Science-Policy-Business and Sulfur Markets

Richard B. Rood
734-647-3530
rbrood@umich.edu

LECTURE NUMBER 13
March 6, 2007

Class News

- Some business
  - Nina Mendelson is set for March 30?
    - That’s a Friday
    - Time: 10:00 AM
    - I need to find a room

Class News

- New experimental web site
  - http://climateknowledge.org/class/aoss605/tiki-index.php
- Lecture Road Map
  - Previous: Rood, Managing to the Climate Problem:
  - 3/6: Rood, Science-Policy-Business, Sulfur Market as Model, Link to Next Set of Lectures
  - 3/8: Lemos, Winners and Losers
  - 3/13 & 3/15: McCormick and O'Neill, Public Health
  - 3/20: Andy Hoffman, Business and Climate Change

Readings

- Basic information on the Kyoto Protocol
  - Environmental Literacy Council
  - Kyoto Protocol
- Beyond Kyoto
  - International Climate Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico

Ideas and Things

- NEWS: Anyone hear or read any news they want to discuss – or come back to?
  - What do you think of the idea than "development" will solve the climate problem?
  - Evangelical divisions

- Role of efficiency / Standard reasons why it is not happening. / Why it is different from cycles

Projects

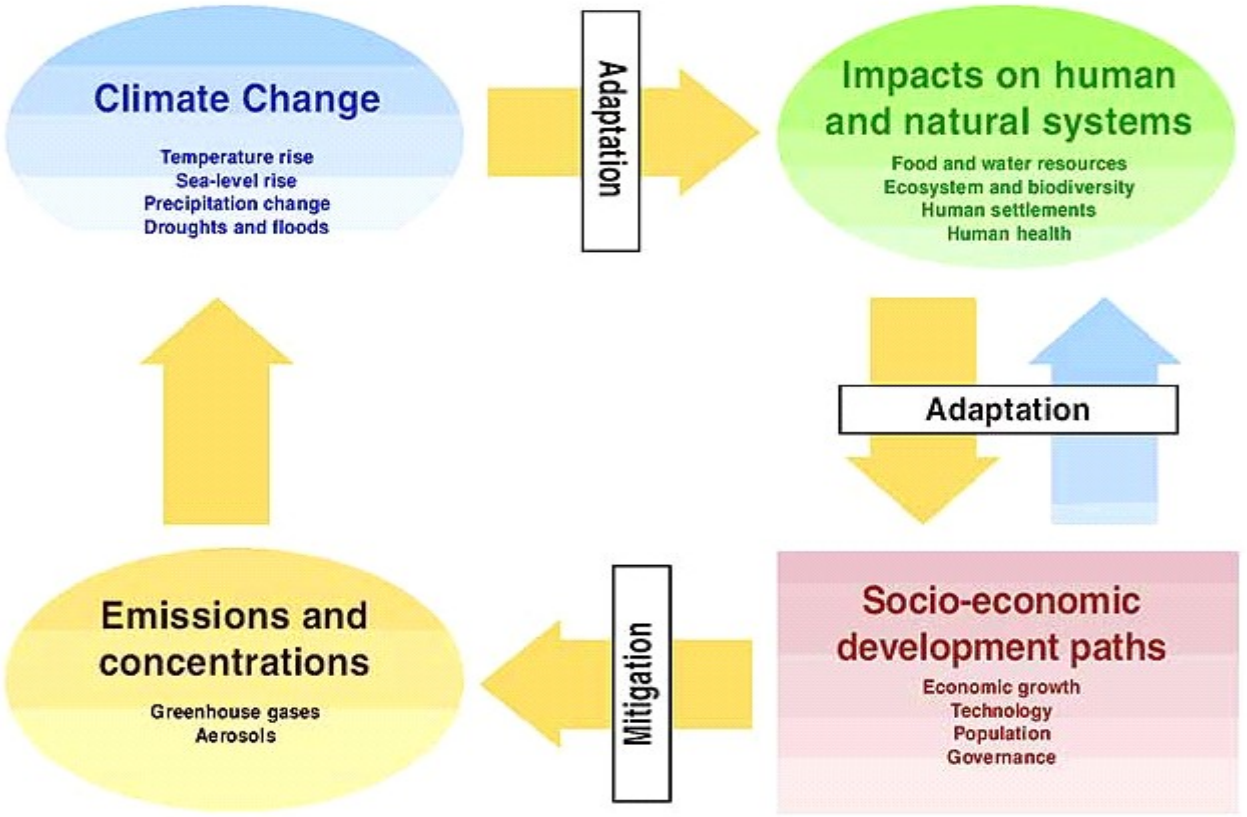
Outline

- Policy in a Management Paradigm
- International and National Policy Attempts
- United Nations Framework Convention on Climate Change
- Kyoto Protocol
- Beyond 2012: Climate Dialogue at Pocantico
- Sulfur Market as a Model

Science, Mitigation, Adaptation Framework

Adaptation is responding to changes that might occur from added CO_2

It's not an either / or argument.



Mitigation is controlling the amount of CO_2 we put in the atmosphere.

Mitigation-Adaptation

- Last lecture we saw that Mitigation and Adaptation mapped into a number of dichotomies
  - reactive – proactive
  - certainty - uncertainty
  - rich-poor
  - winners-losers
  - right-wrong
- From a knowledge point of view
  - It’s not either – or ; it’s both

Basic Management

- If there is a goal which you must meet, then you need to manage towards than goal.
  - If the goal is critical to success,
  - If the goal must be met on some schedule,
  - then this raises the level of management that is needed.

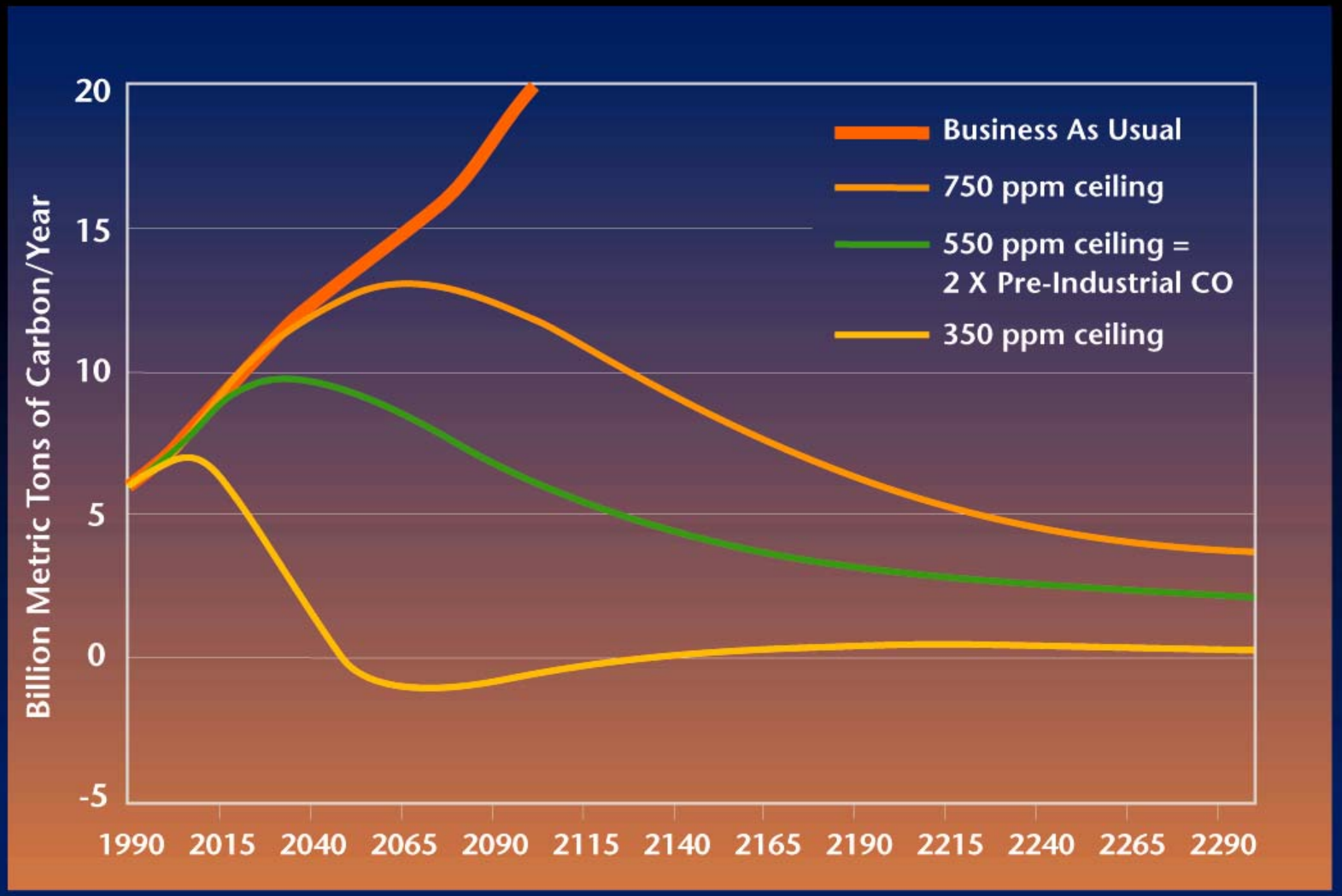
NEED CARBON POLICY

- We need a carbon policy which is integrated with energy policy.
  - Some alternative energy sources don't do much for reducing carbon dioxide in atmosphere.
  - Coal is viewed as our easy energy security
    - Without sequestration (carbon removal), coal makes the problem worse.

- Concern: Quest for energy security-national security, demand for cheap energy will reduce priority we give to reduction of carbon dioxide in the atmosphere.

Basic constraint on carbon policy

Atmospheric Stabilization Emissions Paths



Basic constraint on carbon policy

Stabilizing concentrations Means Action Now …

Ceiling (ppmv)	350	450	550	650	750
Start Date	Too late	2007	2013	2018	2023
Max Emission	6.0	8.0	9.7	11.4	12.5
Max Year	2005	2011	2033	2049	2062

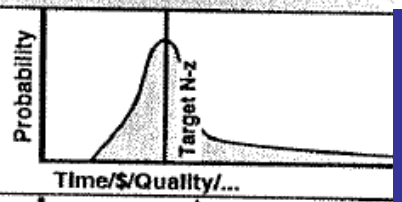
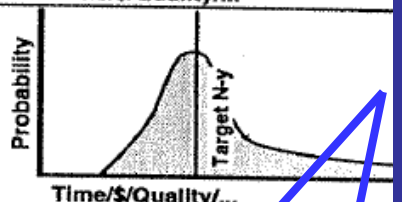
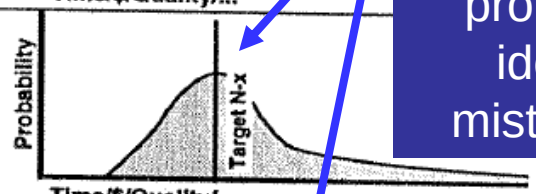
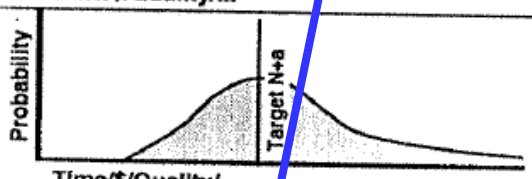
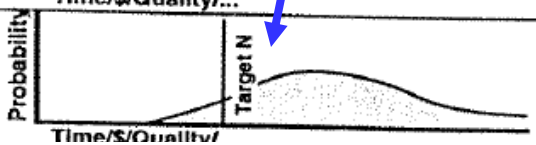
1950 – 1.8 tons // 1990 – 5.8 tons // 2000 – 6.5 tons

Some carry away messages

- Determine what is a tolerable ceiling for carbon dioxide.
  - Gives cap for a cap and trade system.
  - Tolerable ceilings have been posed as between 450 and 550 ppm.
    - Ice sheet melting and sea level?
    - Oceanic circulation / The Gulf Stream?
    - Ocean acidification?
- Determine a tolerable measure of increased temperature
  - British policy → 2^{o} C

Another Management Idea

Evolution of Process Capability

Level	Process Characteristics	Predicted Performance
5 Optimizing	Process improvement is institutionalized	
4 Managed	Product and process are quantitatively controlled	
3 Defined	Technical practices are integrated with management practices and institutionalized	
2 Repeatable	Project management practices are institutionalized	
1 Initial	Process is informal and ad hoc	

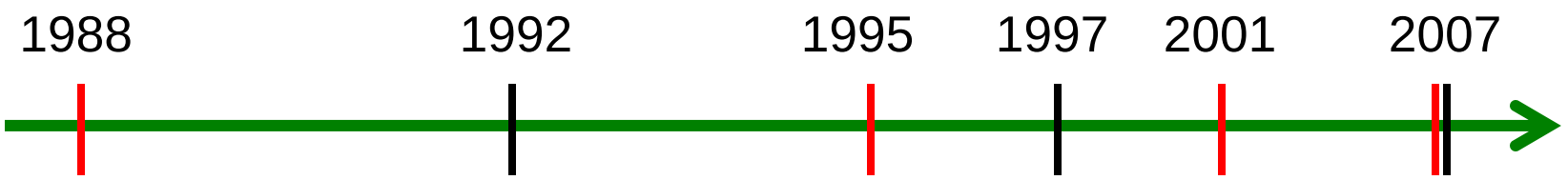
The first and largest improvements come from a plan, an approach to the problem, and identifying mistakes early

This axis is ability to target cost, quality, time

A personal conclusion

- If we are going to manage the climate change problem, as opposed to fixing it, we need to develop a stable, integrated policy.
  - This is a massive task.
  - Are there new paradigms for developing this?
    - Do we have to rely on ozone model?
    - Do we have to rely on sulfur model?

Development of International Climate Change Regime



IPCC established

Framework Convention (UNFCCC)

Kyoto Protocol

?????

Scientific assessment

Non-binding aim

Binding emissions target

Framework Convention on Climate Change (US in part of this.)

- UN Framework Convention on Climate Change (1992, non-binding, voluntary, 190 signers)
  - Reduce CO_2 Emissions in 2000 to 1990 levels
  - Inventories of greenhouse gas emissions
  - Mitigate Climate Change

- Mid-1990's
  - No reduction in emissions
  - Evidence of warming and impacts

Framework Convention on Climate Change

- Ultimate Objective of the UNFCCC (Article 2)

"...stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to:

- allow ecosystems to adapt naturally to climate change;
- ensure that food production is not threatened; and
- enable economic development to proceed in a sustainable manner.

1992 Convention Commitments

- **All Parties agree to:**
  - **4.1.b. Mitigate emissions and enhance sinks**
  - **4.1.c. Promote technology development and transfer**
  - **4.1.e. Cooperate on research and observation**
- **Developed Countries' aim to return emissions to 1990 levels by the end of the century**

Assessment

- Mid-1990's
  - No reduction in emissions
  - Evidence of warming and impacts
- 2001
  - No reduction in emissions
  - Evidence of warming and impacts
- 2007
  - No reduction in emissions
  - Evidence of warming and impacts

Kyoto Protocol followed 1995 assessments

Kyoto Protocol

- Kyoto Protocol (December, 1997, binding limits on or reduction of emissions)
  - Must be signed (155 signers (?186)) and ratified
    - At least 55 countries
    - That represent 55 % or more of emissions
  - Open for signatures on March 16, 1998
  - Went into effect on February 16, 2005
    - After Russia signed and ratified

Kyoto Protocol Requirements

- Developed nations reduce their emissions 5.2% below 1990 emissions
  - Reduction (increases) vary across countries
  - Relaxed a little over the years to attract signers
  - (Treaty: U.S. 7% reduction: Actual: 12% higher in 2004, 30% by 2012)
- Addresses “six” greenhouse gases (CO_2, Methane CH_4, Nitrous Oxide N_2O, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride)
- Commitment period 2008-2012
- Set of other activities
  - Improve “local emission factors”
  - Inventories of emissions and sinks
  - Mitigation and adaptation plans
  - Environmentally sound technology diffusion to developing nations

Kyoto Protocol Issues

- Amount and distribution for limits and reductions
- What greenhouse gases to include
- Developing countries in or out of emission requirements
- Trading, market-based mechanisms
- Role of removing greenhouse gases

Kyoto Protocol: Important Add ons

- Market-based mechanisms
  - Emissions trading
  - Joint implementation
  - Clean development mechanisms

- “Common but differentiated responsibilities”

Flexibility in Achieving Targets

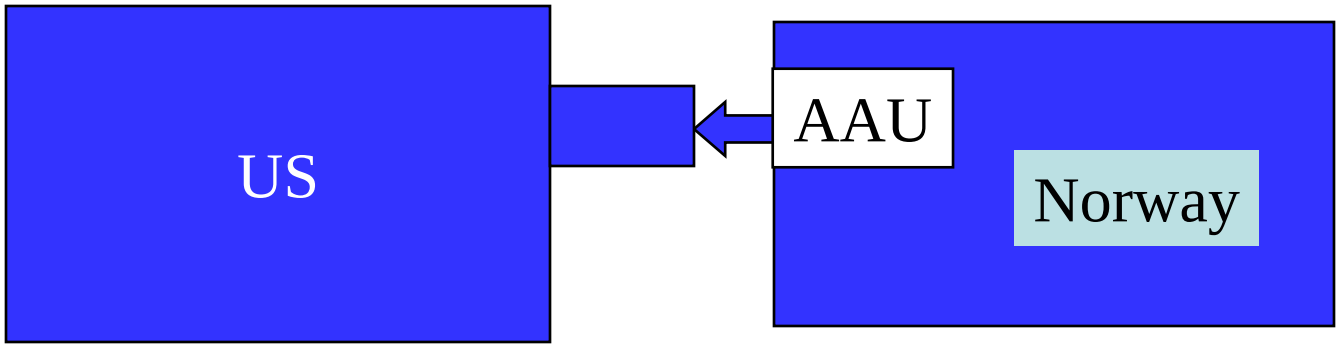
- **"What" flexibility**
  - **Targets apply to CO_2-equivalent emissions of basket of six GHGs**
  - **Can use carbon sinks (e.g. forests) as offsets**
- **"When" flexibility**
  - **Five-year commitment period**
  - **Banking**
- **"Where" flexibility**
  - **Market mechanisms: ET, JI, CDM**

Kyoto Mechanisms:

- **Bubbles (Art. 4)**
  - **Any group of Annex I countries may pool emissions targets**

Kyoto Mechanisms:

- **Emissions trading (Art. 17)**
  - **Developed countries and firms can trade parts of their “assigned amounts” of emissions**
  - **Successfully used in US in sulfur dioxide program**

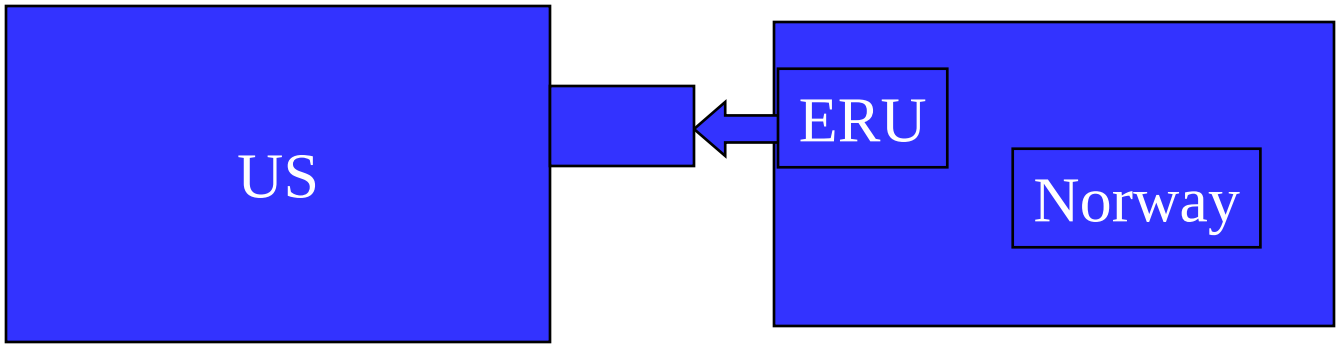


Kyoto Mechanisms:

- **Joint implementation (JI) (Art. 6)**
  - **One Annex I country undertakes a project in another country to reduce emissions or enhance sinks**
  - **The project generates an “emission reduction unit,” which can be transferred**
  - **ERUs subtracted from transferor’s assigned amount and added to transferee’s assigned amount**

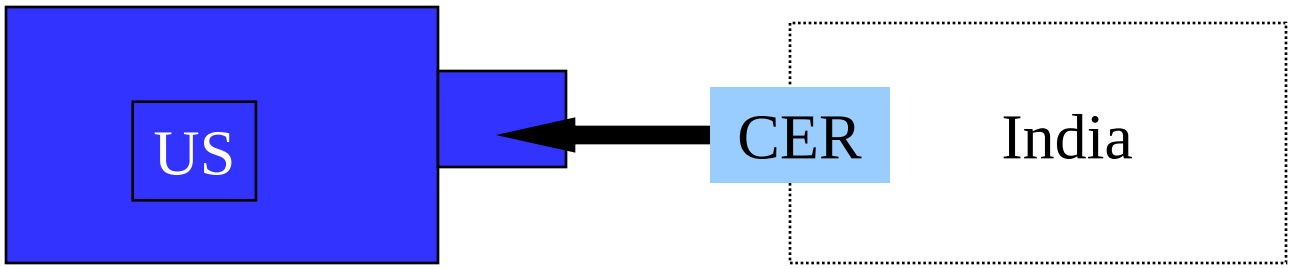
Kyoto Mechanisms:

- **Joint Implementation (Art. 6)**



Kyoto Mechanisms:

- **Clean Development Mechanism (Art. 12)**
  - **Annex I party can undertake mitigation project in developing country**
  - **Win-win approaches**
    - **Developing countries get climate-friendly technology**
    - **Projects generate “certified emission reductions” (CERs), which developed countries can use to meet emission targets**



Kyoto Protocol: Issues with Market-based Mechanisms

- Trading with countries who do not have emission limits / non-ratifying countries
- Integrity in the trading market
  - "false" credits
  - Reporting
  - Measurements
  - Verifying

“Flaws” in Kyoto Protocol

- Participation of Developing Countries
  - Large populations, large projected growth
- Participation of the United States
  - 25 % of greenhouse gas emissions
- Other “flaws”
  - Does not go far enough: Emission goals don’t adequately mitigate dangerous climate change
  - 2008-2012 commitment period – then what?

Elements of “U.S. Position”

- Will not be ratified unless developing countries are included in emission limits
- Continuing concerns
  - Impact on economic growth and gross national product
    - CO_2, currently, directly related to enterprise, economy …
  - Robustness of scientific justification and observations
  - Winners outweigh losers

Issues of implementation

- Rules that govern compliance
- The rules of development and transfer of cleaner, low emission, technologies
- The role of carbon sinks: trees, removal technology, ….
- The reward/punishment for those who take the initiative to address their emissions unilaterally

Constituencies in the community

- “G-77” and China: ~130 developing countries, work by consensus (generally represent The Africa Group)
  - Economic development and emission limits
  - Sell their potential carbon credits for profit
- The Alliance of Small Island States (AOSIS)
  - Tightest control on global emissions
- Organization of Petroleum Export Countries (OPEC)
  - Protection of their economic well being

Constituencies in the community

- European Union (EU)
  - Coordinated position as environmental leader with very ambitious emission reduction goals
- Japan, U.S., Switzerland, Canada, Australia, Norway, New Zealand (JUSSCANNZ)
  - Non-EU developed countries
  - Cost of tackling the climate problem
    - U.S., Canada, Australia: Low-efficiency energy use
    - Japan, Switzerland, Norway, New Zealand: High-efficiency energy use

Constituencies in the community

- Environmental Non-Governmental Organizations (ENGO)
  - Accept climate change science
  - Differ on acceptance of market-based mechanisms
  - Differ on role of businesses in tackling climate problem
  - Differ on role of geo-engineering
- Business and Industry Non-Governmental Organizations (BINGO)
  - “Green” companies: Accept science and see business advantage or necessity
  - Middle ground: Accept science and cautious approach to mitigation
  - “Gray” companies: Mostly U.S. fossil-fuel based industries: Question science and impact, Cost of mitigation outweighs benefits
    - Global Climate Coalition
    - Climate Council
      - Relationship with OPEC?

Beyond 2012

- International Climate Efforts Beyond 2012: Report of the Climate Dialogue at Pocantico
  - This is a report published by Pew of a collection of experts on climate change
  - It is very soft in its recommendations
    - Like keep the international community together
    - Identification of what is important in any viable treaty
    - Important problem, keep international attention

Where does this leave us?

CLIMATE CHANGE ↔ ENERGY

ENVIRONMENTAL SECURITY
ENERGY SECURITY
FOOD SECURITY
NATIONAL SECURITY

CARBON / ENERGY POLICY

P1 P2 Pn

UNCERTAINTY
INFRASTRUCTURE
RISK // OPPORTUNITY
LIABILITY

ECONOMY
Cost of Mitigation / Adaptation ↔ BUSINESS

OTHER MOTIVATORS

MARKET-BASED SOLUTIONS?

Sulfur Market as a paradigm for CO_2 Market

- How is the same how is it different?

Cost-effective regulation

- Context: SO_2 emissions (1980 baseline)
  - 14.92 million tons of SO_2
  - primarily from coal-fired electricity generation
  - acidification of lakes, rivers, and forests
- Acid Rain Program (1990)
  - 1990 amendments to Clean Air Act
  - SO_2 allowance market
- The “Cap”
  - 8.95 million tons per year of SO_2 …therefore,
  - 5.97 million tons per year of SO_2 abatement

Cost-effective regulation (cont.)

- "cost effectiveness": what is the least-cost way of achieving a specific goal?
- Goal – "The Cap"
  - SO_2 emissions of 8.95 million tons per year
- Cost: SO_2 abatement cost
  - Aggregate cost: abatement cost summed over all electricity generators
- Policy tool – "Cap-and-trade" program
  - Theoretical finding: a market provides the incentive for companies to undertake least-cost abatement in the aggregate.

Cost-effective regulation (cont.)

Estimates for the SO_2 market:

Abatement cost without trading = $1.82 billion/yr

Abatement cost with trading = $1.04 billion/yr

(least-cost abatement)

Cost savings = $0.78 billion/yr

Cost-effective regulation (cont.)

- The “trade” in “cap and trade” is environmentally neutral
  - The cap remains fixed regardless of trading activity
- The cap is the intersection of science-based knowledge and the market

Company compliance decisions

- Context: SO_2 “allowances”
  - An allowance = 1 ton of SO_2 emission
  - Companies (electricity generators) are given a “quota” -- a fixed number of allowances each year

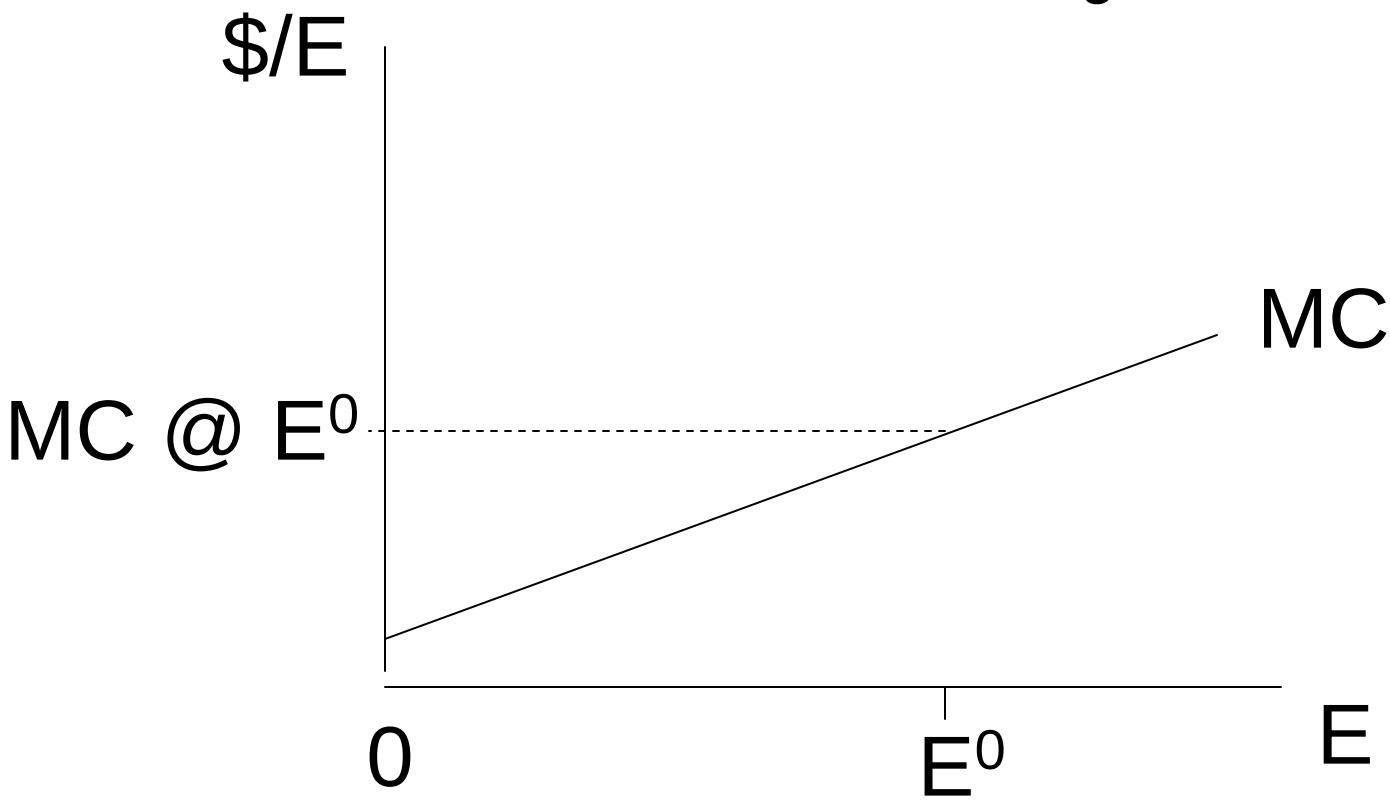
- Compliance options:
  - Without trading: Reduce SO_2 emissions to comply with their quota
    - Install new abatement technology (SO_2 “scrubbers”)
    - Use cleaner fuel sources (e.g., switch to low-sulfur coal)
    - Produce less electricity (typically not considered!)

Example (Detailed Link)

- Monroe Power Plant (Monroe, MI)
  - Owned by Detroit Edison
  - 4th largest coal-fired power plant in country
- 2004 data
  - 95,364 allowances allocated
  - 99,735 tons of emissions
  - 4,371 tons in excess
    - Purchased these on the market
    - Or, banked them from a prior year

Marginal cost of abatement (cont.) (without trading)

The area in red is the company's total cost of abating to E^0.



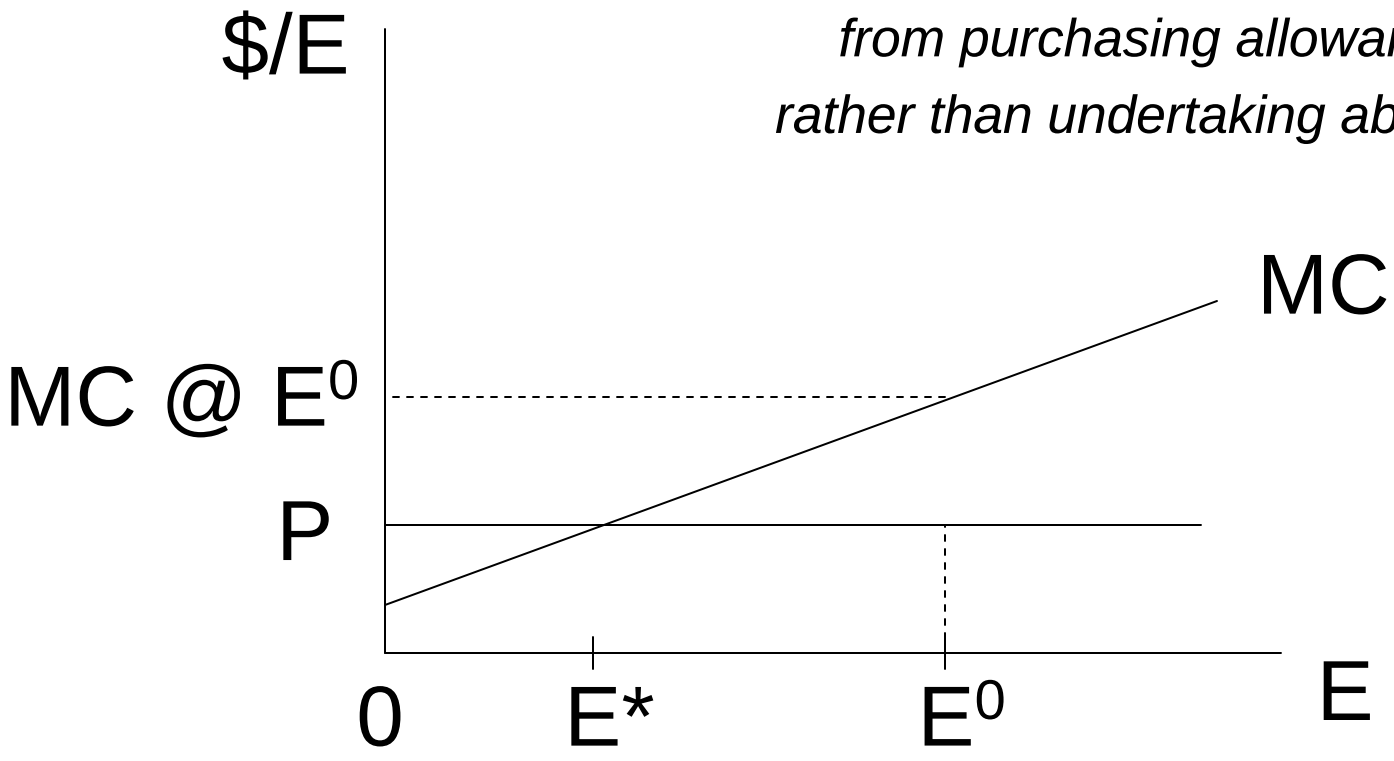
Company compliance options (with trading as an option)

- Compliance options:
  - Without trading: Reduce SO_2 emissions to comply with their quota (scrubbers, low-sulfur coal)
  - With trading: *Same options as above* ***plus***
    - Purchase allowances at the market price (P)

Purchasing allowances as a compliance option

At price P, the company purchases ($E^0 - E^*$)

The area in red is the cost savings from purchasing allowances rather than undertaking abatement



Cost-effective regulation (*repeat*)

Estimates for the SO_2 market:

Abatement cost without trading = $1.82 billion/yr

Abatement cost with trading = $1.04 billion/yr

(least-cost abatement)

Cost savings = $0.78 billion/yr

43% reduction in abatement cost!!!

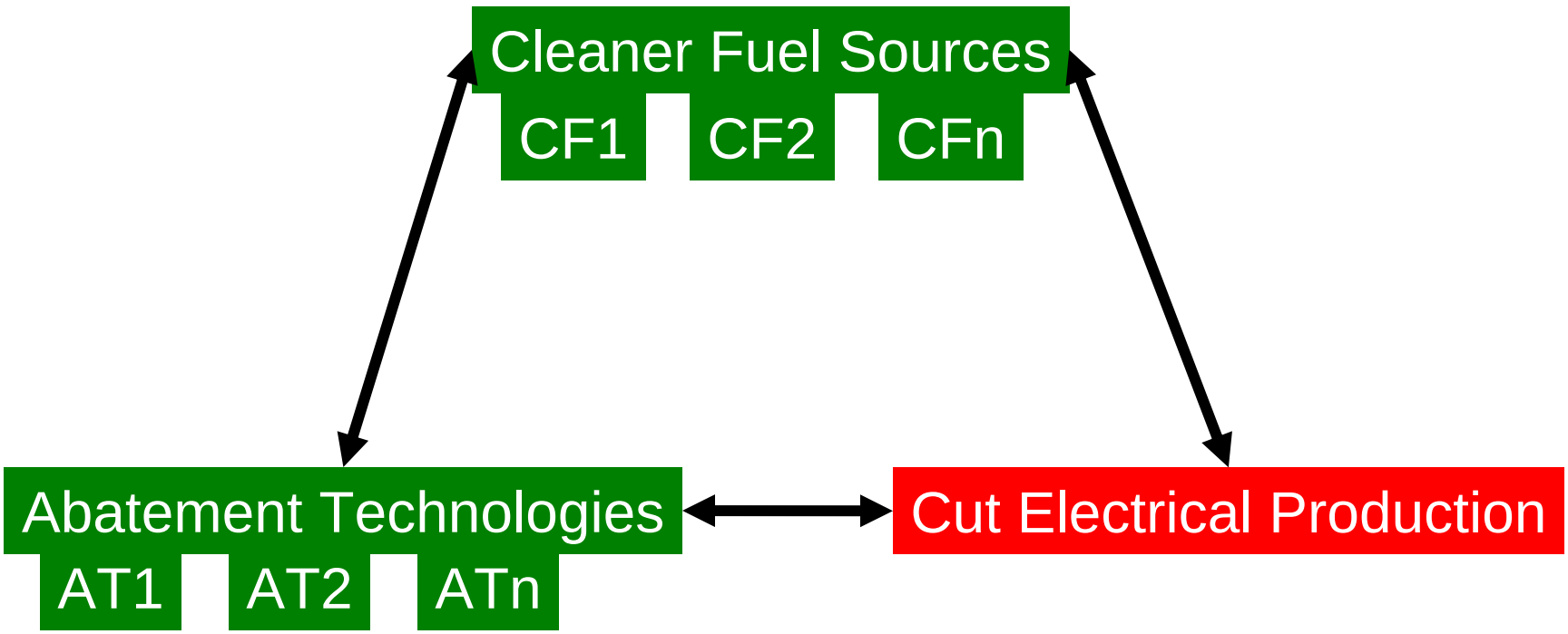
General results

- **P < MC** implies a *buyer* on the market
  - A buyer saves money by purchasing allowances to cover its emissions.
- **P > MC** implies a *seller* on the market
  - A seller makes money by undertaking extra abatement and selling its excess allowances.
- These incentives give rise to least-cost abatement.
  - We achieve cost-effective regulation
- The existence of this tension or balance between marginal cost and price of abatement implies that there is a market. There are options.

Compliance options

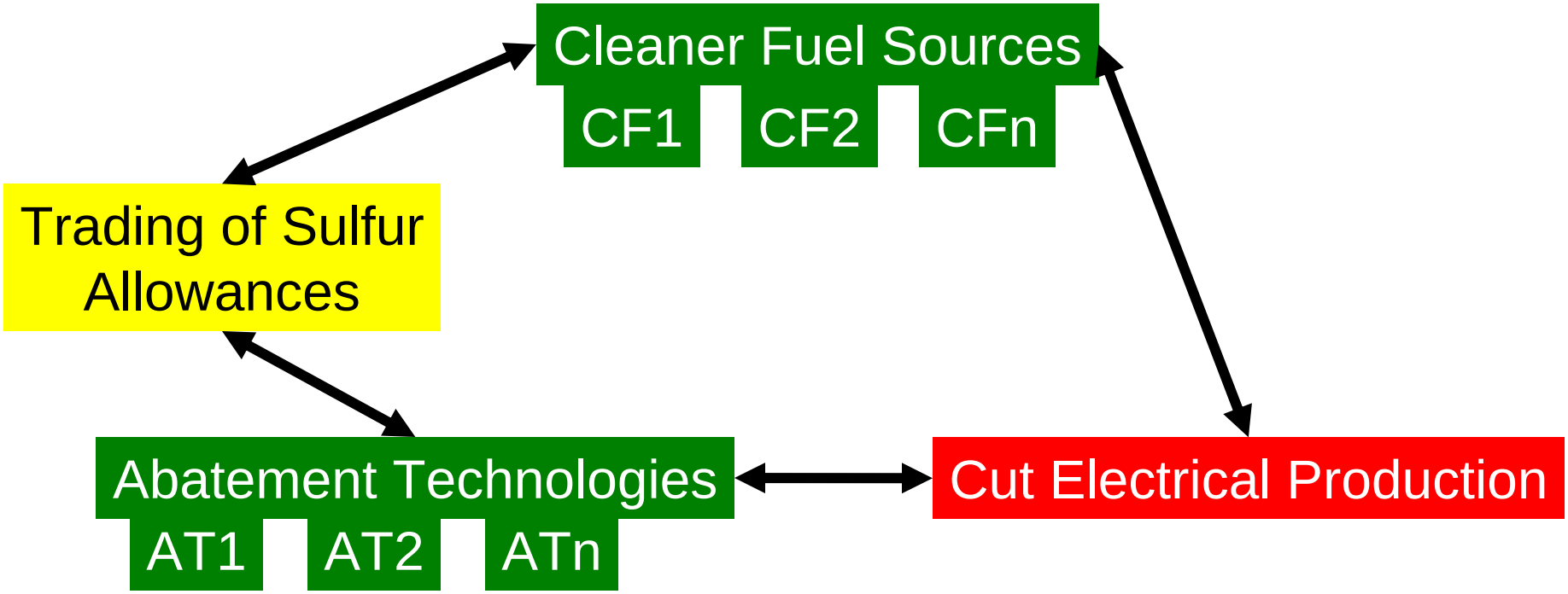
- Compliance options:
  - Without trading: Reduce SO_2 emissions to comply with their quota
    - Install new abatement technology (SO_2 “scrubbers”)
    - Use cleaner fuel sources (e.g., switch to low-sulfur coal)
    - Produce less electricity (typically not considered!)

Sulfur market



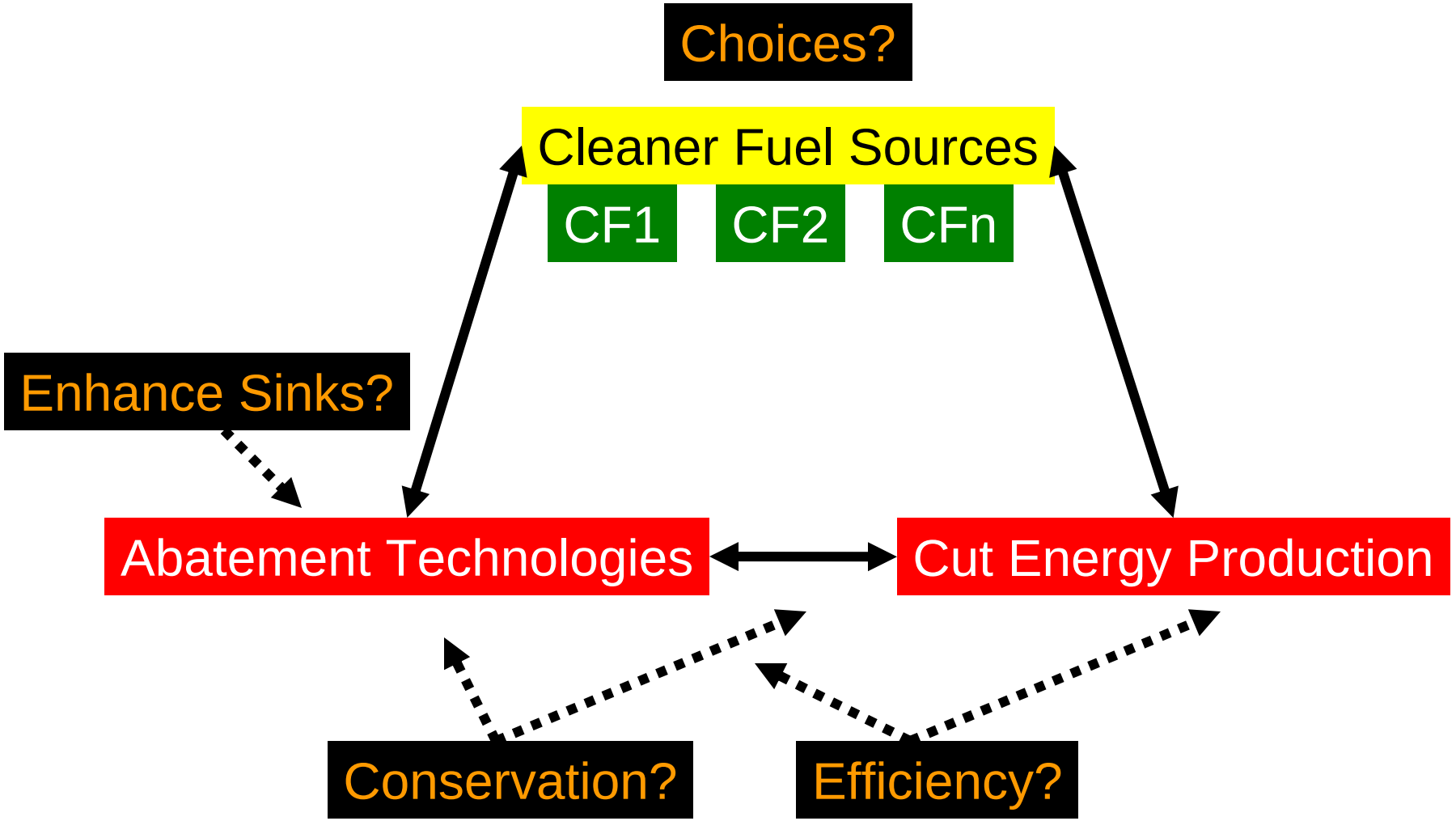
Where is efficiency?

Sulfur market



Where is efficiency?

Carbon market



Carbon market

Choices?

Trading of Carbon Allowances

Cleaner Fuel Sources

CF1 CF2 CFn

Enhance Sinks?

Abatement Technologies

Cut Energy Production

Conservation?

Efficiency?

Some Market Issues

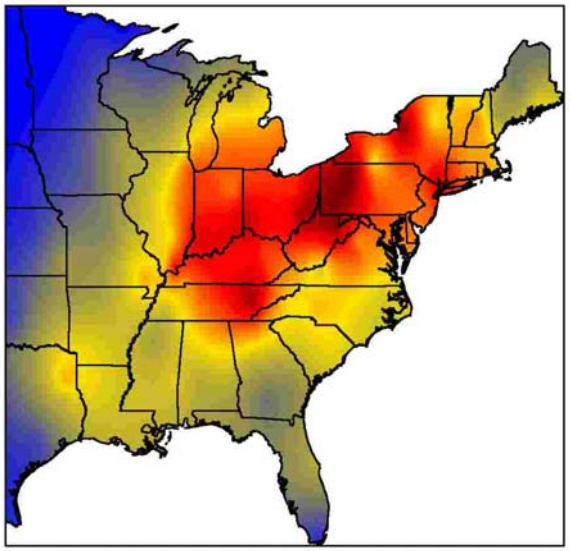
- What is the role of allowances?
  - Savings relative to what baseline?
- Cost of allowance relative to other choices?
- How do we make a carbon market?

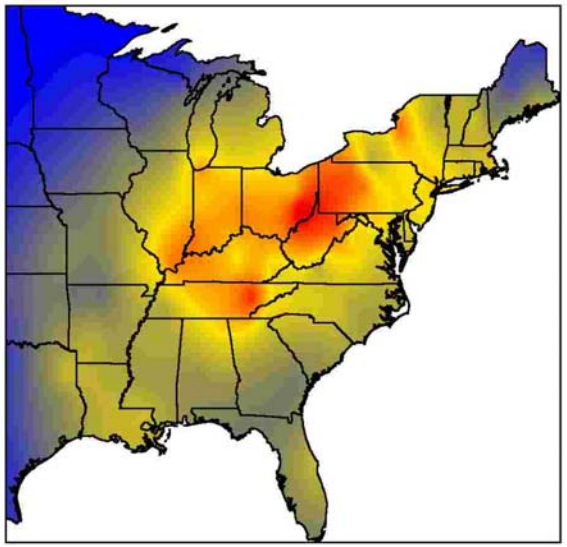
Transition to: Acid rain program and evidence on the SO_2 market

The Acid Rain Program

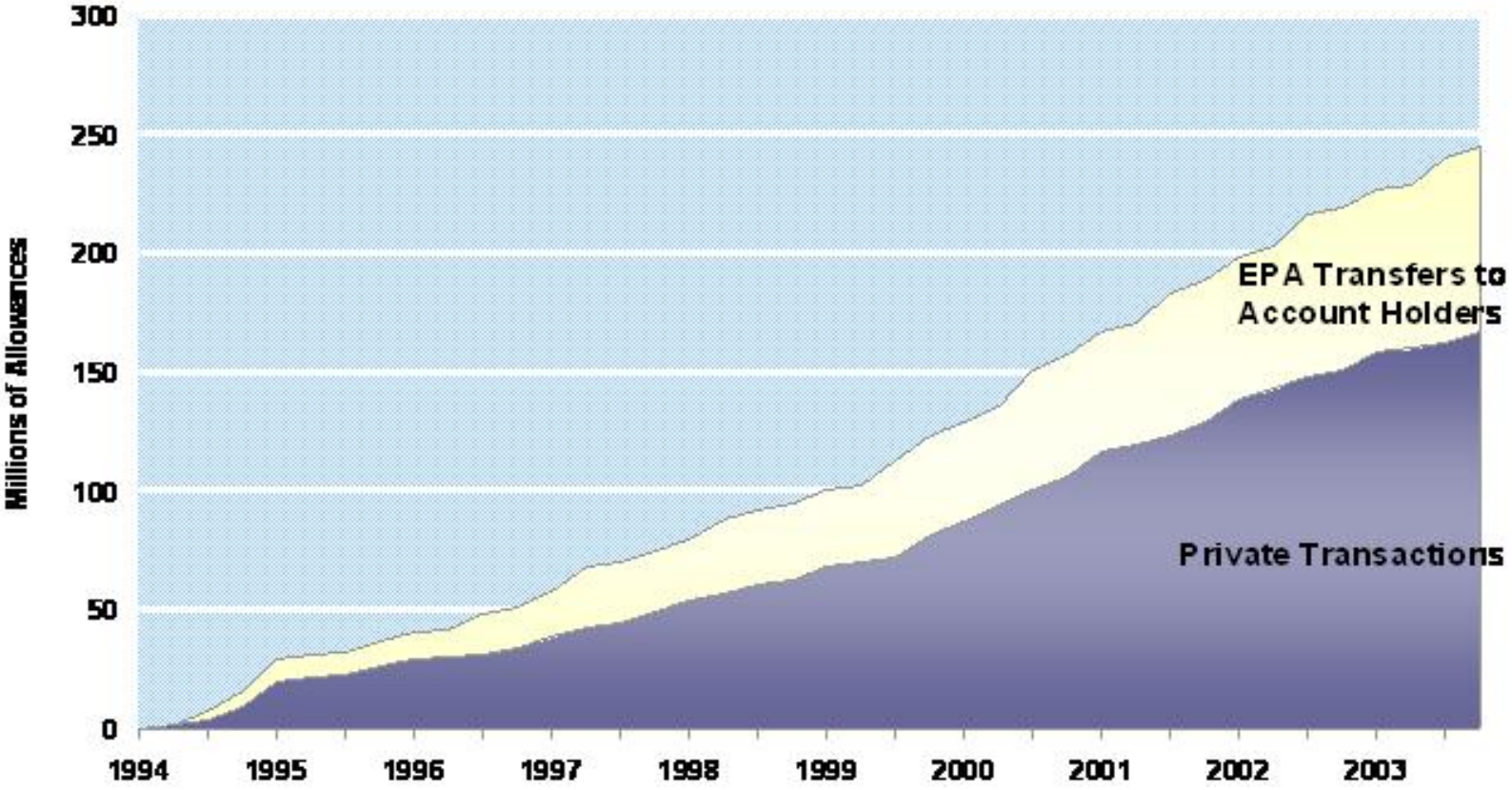
- Phase I: 1995-1999
  - 110 dirtiest electric power plants
  - 7-8.7 million allowances allocated per year
- Phase II: 2000-2010
  - All fossil-fueled electric power plants
  - 9.2-10 million allowances allocated per year
- After 2010: 8.95 million allowances/year
- Banking of allowances permitted

Trends in Wet Sulfate Deposition in the Eastern United States (1989-1991 vs. 1995-1998)

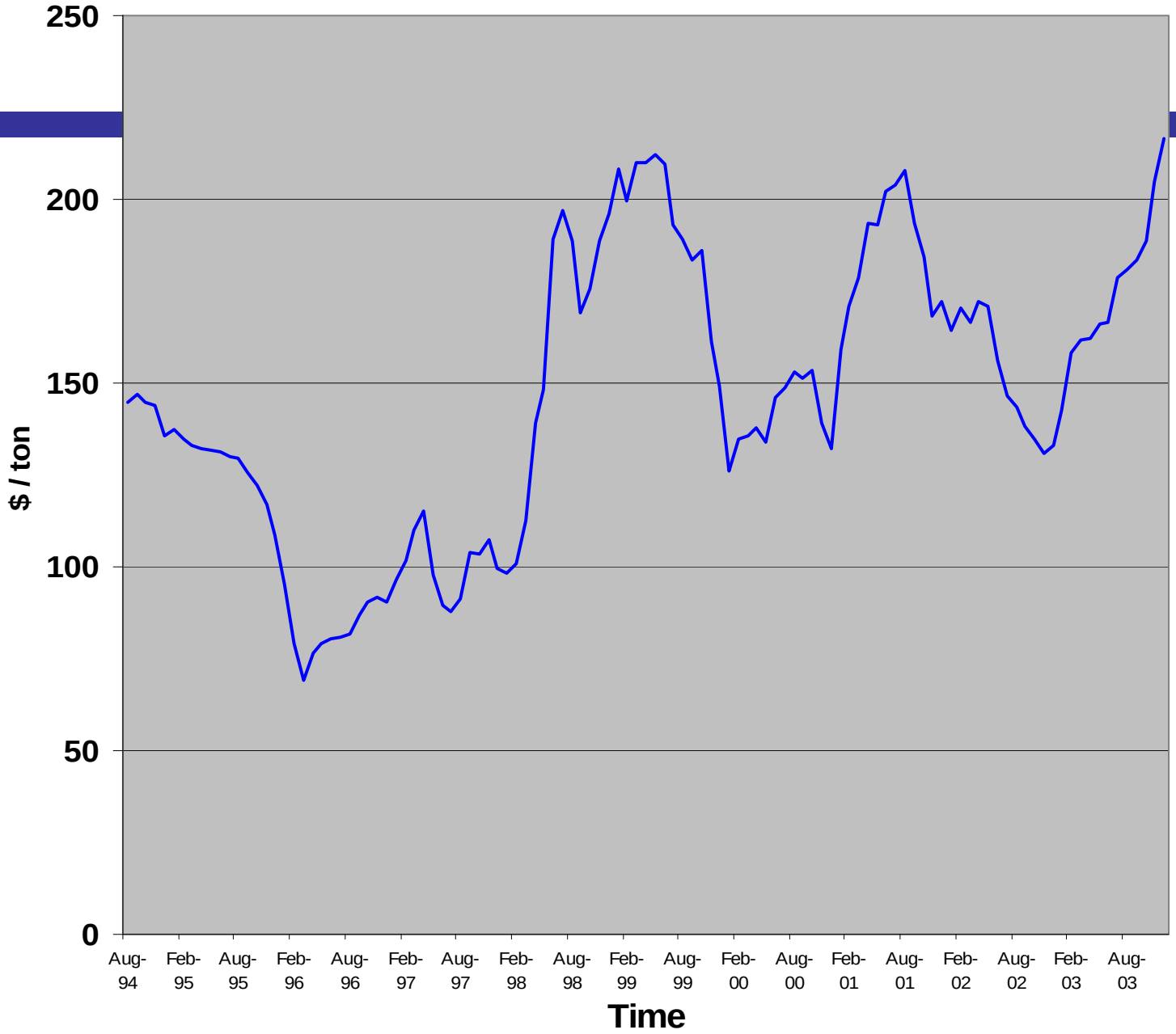




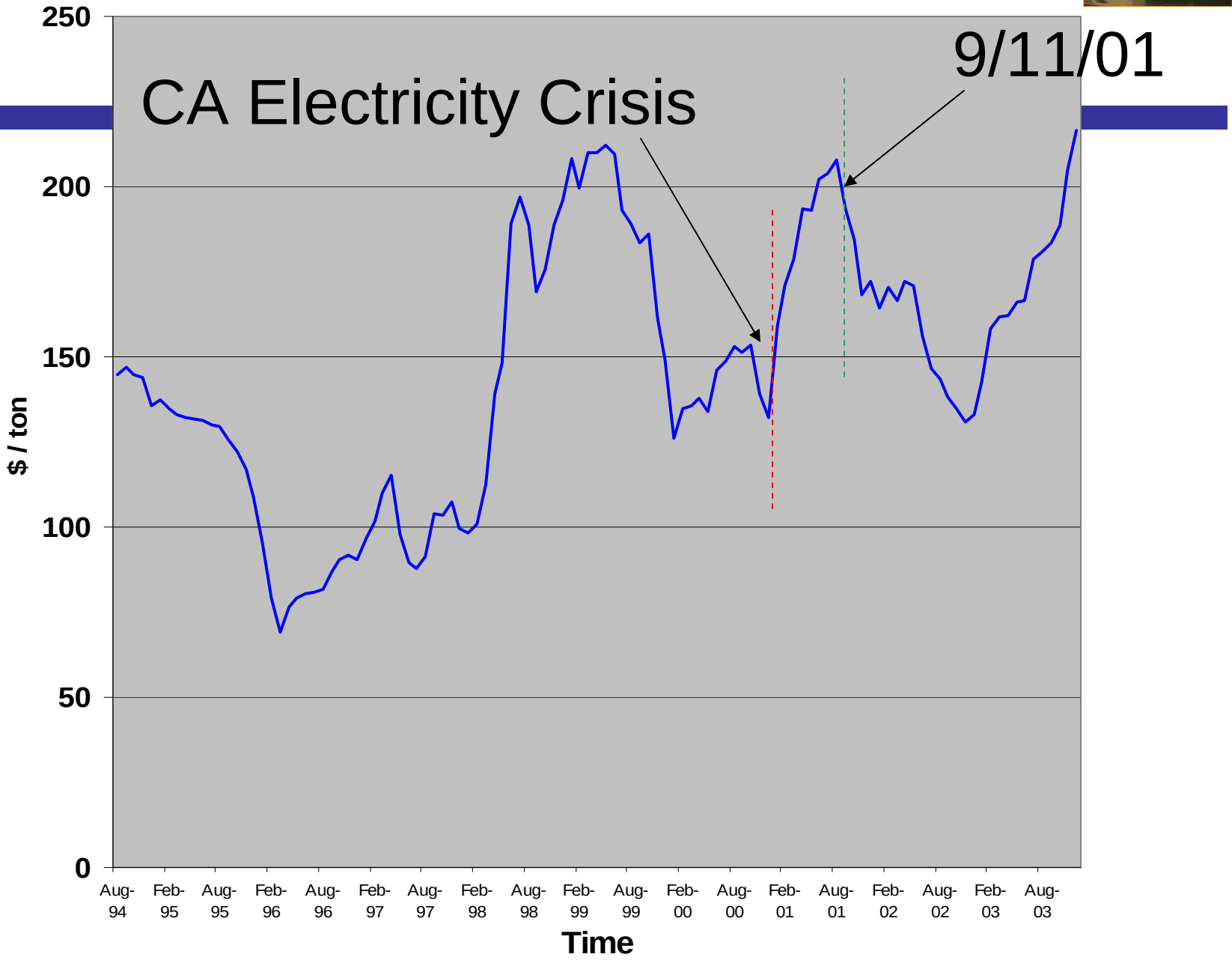
Cumulative SO_2 Allowances Transferred (through 2003)



SO2 Spot Market Prices, Aug 1994 - Dec 2003



SO2 Spot Market Prices, Aug 1994 - Dec 2003



Other air pollution markets under the Clean Air Act

- Nitrogen oxides (NO_x)
  - Precursor to smog (ground-level ozone)
  - Adverse effects on respiratory system
  - Interstate market for NO_x in 19 eastern states
- Mercury
  - Impaired brain and nervous system development in infants and children
  - Neurological disorders in adults
  - *Proposed* market for mercury
  - Very controversial. Concern about “hot spots” – mercury emissions concentrated in a relatively small geographic area.

CO_2 markets to implement climate policy

(details of EU Market)

- Kyoto Protocol (1997)
  - Participating nations: ~ 7-8% below 1990 emissions
  - European Union's CO_2 market most advanced
  - Expansion to all participating nations
- Kyoto's Flexibility Mechanisms
  - Emissions Trading System (ETS)
    - Can comply by purchasing CO_2 credits from the ETS market
  - Joint Implementation (JI)
    - Can comply by purchasing CO_2 credits from an entity in an industrialized country
  - Clean Development Mechanism (CDM)
    - Can comply by purchasing CO_2 credits from an entity in a developing country

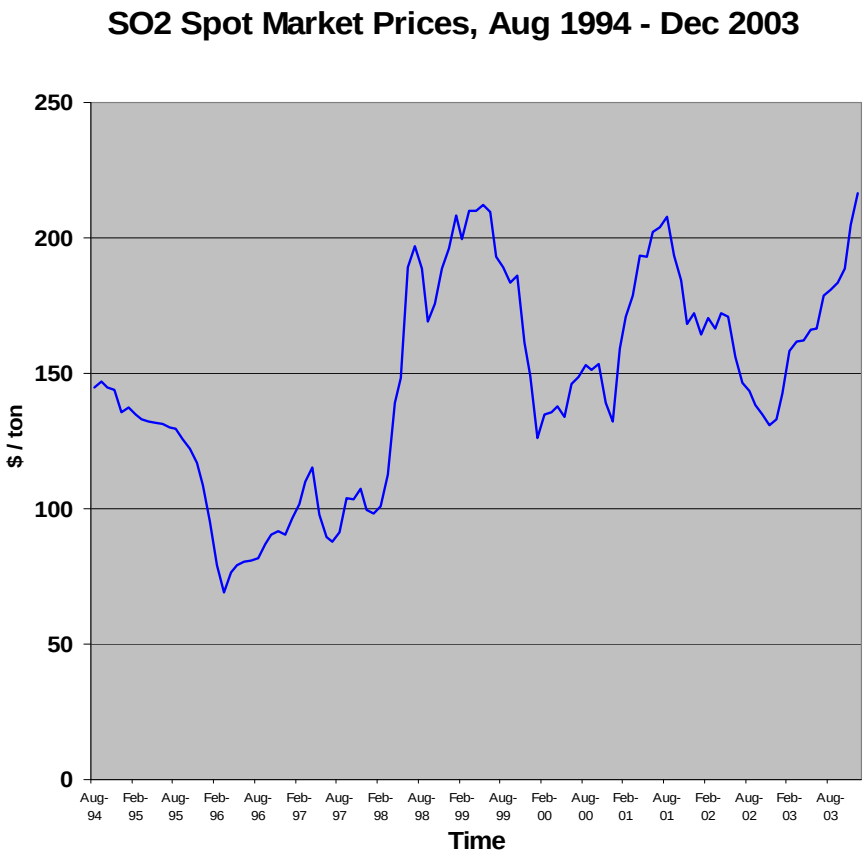
Miscellaneous issue: emission tax vs. cap-and-trade

- Regulated firms strongly prefer cap-and-trade
  - quota distributed for free – enormous $$ value!
  - compare to: tax per unit of emissions
- Monroe power plant example
  - 95,364 SO_2 allowances allocated for free in 1994
  - All allowances were used to cover emissions
  - What if taxed at $200/ton?

95,365 * 200 = $19,073,000

Emission tax vs. cap-and-trade (cont.)

- The regulator likes the certainty of the cap; tax has an uncertain effect on aggregate emissions
  - Environmentalists probably like this certainty, too
- Example: volatile SO_2 prices, yet certain cap.



Emission tax vs. cap-and-trade (cont.)

- What politician will support a tax program?
  - Clinton/Gore's failed BTU tax, early in 1st term
- Cap-and-trade as the consensus strategy …at the moment.

Conclude: Political economy of cap-and-trade programs

- Environmentalist perspective
  - Set the cap as low as politically feasible
- Business perspective
  - Maintain flexibility in compliance options
  - Cap and trade is most flexible
- Regulator perspective
  - Buy-in from stakeholders
    - Good for environment *and* cost effective
  - Enforceable

Many environmental organizations are now advocates for cap-and-trade programs

Further Reading

- Tom Tietenberg, *Environmental and Natural Resource Economics*, 7th Edition, 2006.
  - It includes several chapters on environmental regulation—both principles and applications.
- Ellerman, Joskow, Schmalensee, Montero, and Bailey, *Markets for Clean Air: The U.S. Acid Rain Program*, 2000.
  - An exhaustive evaluation of the acid rain program and SO_2 market by a team of great economists.

Example: DTE Marginal Cost of Abatement

- Monroe Power Plant (Monroe, MI)
  - Owned by Detroit Edison
  - 4th largest coal-fired power plant in country
- 2004 data
  - 95,364 allowances allocated
  - 99,735 tons of emissions
  - 4,371 tons in excess
    - Purchased these on the market
    - Or, banked them from a prior year

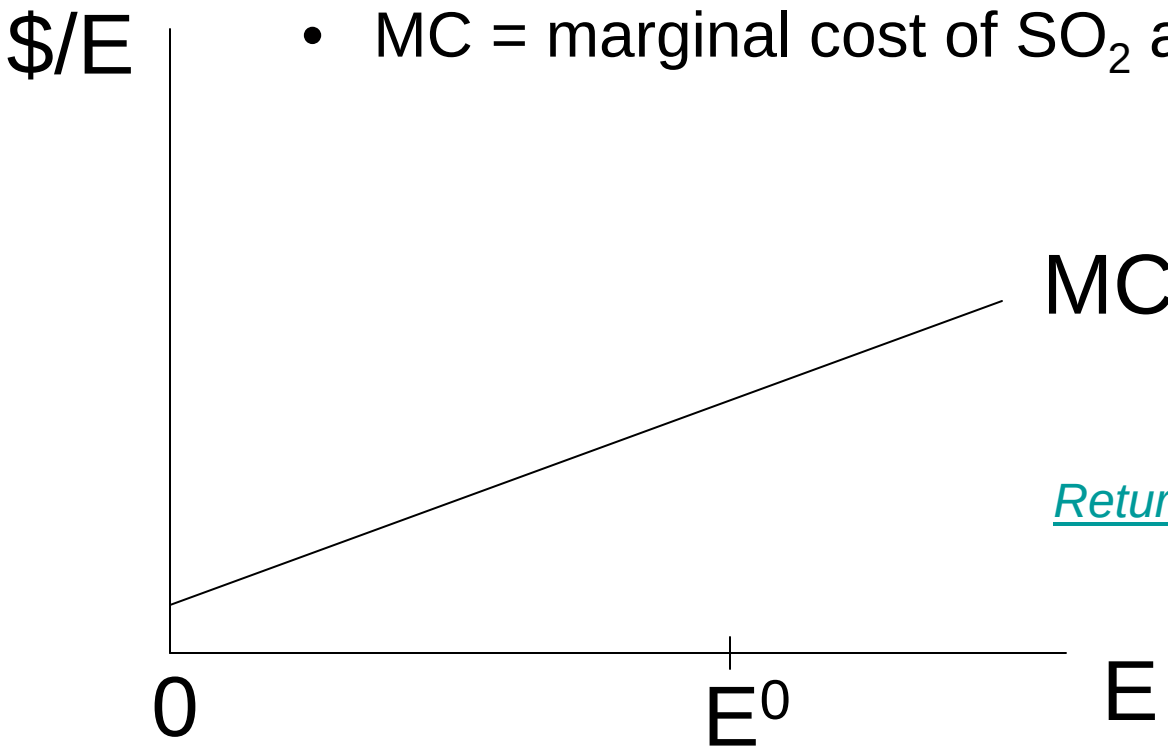
Company compliance decisions (cont.)

- Analytical concept: a company's *marginal cost of abatement*
  - a mathematical function: marginal cost increases as the amount of pollution abatement increases.

Return to Main Presentation

Marginal cost of abatement (single company)

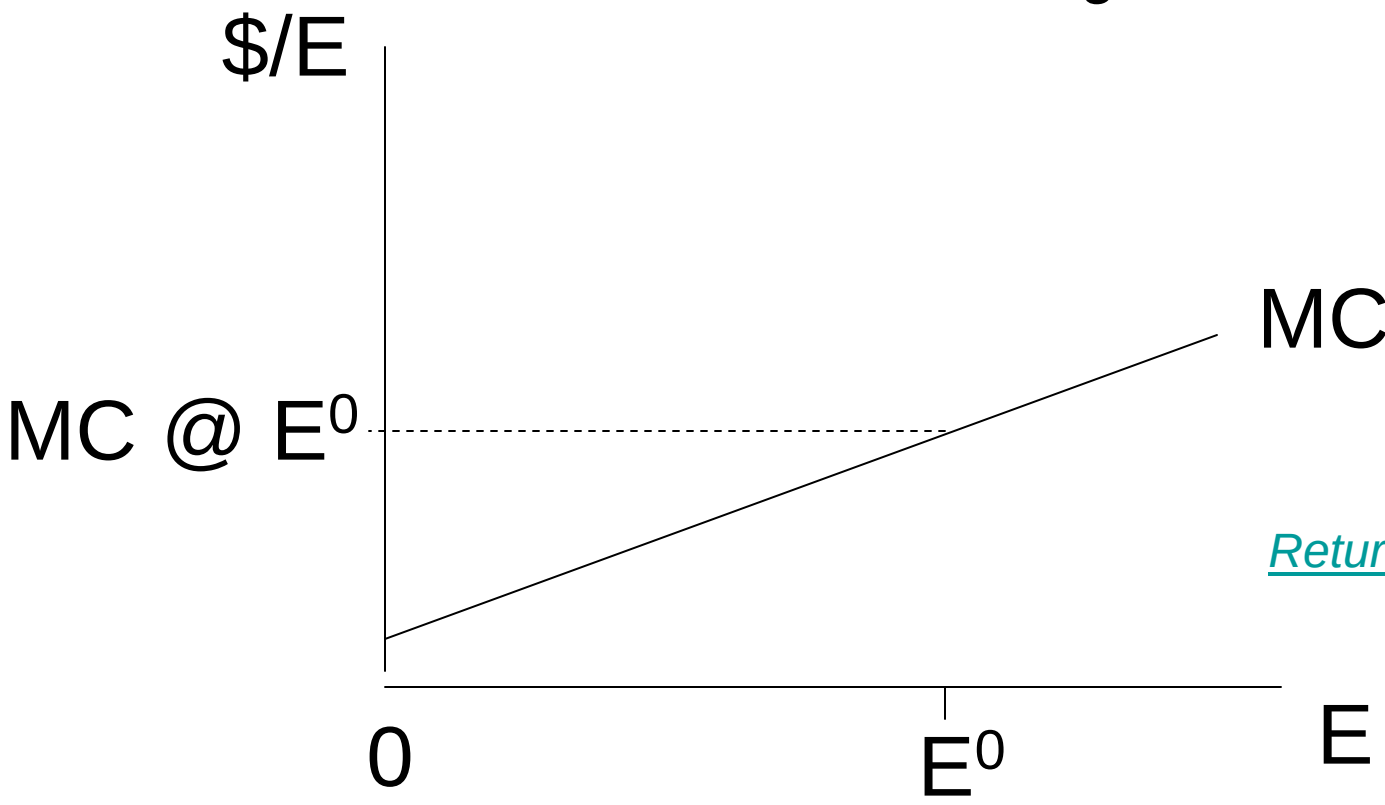
- E = SO_2 emissions abatement
- E^0 = required abatement without trading
- $/E = dollars per ton of E
- MC = marginal cost of SO_2 abatement



Return to Main Presentation

Marginal cost of abatement (cont.)

The area in red is the company's total cost of abating to E^0.



Return to Main Presentation

Company compliance options (with trading as an option)

- Compliance options:
  - Without trading: Reduce SO_2 emissions to comply with their quota (scrubbers, low-sulfur coal)
  - With trading: *Same options as above* ***plus***
    - Purchase allowances at the market price (P)

Return to Main Presentation

Simple intuition of market incentive

Consider the following example:

-- \$300 to abate a ton of SO_2

compared to

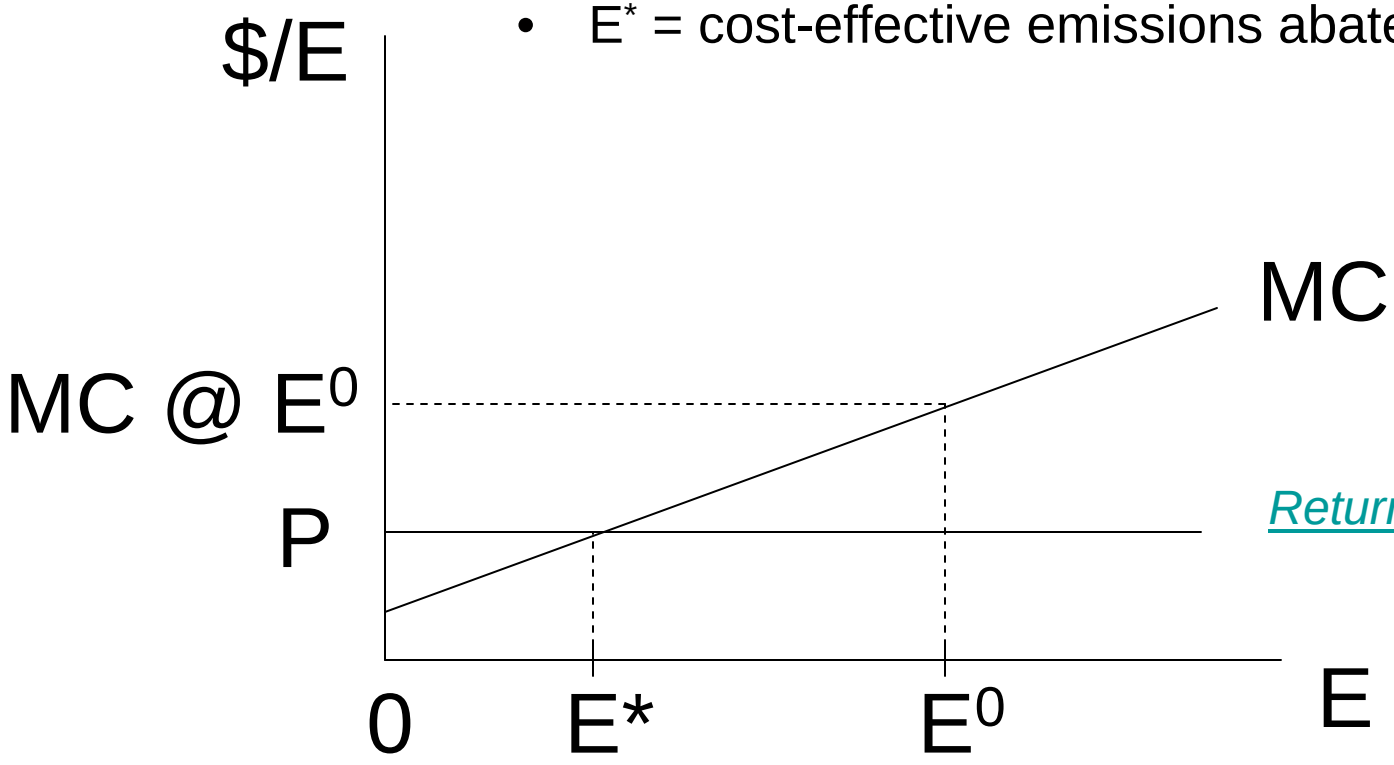
-- \$170 to purchase an SO_2 allowance.

The company saves \$130 by using an allowance to cover its emission

Return to Main Presentation

Marginal cost *versus* allowance price

- E = SO_2 emissions abatement
- $/E = dollars per ton of E
- P = market price of SO_2 allowances
- E^* = cost-effective emissions abatement

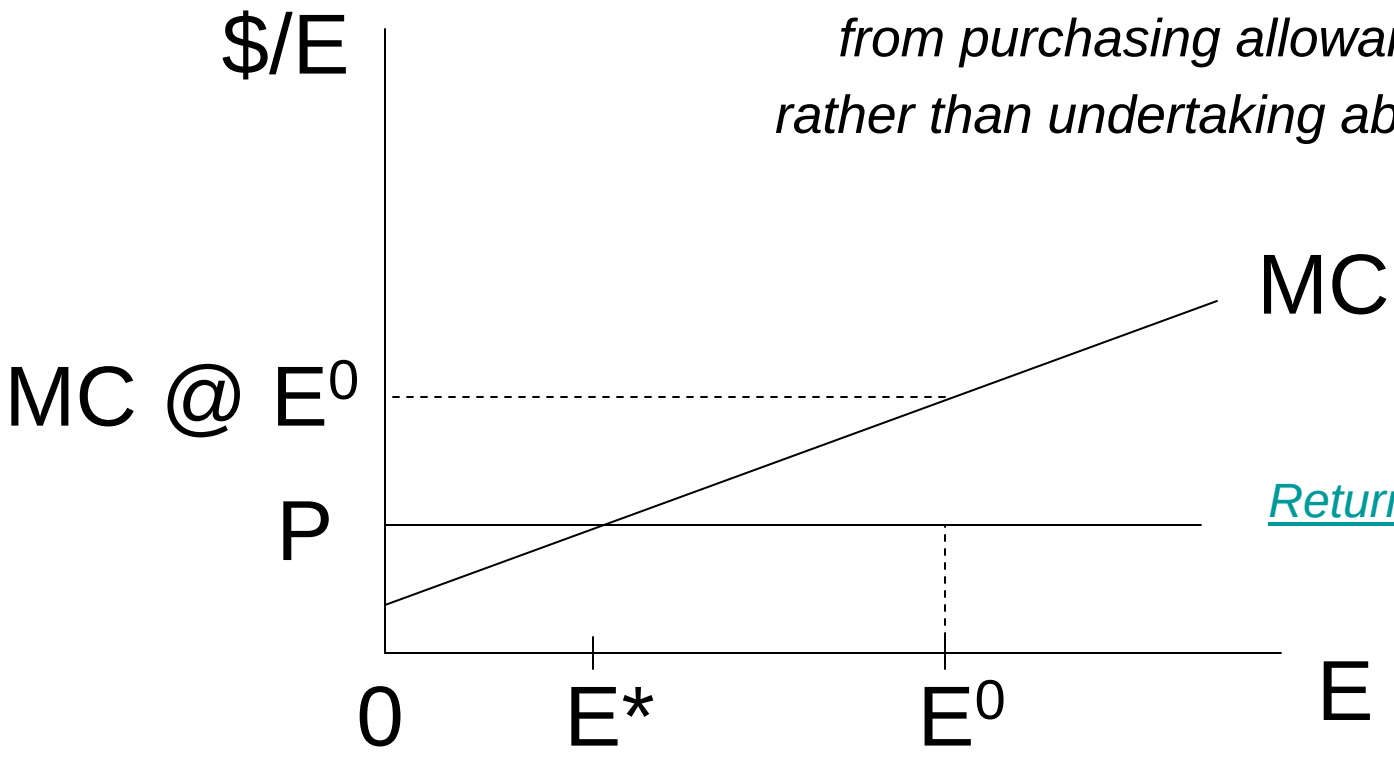


Return to Main Presentation

Purchasing allowances as a compliance option

At price P, the company purchases ($E^0 - E^*$)

The area in red is the cost savings from purchasing allowances rather than undertaking abatement



Return to Main Presentation

General results

- **P < MC** implies a *buyer* on the market
  - A buyer saves money by purchasing allowances to cover its emissions.
- **P > MC** implies a *seller* on the market
  - A seller makes money by undertaking extra abatement and selling its excess allowances.
- These incentives give rise to least-cost abatement.
  - We achieve cost-effective regulation!!!

Return to Main Presentation

Cost-effective regulation (*repeat*)

Estimates for the SO_2 market:

Abatement cost without trading = $1.82 billion/yr

Abatement cost with trading = $1.04 billion/yr

(least-cost abatement)

Cost savings = $0.78 billion/yr

43% reduction in abatement cost!!!

Return to Main Presentation

Does this seem like a conservation equation?

- What is conserved?
- What is different from a physical continuity equation?
- Minimization?

Return to Main Presentation

The model is simple, but there is an issue of complexity

Imagine that you have a savings account and a checking account $\mathbf{M = M^s + M^c}$

Savings: $\mathbf{(M^s}_{\text{tomorrow}} - \mathbf{M^s}_{\text{yesterday}}\mathbf{)}/N = I^s - e^s\mathbf{M^s}$

Checking: $\mathbf{(M^c}_{\text{tomorrow}} - \mathbf{M^c}_{\text{yesterday}}\mathbf{)}/N = I^c - e^c\mathbf{M^c}$

And we can transfer money from

Checking to savings – $T^{c\rightarrow s}$

Savings to checking - $T^{s\rightarrow c}$

Savings: $\mathbf{(M^s}_{\text{tomorrow}} - \mathbf{M^s}_{\text{yesterday}}\mathbf{)}/N = I^s - e^s\mathbf{M^s} + T^{c\rightarrow s} - T^{s\rightarrow c}$

Checking: $\mathbf{(M^c}_{\text{tomorrow}} - \mathbf{M^c}_{\text{yesterday}}\mathbf{)}/N = I^c - e^c\mathbf{M^c} - T^{c\rightarrow s} + T^{s\rightarrow c}$

Return to Main Presentation

- Through carbon could we couple a cap and trade market with a climate model or an emissions model?

Return to Main Presentation

Some details of European CO2 Market

Warning: C or CO_2; ton or tonne; $ or euros?

- Commonly \$/ CO_2; sometimes \$/C
- To convert: \$/CO_2 * CO_2/C = \$/C
- CO_2 = atomic weight of 44
- C = atomic weight of 12

- tonne = metric ton = 2,204.6 pounds
- tonne, not ton, is the standard measure

- 1.00 euro (€) = \$1.3094 (exchange rate varies!)
- Euro – currency used on European Union market

Return to Main Presentation

EU's Emission Trading System

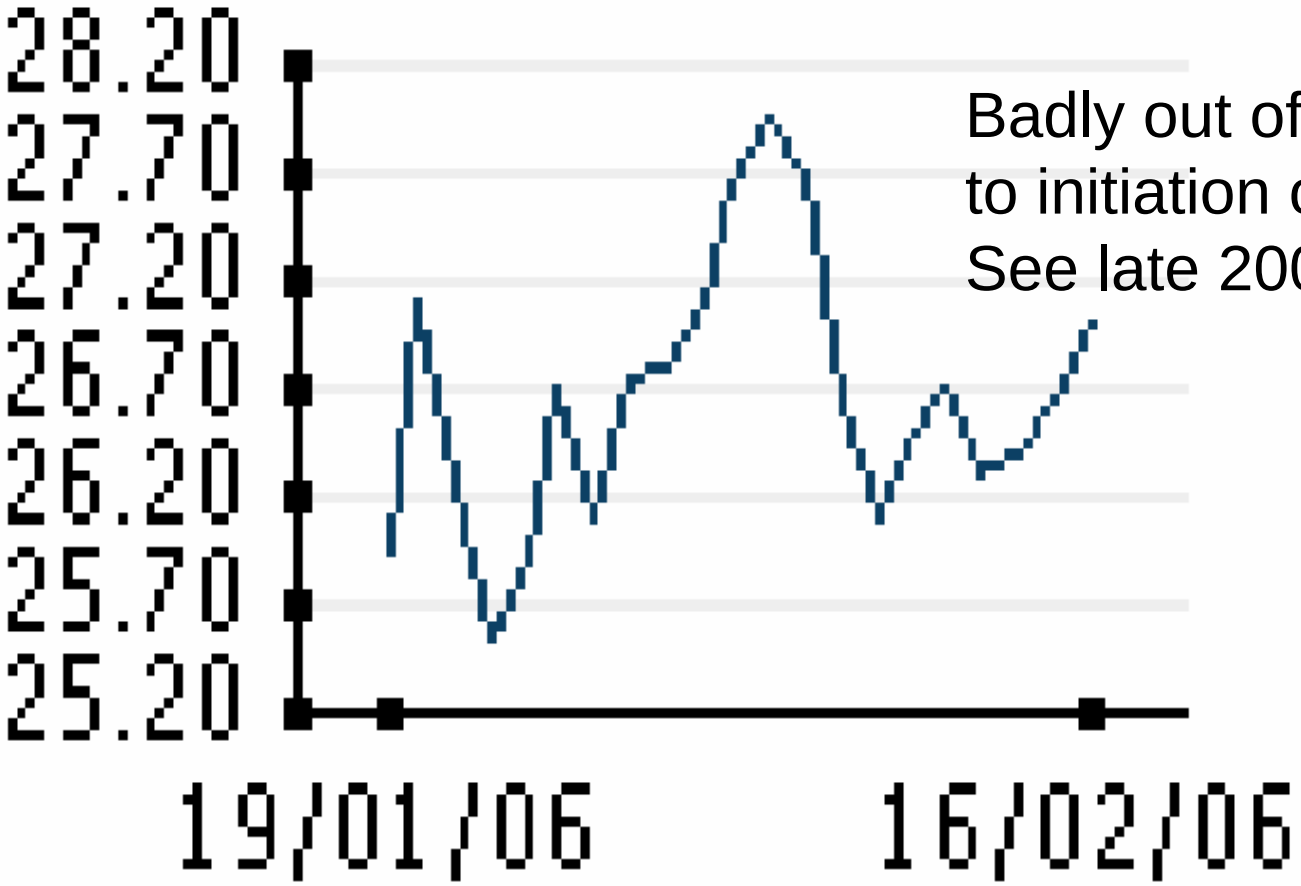
"The European Union is establishing a greenhouse gas emissions trading scheme for the cost-effective reduction of such emissions in the Community."

- EU ETS birth: January 1, 2005
- EUA = European Union allowance
- One allowance = one tonne of CO_2 emission
- EU's cap: about 2.2 billion allowances/yr
- 11,500-12,000 regulated facilities
- Sectors covered: energy (electricity; cogeneration); iron and steel; mineral; pulp and paper.

Return to Main Presentation

Market Prices in 2006 – EU ETS

(euros per ton of CO_2)
(26 euros = 31.2 dollars)



Badly out of date: Close to initiation of market. See late 2006.

Return to Main Presentation

EU ETS (cont).

- Penalty for excess emissions:
  - € 40 per tonne
  - rising to €100 in 2008
- Impressive volume of trading activity
  - 2005: global volume = 800 million tonnes CO_2
  - Jan. 2006: EU volume = 262 million tonnes
- Brokers competing to be the “marketplace”

  (like SO_2: Evolution Markets/Natsource/Cantor-Fitzgerald)
  - Powernext Carbon
  - European Climate Exchange

Return to Main Presentation

EU ETS (cont).

- Companies and traders “get it”

  “Carbon is now being used as a commodity on the same lines as other energy commodities.”

- US SO_2 market: widely hailed as very successful
- EU CO_2 market – the next important experiment in cap-and-trade. Too soon for rigorous evaluation.

Return to Main Presentation

Action in the United States

- McCain-Lieberman Climate Stewardship Act
  - 2001. U.S. withdraws from Kyoto.
  - 2003. McCain-Lieberman proposed.
    - Cap emissions at 2000 levels
    - Implement in 2010
    - Market provision – “cap and trade” system
- 2005 - U.S. Senate passes non-binding resolution
  - “national program of mandatory, market-based limits and incentives on greenhouse gases…”
- Future federal policy
  - Will companies push for consistent approach?

Return to Main Presentation

Action in the U.S. (cont.)

- Regional Greenhouse Gas Initiative (2005)
  - Multi-state coalition (CT, DE, ME, NH, NJ, NY, VT)
  - MA and RI pulled out at 11th hour
- California GHG emission reductions (2005)
  - Reduce emissions to 2000 levels by 2010
    and to 1990 levels by 2020.
- Chicago Climate Exchange (2003)
  - Voluntary participation by companies, cities, NGOs
  - Tradable quotas
  - Baseline: average emissions over 1998-2001
  - 2006 quota: 4% below baseline
  - Market price about $2 per tonne CO_2

Return to Main Presentation