**Acid Rain and the 1990 CAA**

Sulfur Dioxide is one of the criteria pollutants [Map of US](http://milesfinney.net/434/handouts/US_map.pdf)

Chemical reaction involving SO2 and NOx in upper atmosphere

Product of reaction deposited back to earth mainly through (acid) rain

In US, 2/3 of SO2 come from electric power plants burning fossil fuels, mainly coal

Plants in northeast, midwest emit more SO2 than other plants

* Use WV, Penn. coal with high sulfur content
* Older plants, less equipped to decrease pollution

SO2 emissions is regional problem; SO2 can travel up to 600 miles

Tall smokestacks transfer emission to other areas

Acid rain increases acidity in lakes and streams

damage trees at high elevations

Complicated Ecosystem effects:

Directly kills some aquatic life intolerant to acidic waters

Frogs tolerate acidic conditions

mayfly (insect) are sensitive to acidic levels

mayfly an important supply of food for frogs

Most affected area is Adirondack Mountains in Northern New York

 Away from industrial area

[Effects of acid rain in Adirondacks](https://www.adirondackcouncil.org/page/acid-rain-86.html)

[Images Adirondack Acid Rain](https://www.google.com/search?q=adirondacks+acid+rain&rlz=1C1GCEV_en&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjels__h8HhAhVJqZ4KHUtUDfsQ_AUIDigB&biw=1280&bih=578#imgrc=Q-Gkn3YW90JnKM:)

[West Virginia Plant](http://milesfinney.net/434/articles/WV_plant.pdf)

**1990 Amendment to Clean Air Act**

designed to decrease SO2 emissions among large sources

**SO2 allowance trading program**

Large emitters given tradable SO2 “permits”

**Economics of pollution trading**

Polluting firms given limited number of tradable “rights” to SO2

Example:

Firm given 100 yearly permits each worth 1 ton

Choices open to firm:

1. Emit 100 tons SO2 over year using all rights
2. Emit less than 100 tons and sell remaining rights
3. Buy rights if anticipated emissions over 100 tons

Pollution rights trading:

 Should work to equate MAC among sources

Decrease total social cost of decreasing pollution

Firm B

Firm A

 $ $

MAC

MAC

25

8

Emissions/week

Emissions/week

5

5

12

12

If firms could ignore pollution costs, each emit 12 tons SO2/ week

Suppose each firm given tradable permits to five tons per week

Both firms would have to cut back by 7 tons per week

Firm A’s MAC for eliminating 7th ton is $8; $25 for firm B

Gains to trade? Buyer? Seller?

Social Efficiency of Trading?

Trading should proceed until MACs equal

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | **Marginal Abatement** |
|  |  |  | **Costs ($1,000/week)** |
| **Emissions (tons/week)** | **Source A** |  | **Source B** |
|  | 12 |  | 0 |  | 0 |
|  | 11 |  | 1 |  | 2 |
|  | 10 |  | 2 |  | 4 |
|  | 9 |  | 3 |  | 6 |
|  | 8 |  | 4 |  | 10 |
|  | 7 |  | 5 |  | 14 |
|  | 6 |  | 6 |  | 20 |
|  | 5 |  | 8 |  | 25 |
|  | 4 |  | 10 |  | 31 |
|  | 3 |  | 14 |  | 38 |
|  | 2 |  | 24 |  | 58 |
|  | 1 |  | 38 |  | 94 |
|   | 0 |   | 70 |   | 160 |

Firm B would be willing to pay up to $25 to avoid eliminating the 7th ton pollution. Willing to pay up to $25 to avoid eliminating the 7th ton, which will leave the firm at 6 tons total emissions instead of 5.

Firm A would be willing to reduce pollution from 5 to 4 if it was compensated for the cost of doing so. Willing to accept at least $10. Willing to sell pollution right for $10 (or more).

Firm B would be willing to pay up to $20 to avoid eliminating the 6th ton pollution. Willing to pay up to $20 for the 7th right.

Firm A would be willing to reduce pollution from 4 to 3 if it was compensated for the cost of doing so. Willing to accept at least $14.

**Pound Traded** **Terms of trade**

First $10 and $25

Second $14 and $20

Third buyer willing to pay up to $14 seller would require at least $24 compensation

Calculate total cost of abatement. I. Firms both reduce by 5 tons II. Firm A at 3 tons Firm B at 7 tons

Discuss trading and varying age and costs of energy firms in Midwest

**Would a marginal tax of $14 put the two firms in the same place? If so, why not implement a tax?**

**Features of program**

Permits were allocated freely to existing power plants within program

* Existing plants obtain valuable asset
* Barrier to entry for new firms
* Alternative: auction

Plants were given time profile of permits

Allowed to bank unused yearly permits

Plants varied dramatically in abatement costs due to age

Many firms switched to low sulfur coal from Wyoming and Montana

Command and control with technology mandate would not have provided incentive

Each firm must install continuous monitoring systems

Violators fined

Phase 1 of program began in 1995 involved 110 utility plants in eastern and midwestern states

Phase 2 began in 2000 and involves 1000 power plants throughout country

[Chart of Program](http://milesfinney.net/434/lecture/acid1.pdf)

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