

***Ex Post* Analysis of the Co-Control
of SO₂ and CO₂ in China:
The Case of Taiyuan**

Presentation by:

Dr. Michael Shelby, U.S. EPA

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Overview

- Background on Study
- Research Question
- SO₂ Control Policy in China and Taiyuan
- The Small Boilers Survey in Taiyuan
- The Survey Results
- Implications
- Climate Policy Conclusions

Background on Study

- This study was conducted by Resources for the Future, a Washington, D.C. research organization
 - Study was “ancillary” to SO₂ emissions trading demonstration underway in Taiyuan, capital of Shanxi Province
 - Taiyuan is a heavy industrial city, located in northern China; surrounded by mountains on three sides
 - Average *annual* SO₂ levels 200 ppm

Taiyuan, China



Reversing the Policy Logic: Climate Benefits from Air Pollution Reductions

- Extensive literature has developed on the ancillary benefits (i.e., conventional air pollution) of greenhouse gas mitigation
- Less attention has focused on the climate benefits of local air pollution strategies
 - while direct climate benefits are important, perhaps more immediate issue in developing countries is local air pollution

Research Question

- This study looks at whether local Chinese air pollution policies may also generate (ancillary) carbon benefits?
- If so...
 - How large?
 - How cost effective?
 - How cost beneficial?
 - What is the potential for expanding such efforts?

SO₂ Control Policy in China

- China has identified SO₂ and particulates as contributing significant air pollution problems
- In response in 1996, China instituted a National “One Control and Two Compliances” policy
 - standards set in mass rather than concentration terms and requires cities to implement Total Emissions Control (TCE)

Small Boiler Policy in Taiyuan

- In June, 1999, Taiyuan issued SO₂ reduction requirements which call for the shutting down of small coal-fired boilers in densely populated areas in six districts
 - small boilers: rated capacity of 2 tons or less of steam per hour
 - all heating boilers required to hook up to district heat
 - restaurants, entertainment centers and public bathhouses required to switch to less polluting fuels (e.g., coal gas, LPG, etc.)

The Small Boilers Survey in Taiyuan

- Survey Implementation
 - RFF worked in cooperation with Taiyuan Environmental Protection Bureau (EPB) and its six district EPBs
 - “Street” environmental personnel of each district EPB carried out the actual survey
- Survey Form
 - Including types, sizes, efficiency, operation time, fuel consumption & cost, investment, etc.

Survey Results

- Carbon and SO₂ emissions before and after policy implementation, 2000 and 2001

	Number of Boilers	Emissions before shut down (tons)		Emissions after shut down (tons)			
		SO2	Carbon	Case A		Case B	
				SO2	Carbon	SO2	Carbon
All Boilers	268	1917	112336	651	55766	26	5198
Boilers continuing to operate	99	532	21435	26	5198	26	5198
Boilers stopped operation	98	515	20637	0	0	0	0
Centralized heating boilers	71	869	70265	625	50569	0	0
Notes:							
1. Case A counts SO2 and carbon emissions of centralized heating as 72% of emissions before shut down.							
2. Case B counts SO2 and carbon emissions of centralized heating as zero.							

Survey Results

(Continued)

- SO₂ Marginal Abatement Costs by Fuels

	Number of boilers	Emissions before shut		Emissions after shut		%of SO ₂ reduction	Investment after (\$)	Energy Cost (\$)		Average Marginal Abatement Cost (\$/ton)
		Total SO ₂ (tons)	Total carbon (tons)	Total SO ₂ (tons)	Total carbon (tons)			before	after	
Coal gas (Diesel)	13	115	4287	4	710	96	212875	60963	265500	3013
Oil	27	138	6036	7	1412	95	336250	83388	515300	4007
LPG	4	15	736	1	178	95	53250	5813	41625	3295
Total	44	269	11059	12	2301	95	602375	150163	822425	3648

Implications

- SO₂ marginal abatement costs (\$3,600/ton) of shutting down small coal-fired boilers are high compared to other options
 - \$60/ton: Taiyuan District Heating
 - \$1,600/ton: coal washing
 - cost studies from other parts of China: \$75-\$250/ton
- However, positive net benefits still found
 - benefits of reducing SO₂: \$4,700-\$21,800/ton

Implications (cont.)

- True net benefits may even be higher since SO₂ reductions are “effective tons”
 - avoid potential for “indoor air” pollution with short stack venting
- If no SO₂ benefits, the breakeven value of carbon reductions is \$84/ton carbon

Climate Policy Conclusions

- Carbon reductions from SO₂ policy are significant: greater than 50% removal for covered units
- Extrapolating to other small boilers in Taiyuan, represents 7-15% of carbon emissions in the city
- Opportunities in other provinces are probably large
- Further data needed to construct carbon supply curve
- Clean Development Mechanism possibilities, especially for small scale projects?