 hour auction
Prepare tools to help simulation

Interactive spreadsheet for VPCs to operate, test & record trades...

...and online portal to trade carbon

<table>
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<tr>
<th>Reg/Generation</th>
<th>Fleet marginal cost of avoided CO2</th>
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<tr>
<td>Plant</td>
<td>Max Output (MW)</td>
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<tr>
<td>A</td>
<td>600</td>
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Generation: 1400 1400 1400 1400 1400 1400 1400 1400
Profit: 10000 10000 10000 10000 10000 10000 10000 10000
Carbon: 735 672 665 659 653 647 641 635
Emission to buy (€/MWh): 32 42 52 62 72 82 92 102
Simulation: ‘running order’

- Six weeks represent six years
- Baseline week/year then five trading weeks/years
- Two trading sessions per day
- 2 sessions x 5 days x 5 weeks = 50 trading sessions
- 4 scenarios
### 4 scenarios test different elements

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<th>Robust Trading</th>
<th>Limited Trading</th>
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| | • 35% of emissions coverable by offsets  
  • Single unified market | • 5% of emissions coverable by offsets  
  • Market divided into two regions which cannot trade allowances  
  • One offset market for whole scenario |
| Different allowances | | |
| Half given larger annual free allowance, and predisposed to be ‘sellers’. Other half short-‘buyers’ | Scenario 1 | Scenario 2 |
| 8: 4 x Seller ; 4 x Buyer | 8: 2 x North seller ; 2 x North buyer  
  2 x South seller ; 2 x South buyer |
| Identical allowances | | |
| | Scenario 3 | Scenario 4 |
| 8: 8 x identical VPC | 8: 4 x North  
  4 x South |
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Generators succeeded

- Over 90% of VPCs met generation and carbon targets
- Different VPCs used different tactics, and changed them during simulation
- All VPCs adjusted dispatch to improve position and all-but-one built new ‘clean’ generation
- Tight competition: half of VPCs finished within 10% of their cohort winner
VPCs reluctant to sell to each other?

- 88% of all trade volume were offsets, where money paid goes to offset supplier

- In two scenarios offsets traded at higher price than allowances, despite the cap on their use

- Very limited reselling of offsets

- 8 of 32 VPCs did not buy carbon from another

- 6 did not use market at all
Carbon prices rose as simulation got harder

Scenario 1: pro-trade & buyer-seller VPCs

Scenario 2: stifle trade & buyer-seller VPCs

Scenario 3: pro-trade & identical VPCs

Scenario 4: stifle trade & identical VPCs
Carbon prices rose as simulation got harder

- Except where generous allowances and liberal offset rules meant constraints did not ‘bite’
Compliance more expensive in stifled trading scenarios

**Buyer-seller VPCs**

- Pro trade (Scenario 1)
- Stifle trade (Scenario 2)

**Identical VPCs**

- Pro trade (Scenario 3)
- Stifle trade (Scenario 4)
Offsets dominate

Scenario 1 trade volumes

Scenario 2 trade volumes

Scenario 3 trade volumes

Scenario 4 trade volumes

- mtCO2
- Year
- Allowance
- Offset
Many factors within a scenario, but generally more trading = more profit

- Excluding two loss making VPCs in scenario 3
- (Scenarios 1 and 2 segments too small to make this analysis)
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Observations for a national ETS – design

- CEC asked for free fixed allowances but:
  - How long should allowances be free for?
  - How do you choose a baseline year and reward generators who’ve already improved?
  - What allocation for new entrants?

- Carbon prices, and therefore compliance cost, higher in ‘stifled’ scenarios. So design system to enhance liquidity

- The larger the carbon market, the greater its liquidity and efficiency

- Instant trade clearing could improve efficiency

- Should tariffs paid to generators still vary by fuel? Does an ETS remove the need for a feed in tariff?
Observations for a national ETS – execution

- We assumed large offset market. Need to ensure quality of credits in that market

- Need regulatory oversight – for financial safety of generators & security of market
Thank you