



Invention and Cap-and Trade Programs

Symposium on Intellectual Property and Entrepreneurship

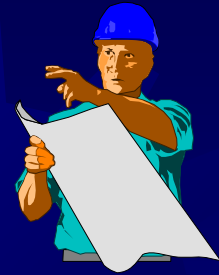
12th Annual BCLT/BTLJ Symposium

Margaret Taylor

*Goldman School of Public Policy
Univ. California Berkeley*

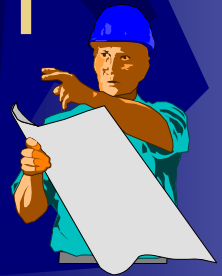
March 7, 2008

Today's Road Map

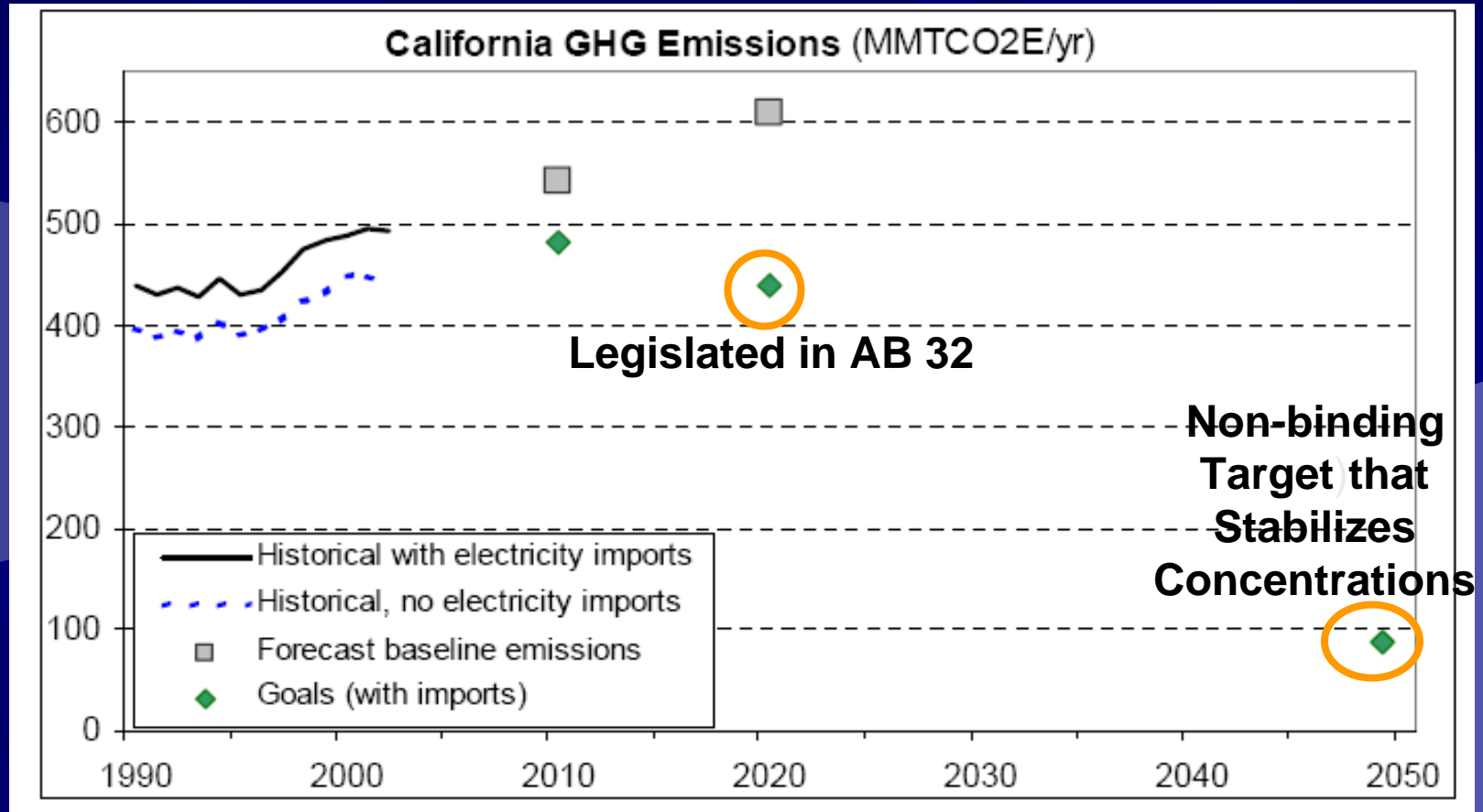


1. Climate change and the need for clean tech innovation
2. What we know about clean tech innovation
3. Climate cap-and-trade programs (CTPs)
4. Evidence re: existing CTPs and invention
5. Climate policy implications

Climate change and the need for clean tech innovation



2050 Goals are our Best Guess for Safety



Even these goals may not be ambitious enough:

- Accelerating growth rate of atmospheric CO₂
- Faster-than-predicted ice melts ...

The Technologies aren't There Yet

- ✱ This will require innovation, probably in multiple technology strategies
- ✱ Designing policies that support innovation is *at least* a smart hedge...

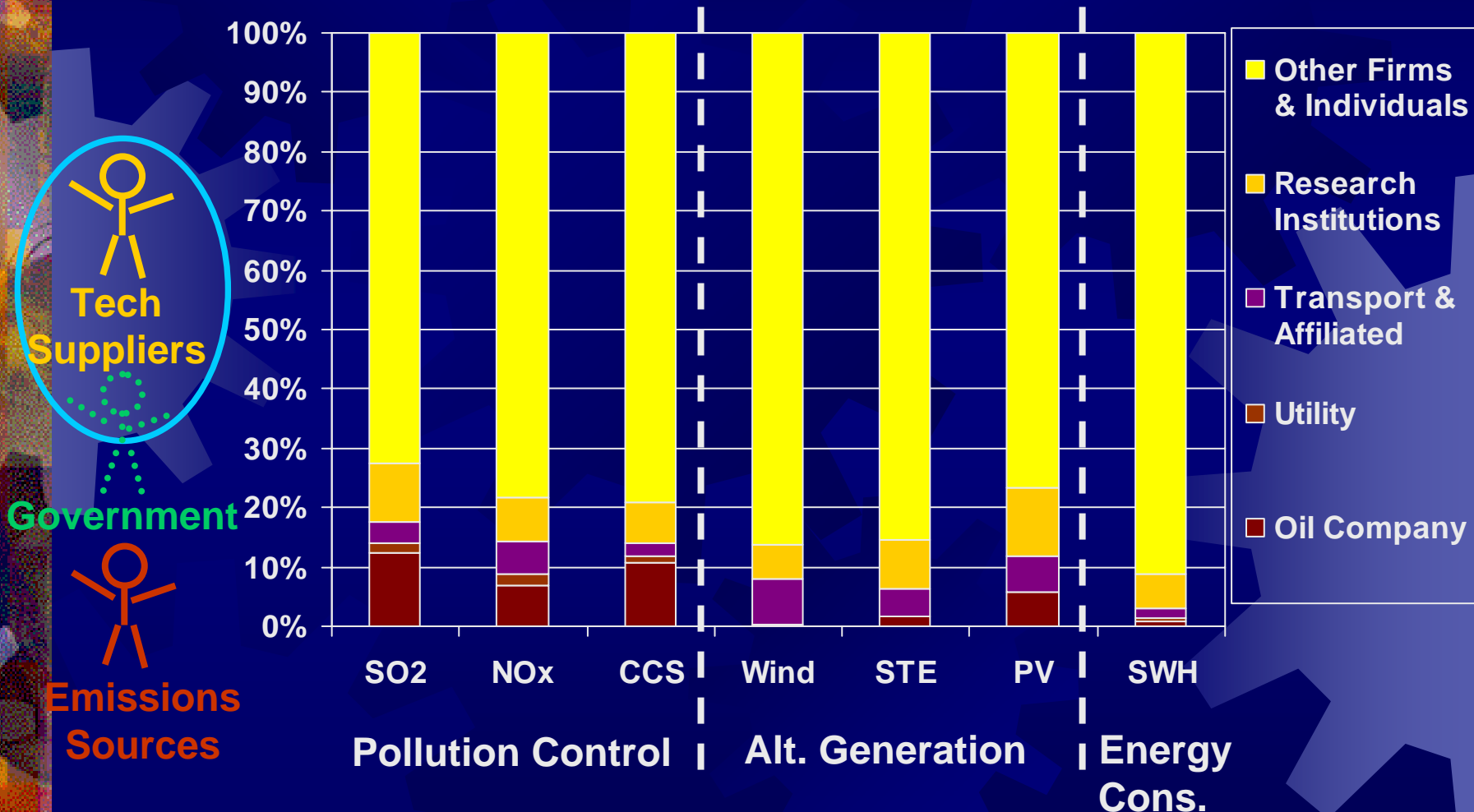
What we know about clean tech innovation



Innovation and “Clean Tech”

- ★ Overlapping activities lead to a successful innovation
 - Invention
 - Commercial adoption and diffusion
 - Post-adoption learning from experience
- ★ Innovative success is difficult to achieve
 - R&D is a long-term, uncertain process
 - From birth to maturity of a technology, lots of obstacles
 - Likelihood of success greatest with the largest number of **searchers** and the broadest field of search
- ★ The private sector is especially important
 - Of all U.S. R&D expenditures tabulated by NSF b/t 1953-2004, 57% by industry with no federal support
- ★ But the private sector
 - Under-invests in R&D compared to “socially optimal” returns
 - Notoriously under-invests in “clean technologies” that help maintain the public good of a clean environment

Who invents clean technologies?



Patent breakdown in carbon relevant technologies by assignee type

Climate cap-and-trade programs (CTPs)



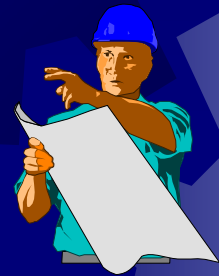
Climate Cap-and-Trade Programs (CTPs)

- ★ Rapidly becoming the world's dominant climate policy instrument. Operating or developing in:
 - European Union
 - Australia
 - Over half of both the U.S. States and Canadian provinces
 - One Mexican state ...
- ★ How they work:
 - Policy-makers set a cap on emissions and then allocate emissions “allowances” to polluting sources that are equivalent, in sum, to the cap
 - If sources can reduce emissions cheaply, they can then try to sell (or bank) excess allowances
 - Price is whatever the market will bear
- ★ Current legislated caps aren't set at “safe” GHG emissions levels
 - If politics goes well, plan is to gradually tighten the caps
 - In the meantime, a lot of hopes are being pinned on CTPs stimulating technological innovation

What do CTPs mean for clean tech innovation?

- ★ Some theory says better than other policies
 - ★ Analysis assumes innovators = emissions sources
- ★ Not much empirical evidence
 - ★ Most work on adoption of existing technologies, not invention that can improve/substitute for existing technologies

Evidence re: existing CTPs and invention





Approach

Look at existing CTPs and invention, with an eye to the climate policy implications

1. Understand the CTPs we have evidence for
2. Understand the relevant technologies and the adoption pattern
3. Measure inventive activity

What CTPs do we have Evidence For?

	Scope	Pollutant	Major Emissions Source
Title IV SO ₂			
OTC/NBP NO _x			
RECLAIM (NO _x)			

What CTPs do we have Evidence For?

	Scope	Pollutant	Major Emissions Source
Title IV SO ₂	National		
OTC/NBP NO _x	Regional		
RECLAIM (NO _x)	Sub-State		

What CTPs do we have Evidence For?

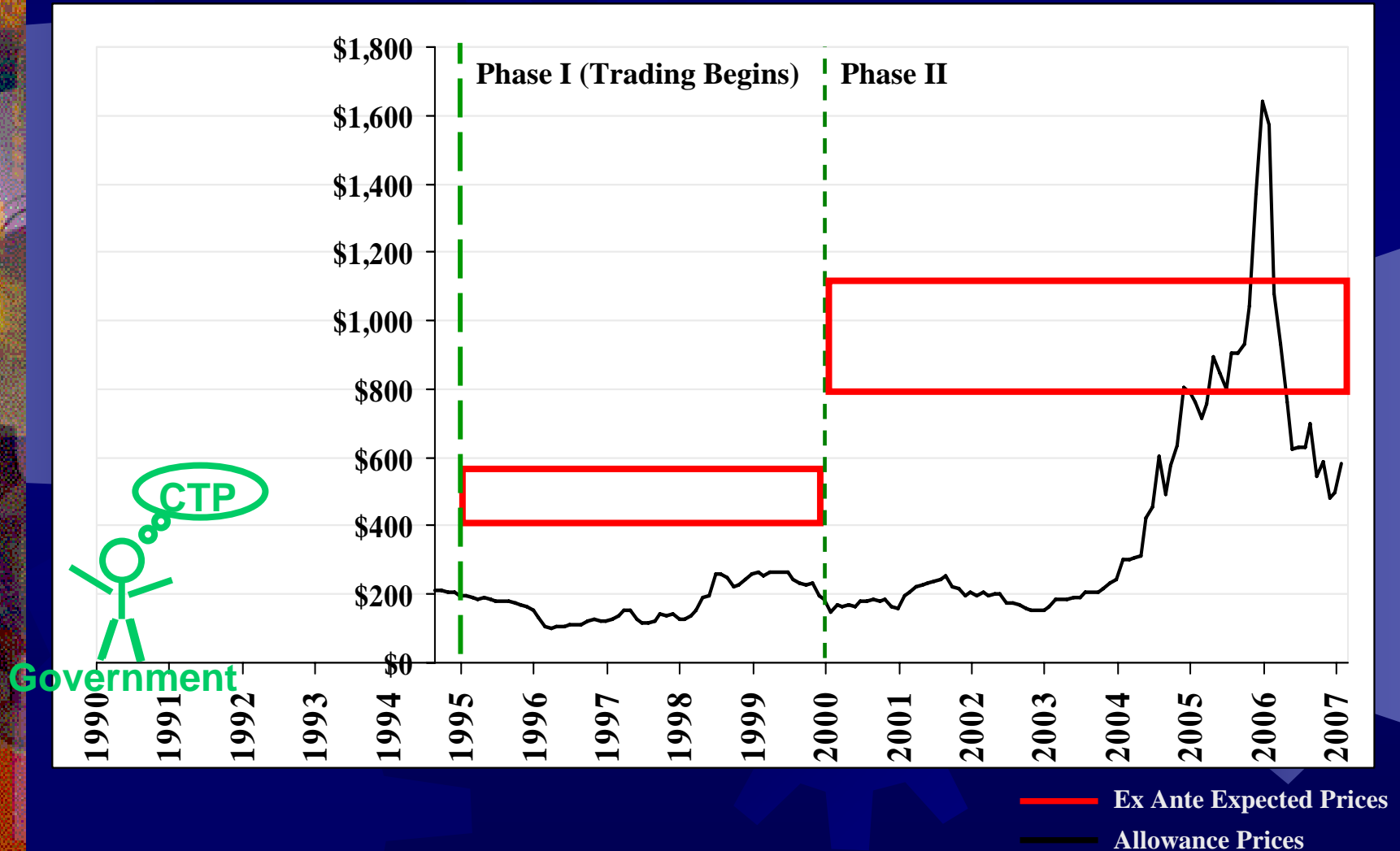
	Scope	Pollutant	Major Emissions Source
Title IV SO₂	National	Sulfur dioxide (SO ₂)	
OTC/NBP NO_x	Regional	Nitrogen oxide (NO _x)	
RECLAIM (NO_x)	Sub-State	NO _x and SO ₂ .	

What CTPs do we have Evidence For?

	Scope	Pollutant	Major Emissions Source
Title IV SO₂	National	Sulfur dioxide (SO ₂)	Coal-fired electric power plants
OTC/NBP NO_x	Regional	Nitrogen oxide (NO _x)	Transportation; Coal-fired power plants largest stationary source
RECLAIM (NO_x)	Sub-State	NO _x and SO ₂ .	Transportation; Manufacturing/Industrial is the largest centralized stationary source, with gas-fired power plants a significant, although not dominant, source

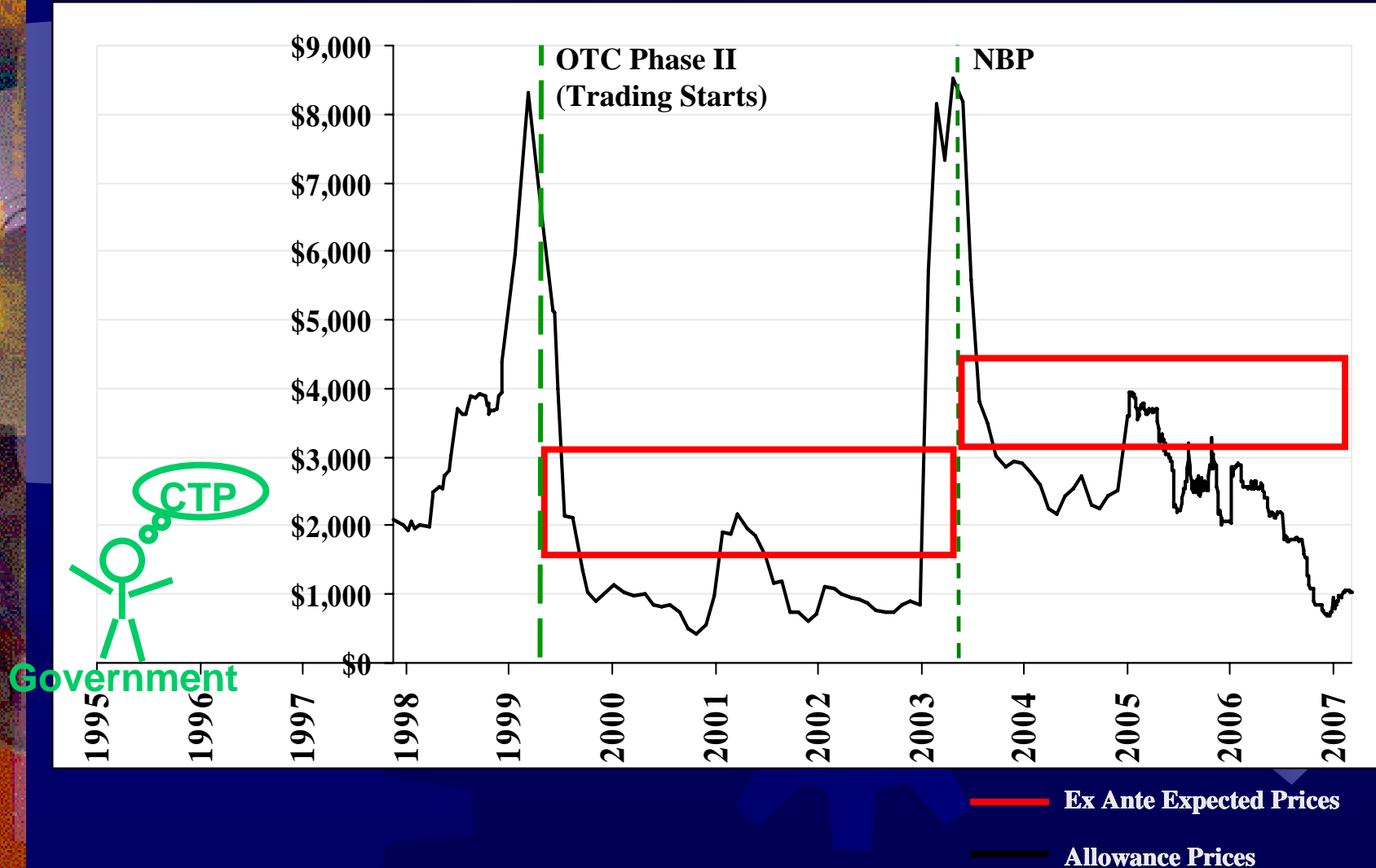
SO₂ Prices (\$/Ton)

- Lower than Expected



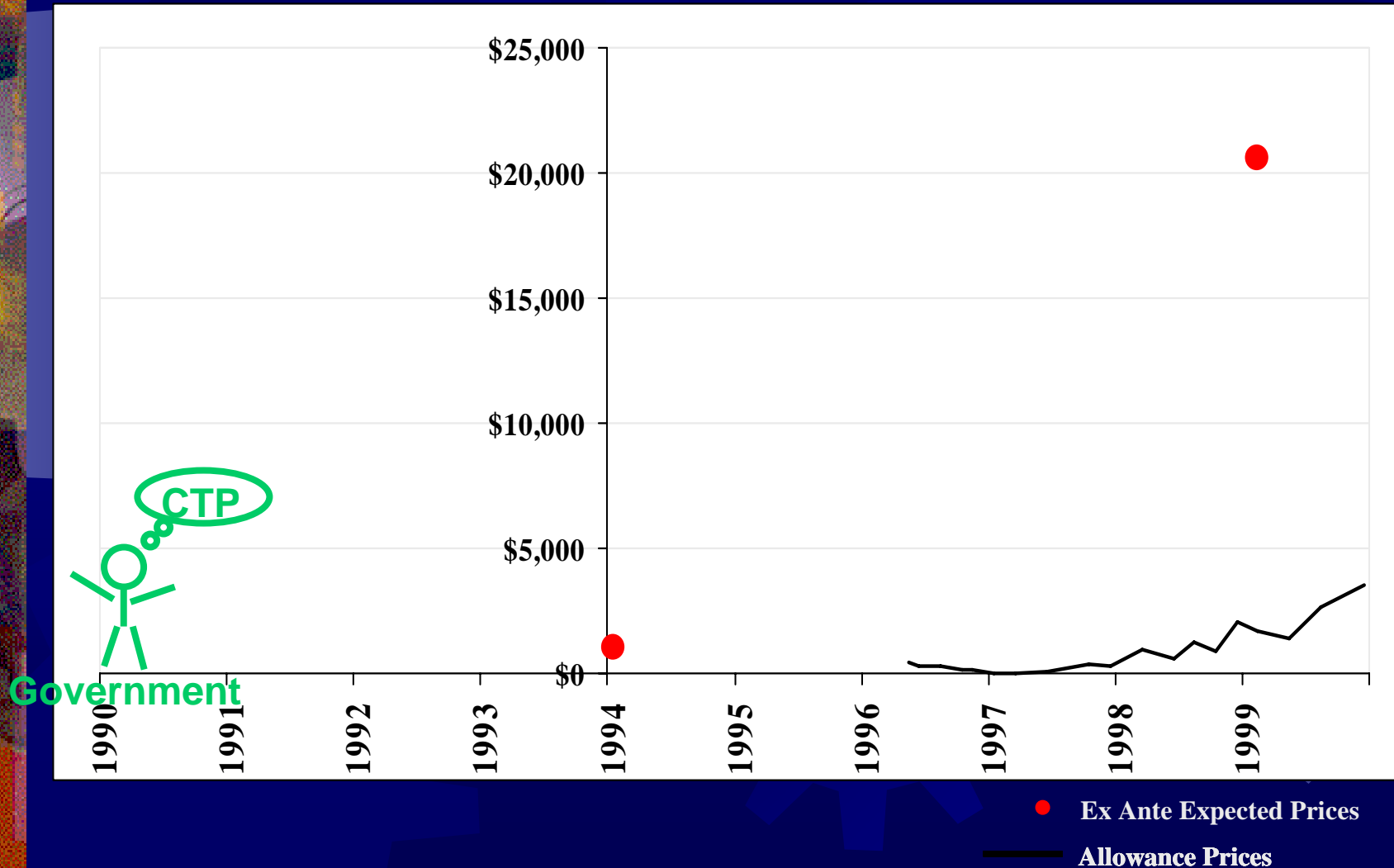
NO_x OTC-SIP Prices (\$/Ton)

- Lower than Expected



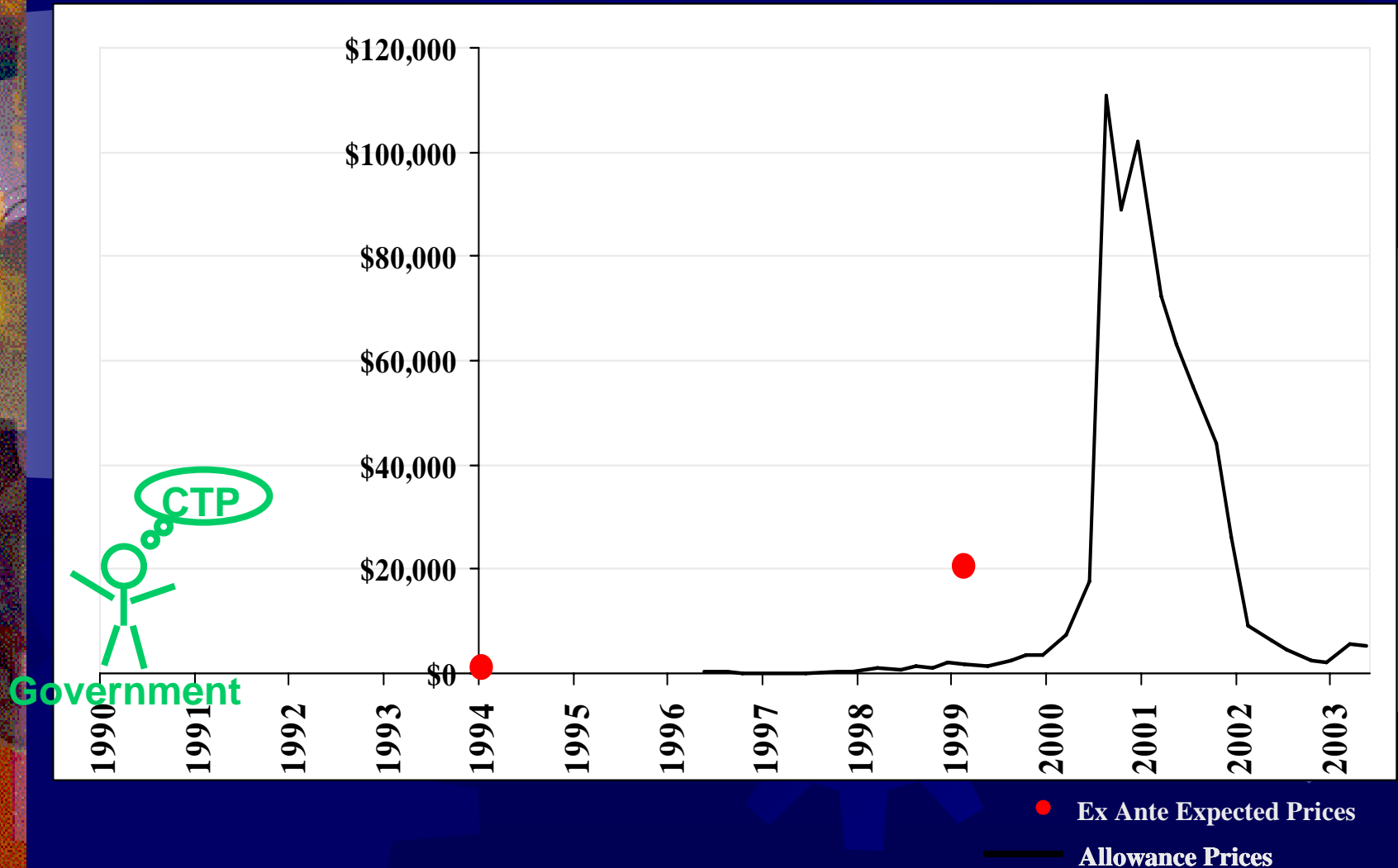
NO_x RECLAIM Prices (\$/Ton)

- Lower than Expected



NO_x RECLAIM Prices (\$/Ton)

- California Electricity Crisis Unexpected



Electricity System, from Coal to Homes



Change Tech



Buy Allowances

SO_2 – Coal
Cleaning



Scrubbers:

SO_2 – FGD

NO_x – SCR

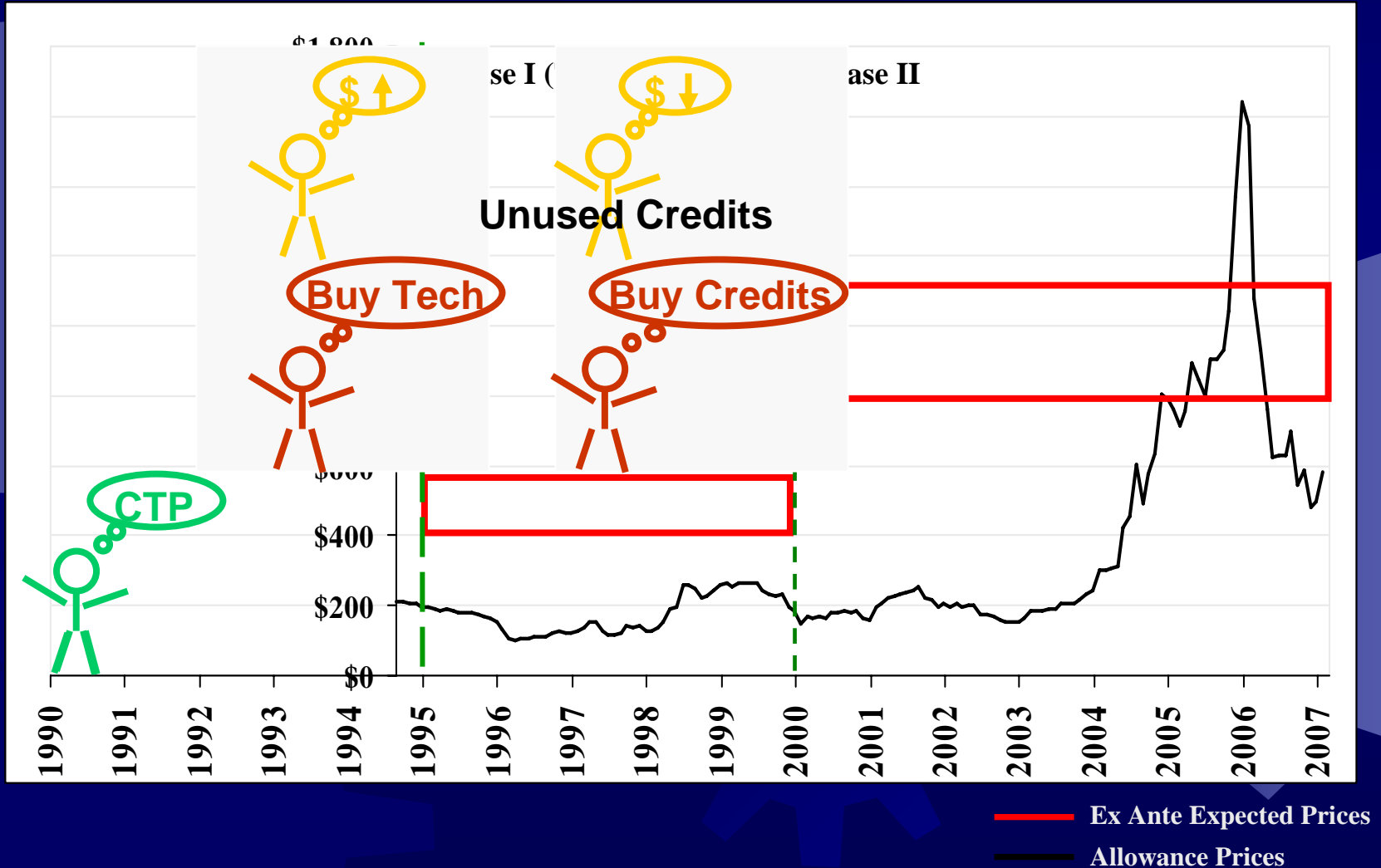
Combustion Modification

NO_x – LNB, OFA



How the Options did in the SO₂ Market

- Prices stayed lower than expected



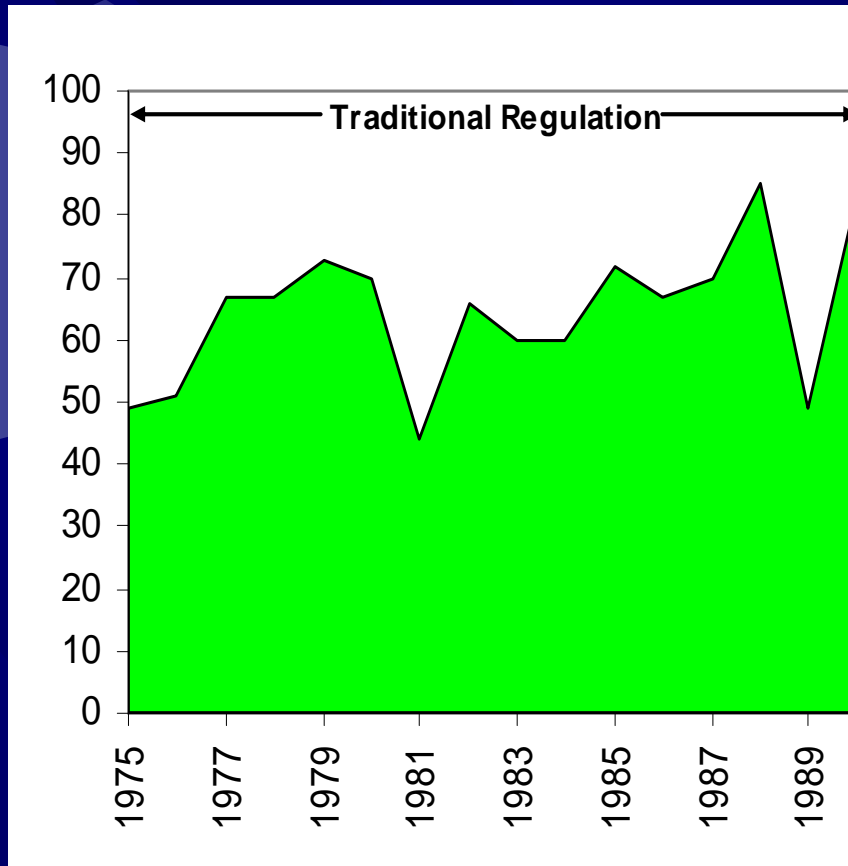
Clean Tech Market Expectations and Realities, across CTPs

- ✱ Less technology employed than expected in each CTP
 - ✱ Despite variations among techs re: cost, performance, market share
- ✱ In at least 2 of 3 CTPs, significant cancellations of tech. orders in progress

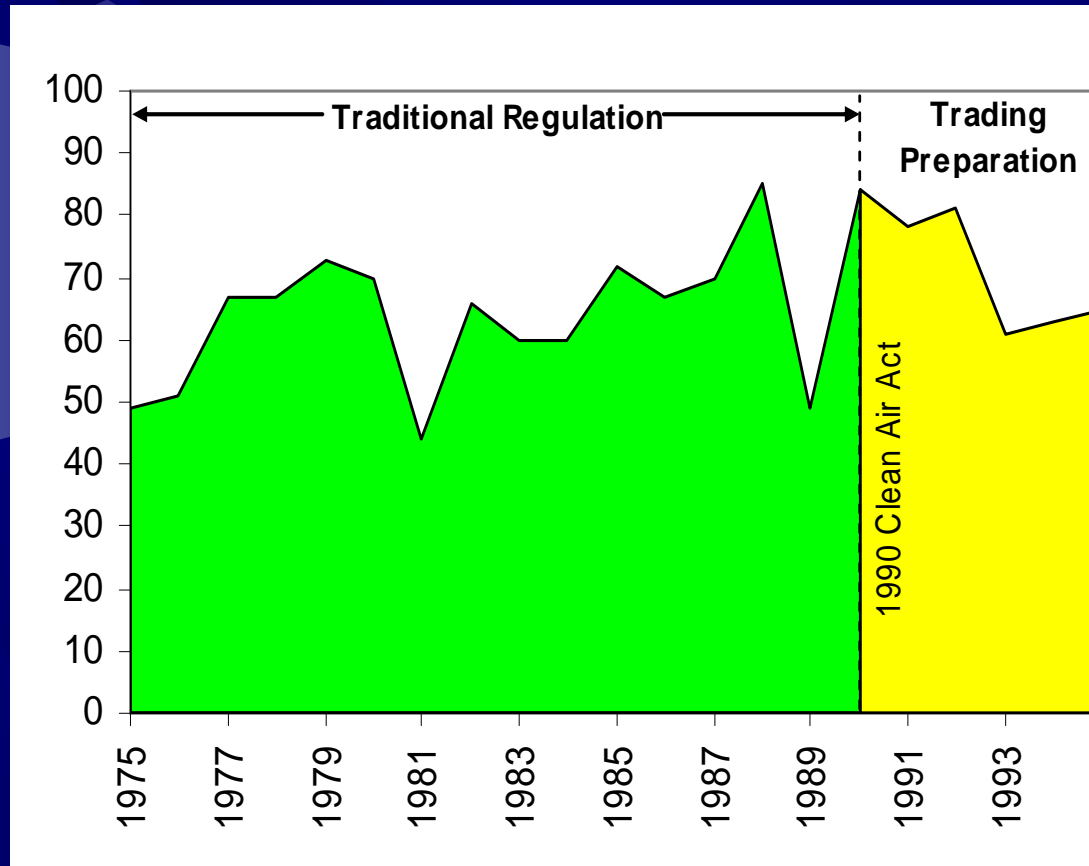
What about Clean Tech Invention?

- ✴ Used patents to gauge
 - ✴ The most widely used measure of invention with an eye to commercialization
- ✴ Considered a range of SO₂ and NO_x techs.
 - ✴ Used published, replicable patent searches
- ✴ Corrected for continuation, pendency issues
- ✴ Checked against potential reclassifications, USPTO trends, market data

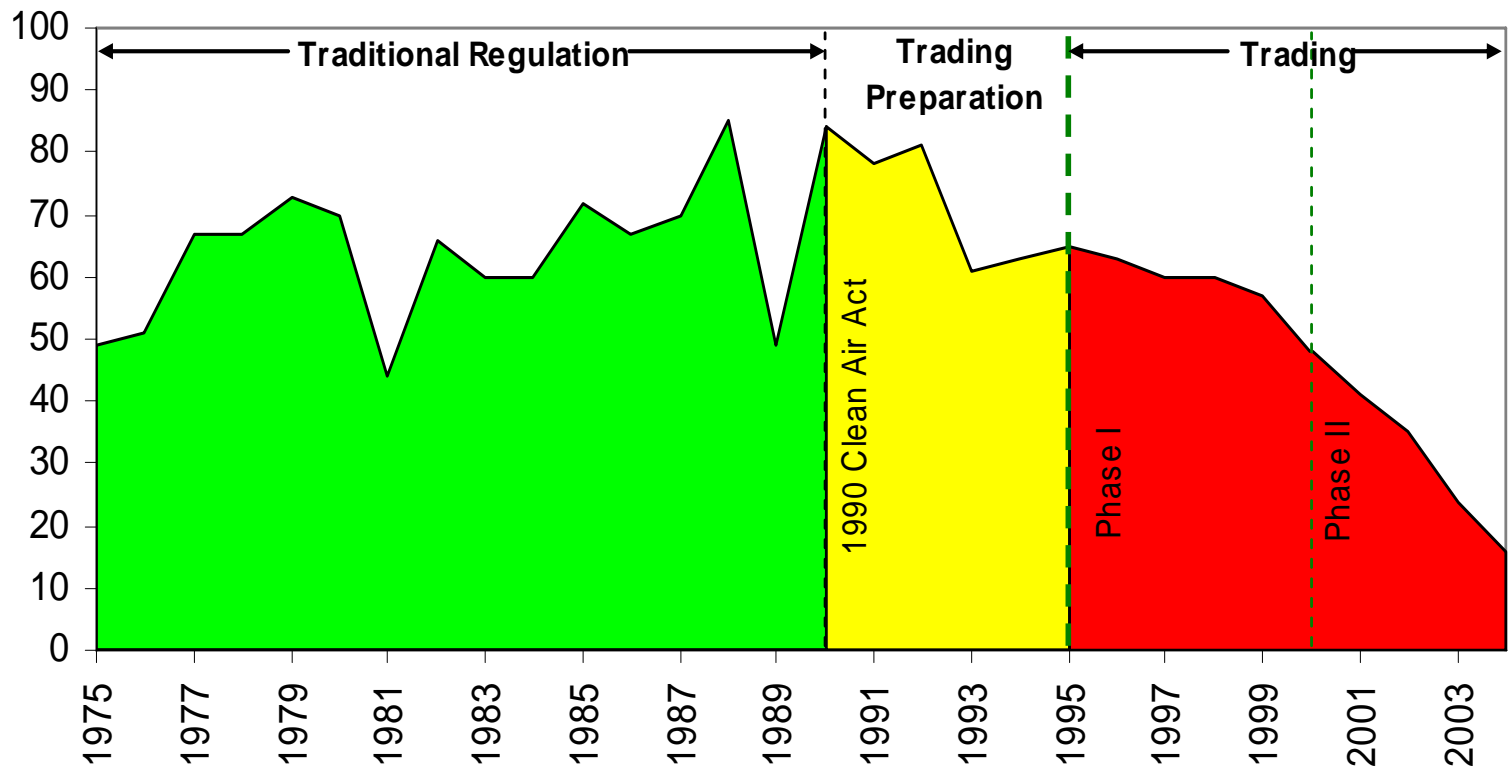
SO₂ Patenting Activity: Scrubber



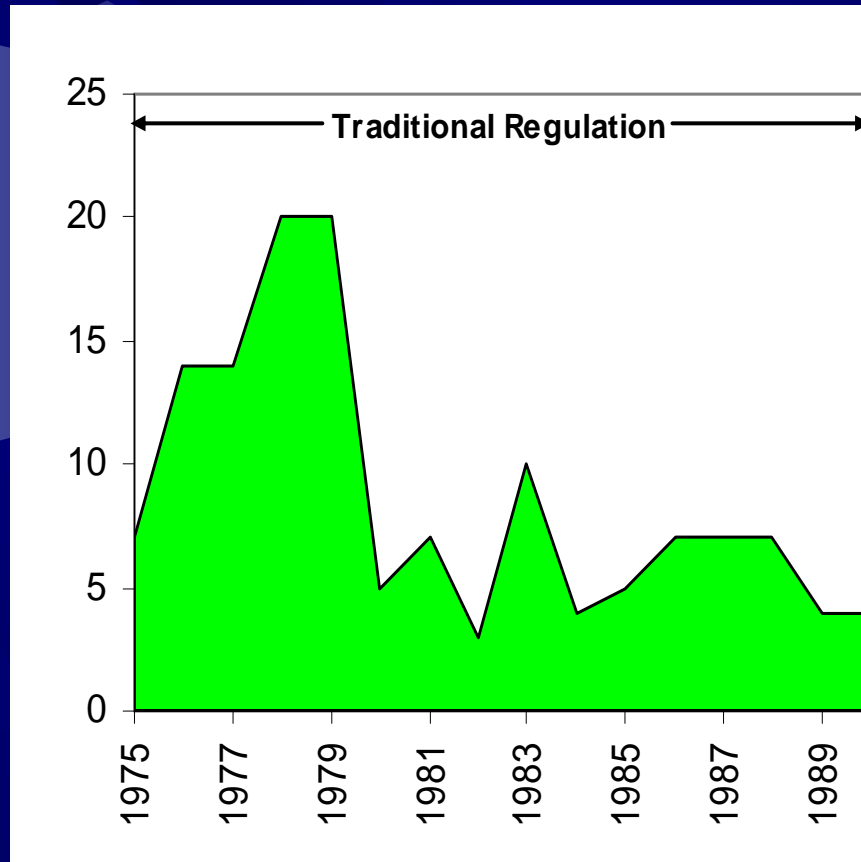
SO₂ Patenting Activity: Scrubber



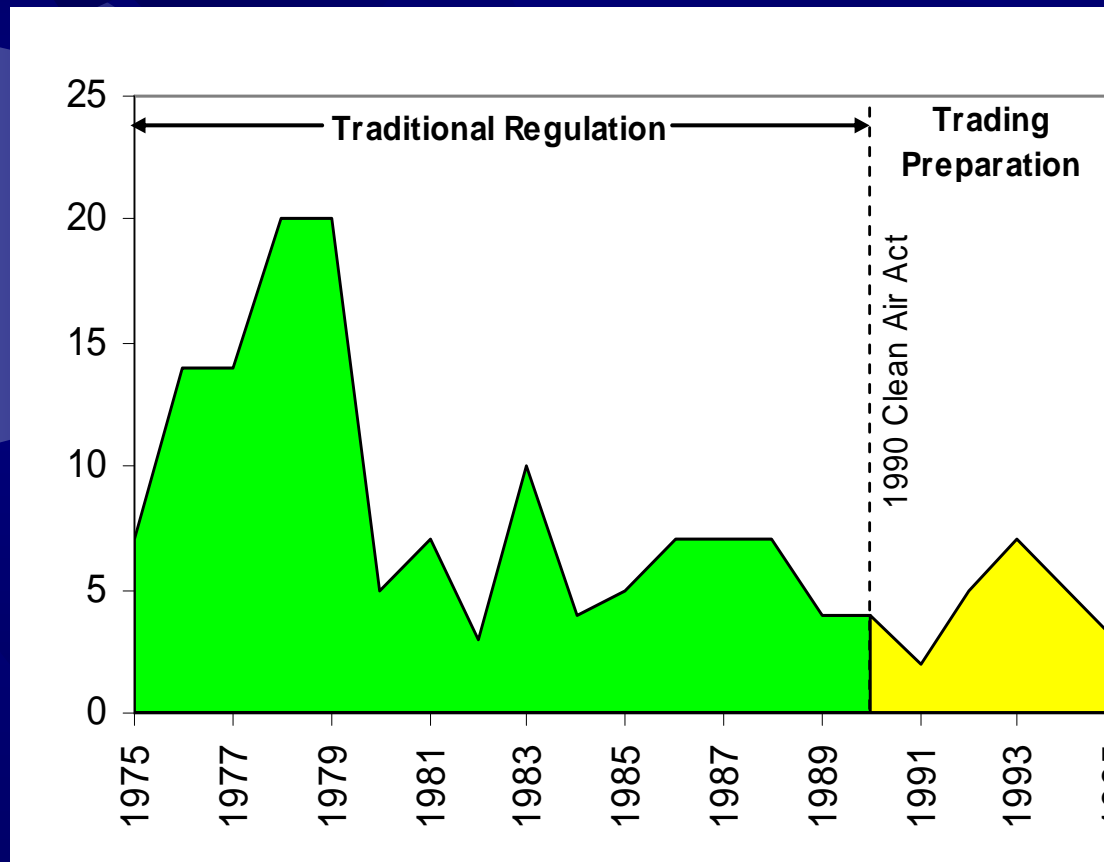
SO₂ Patenting Activity: Scrubber



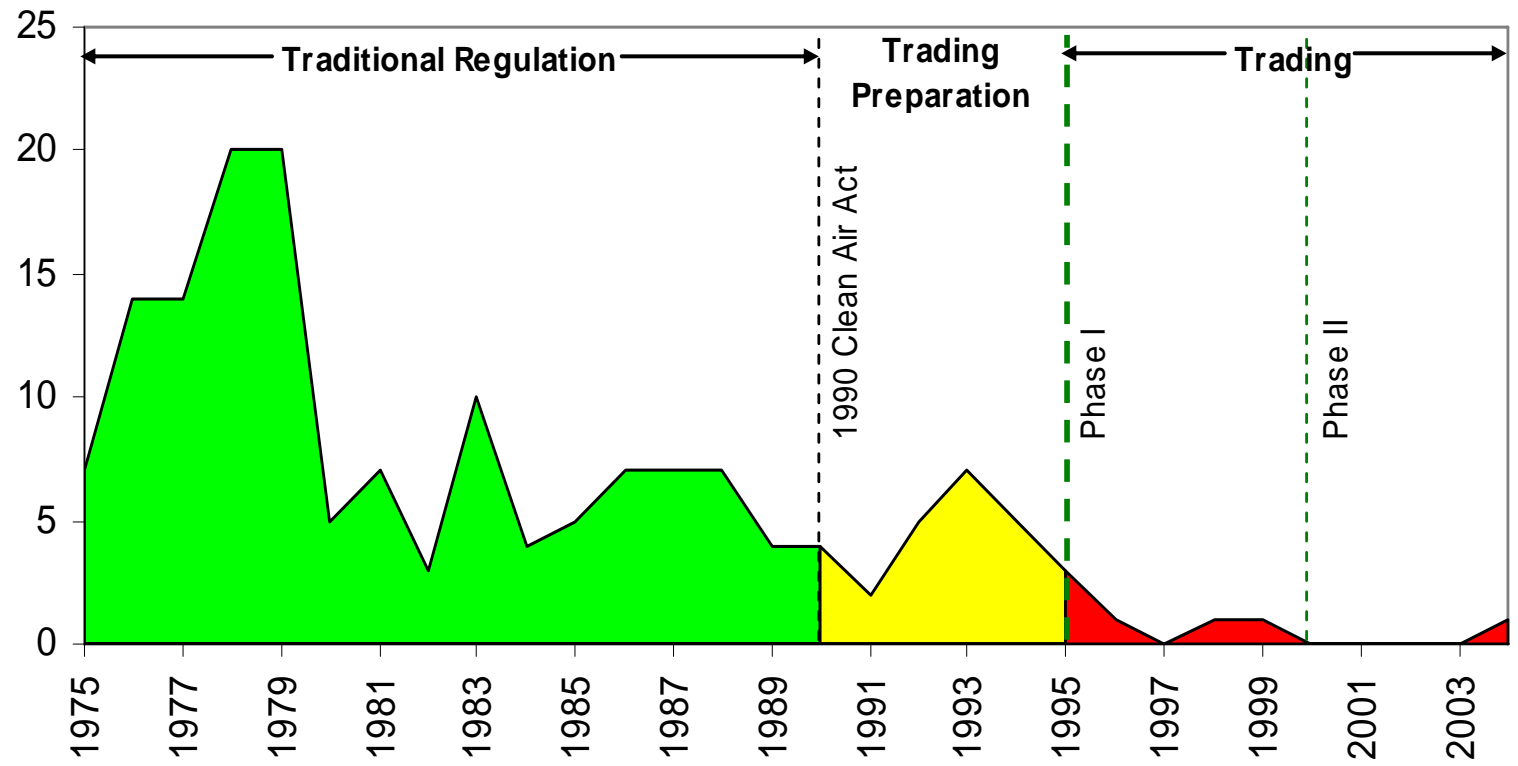
SO₂ Patenting Activity: Coal Cleaning



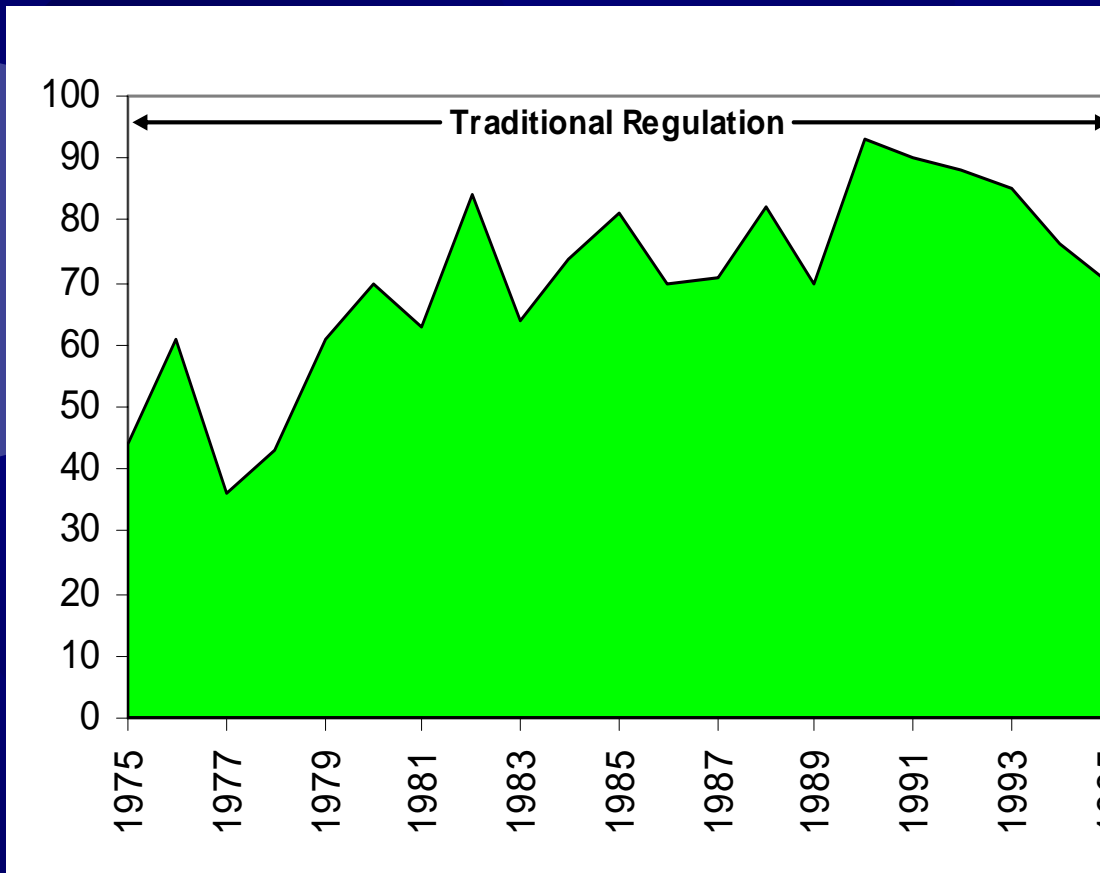
SO₂ Patenting Activity: Coal Cleaning



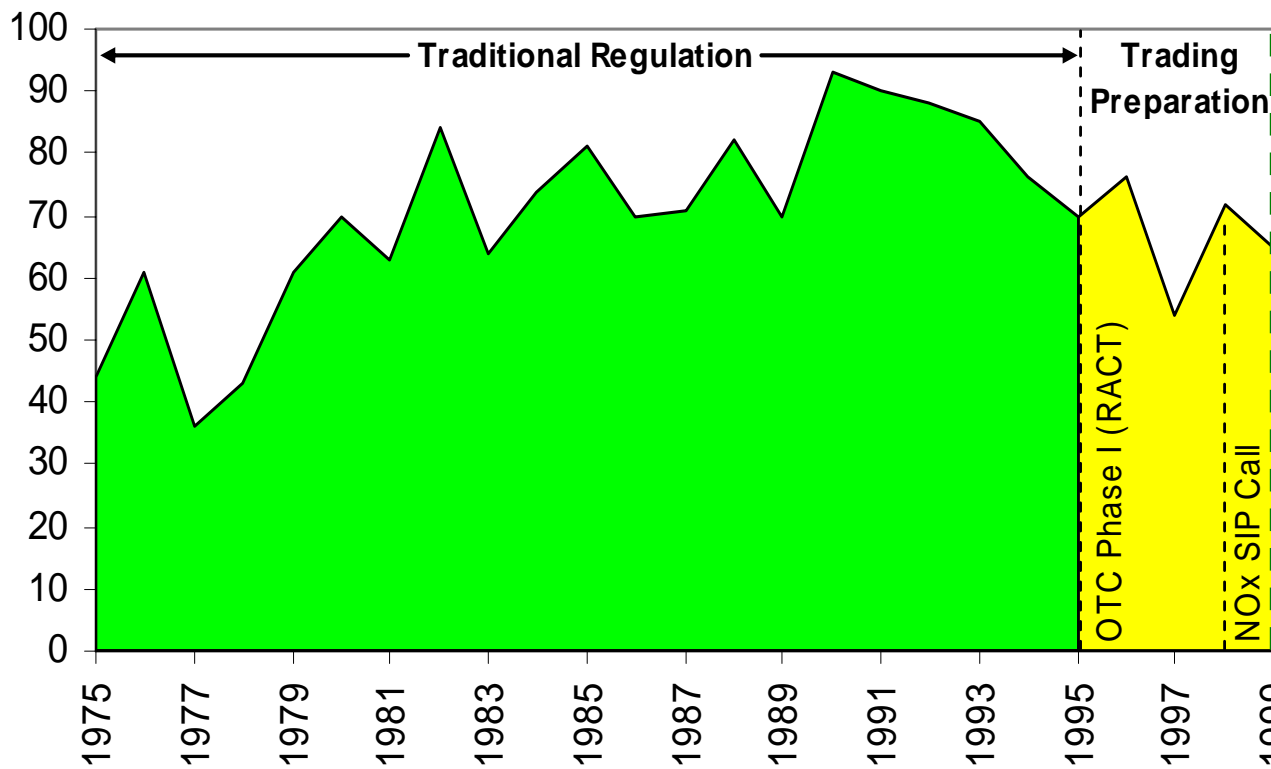
SO₂ Patenting Activity: Coal Cleaning



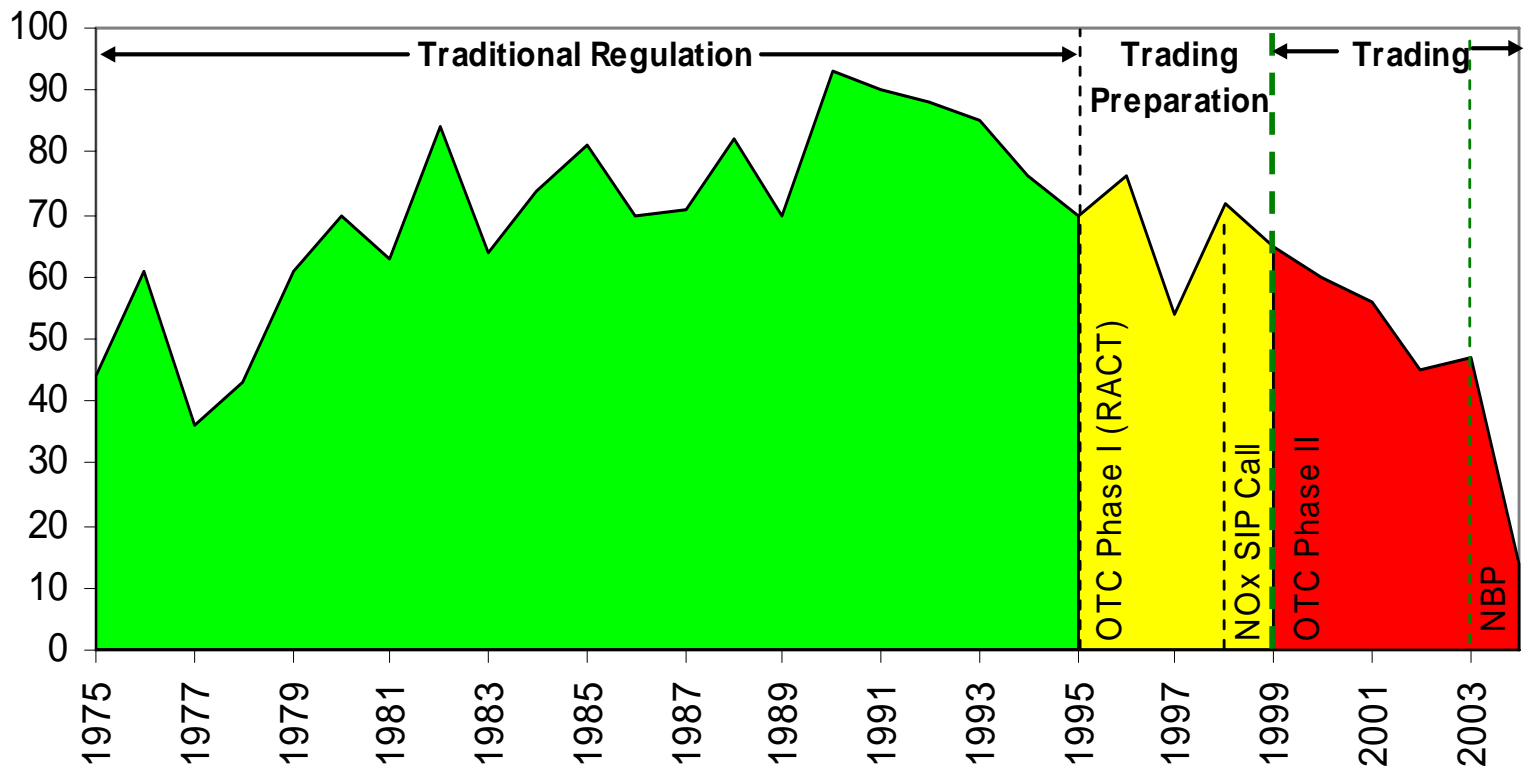
NO_x Patenting Activity: Scrubber



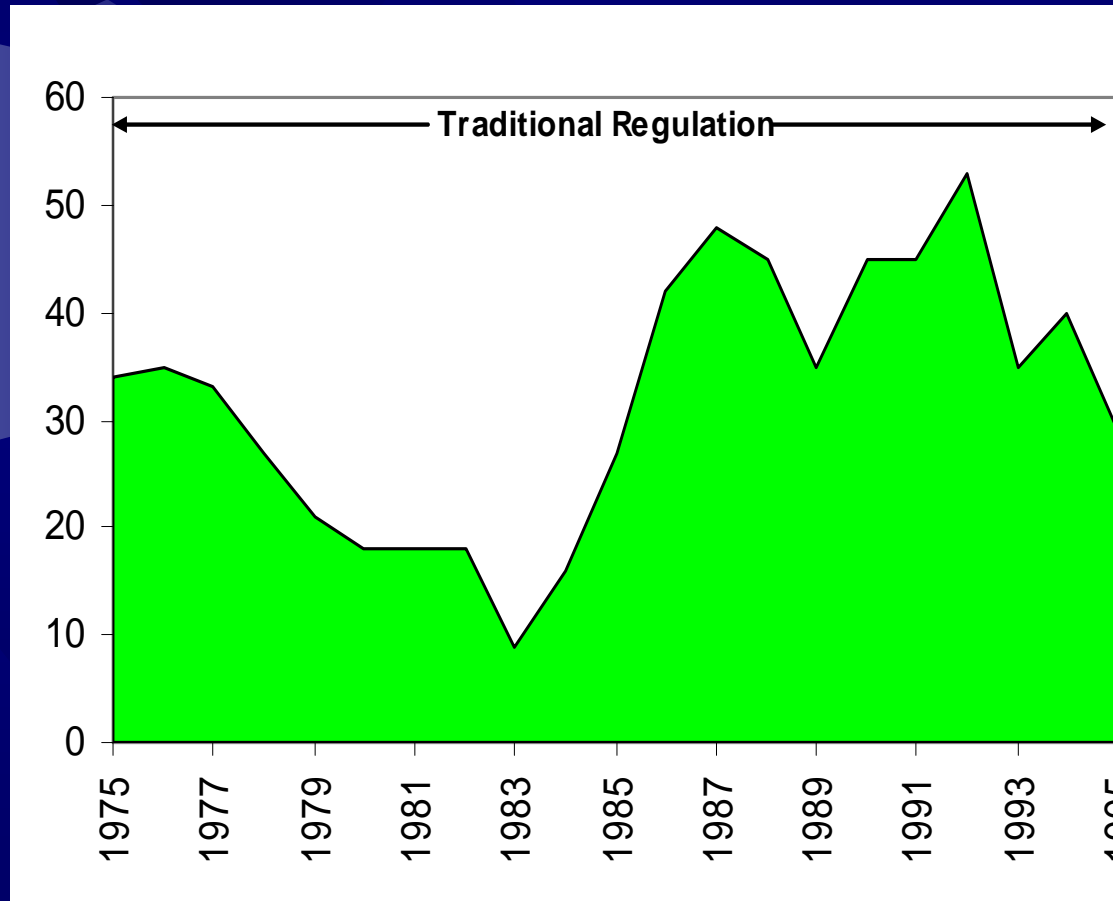
NO_x Patenting Activity: Scrubber



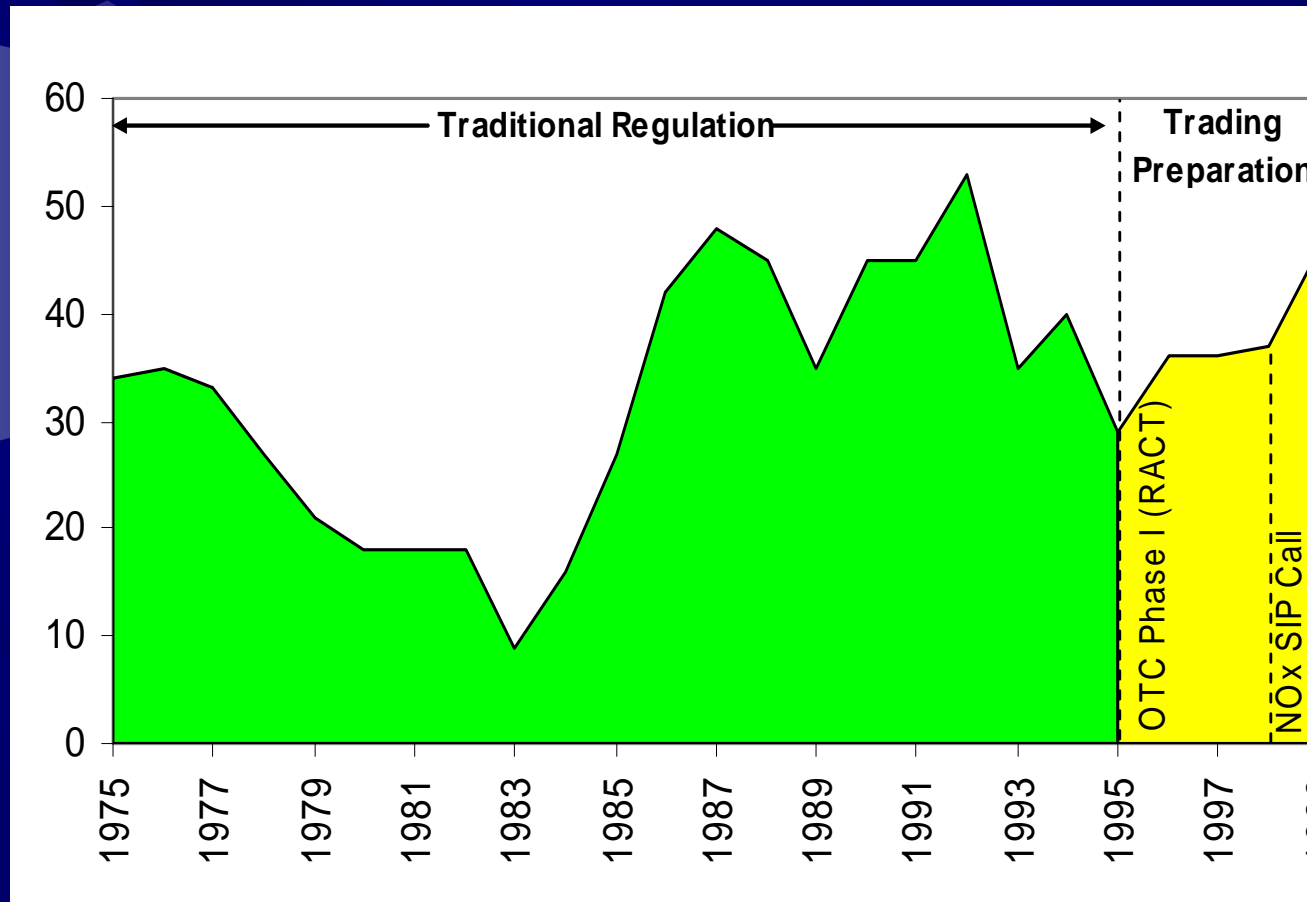
NO_x Patenting Activity: Scrubber



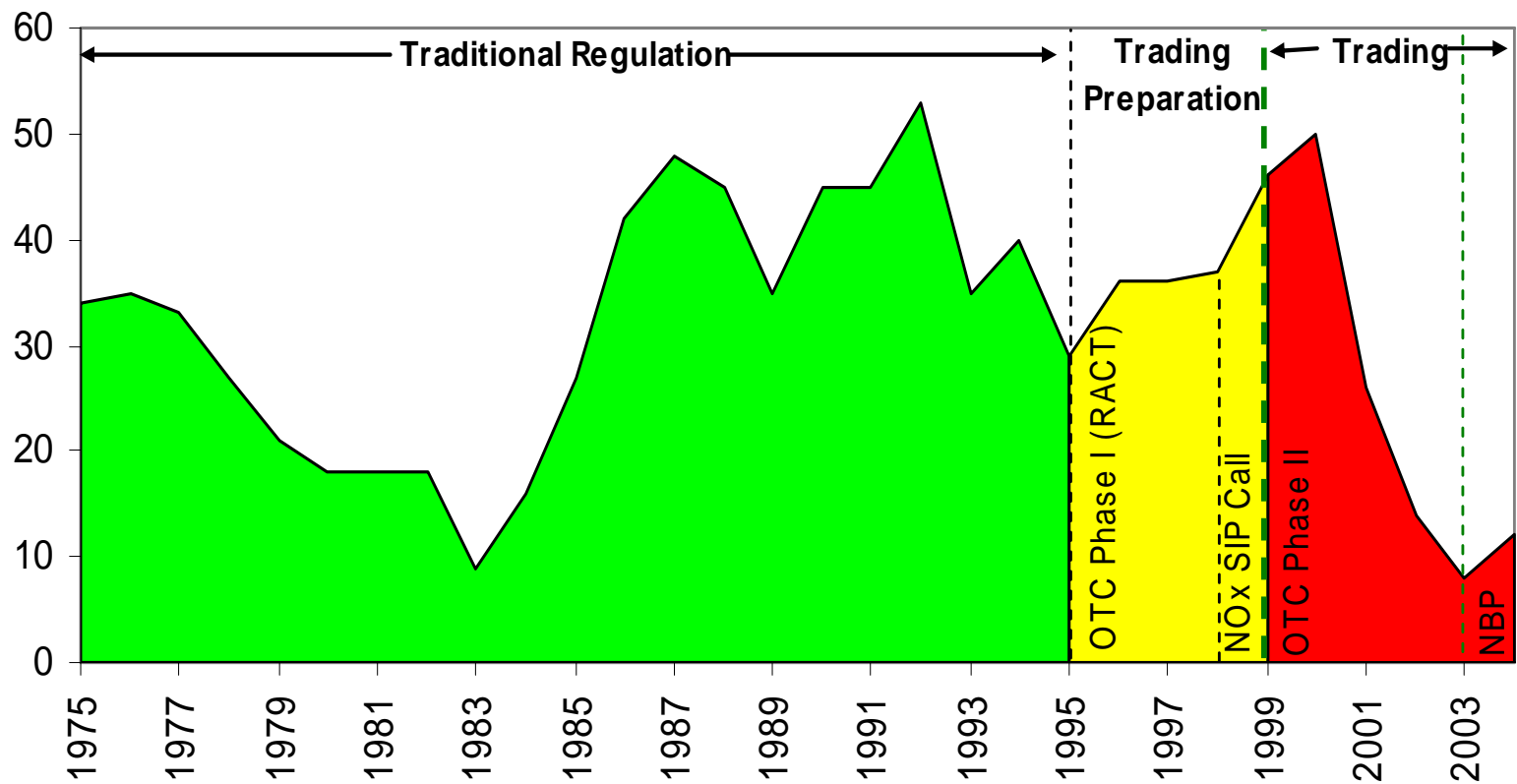
NO_x Patenting Activity: Combustion Modification



NO_x Patenting Activity: Combustion Modification



NO_x Patenting Activity: Combustion Modification



Climate policy implications



Will it Happen in Climate CTPs?

Only one operating so far: EU Emissions Trading Scheme

☀ Prices (€/Ton) lower than Expected



Electricity System, from Coal to Homes



Change Tech



\$ Buy Allowances

Generation Switching

Scrubber:

CO₂ – CCS

Efficiency Improvements

Distributed Generation

Energy Efficiency

Why worry?

- ✱ Probably not bad for cheap, existing options
- ✱ But what about relatively expensive, potentially highly effective technologies that still need long lead times?
 - ✱ If we're certain that allowance prices reflect true balancing of societal benefits and costs, then invention results not a worry
 - ✱ But what if we're not certain about the caps?



Could Play with Quantities

1. Start with a strict cap and initial allowance auction (use revenues for R&D)
2. Set regular intervals (5 years?) to modify the cap, but don't set exact levels when law is initially passed
 1. Allows you to adjust to climate science, technologies
 2. (Could revalue some of the banked allowances for similar effect)
3. Charge an independent board with the modifications

Preserves the advantages of a CTP while sustaining the market expectations of technology suppliers



Could Play with Prices



Safety Valve



Isn't this a carbon tax w/brokerage fees?



Symmetric Safety Valve





Could Play with Other Policies

★ Public R&D funding?

- Risky to count on sustaining high levels over time (politics, budget exigencies)
- Involves government picking winners

★ Public subsidy programs?

- Similar risks

★ Standards?

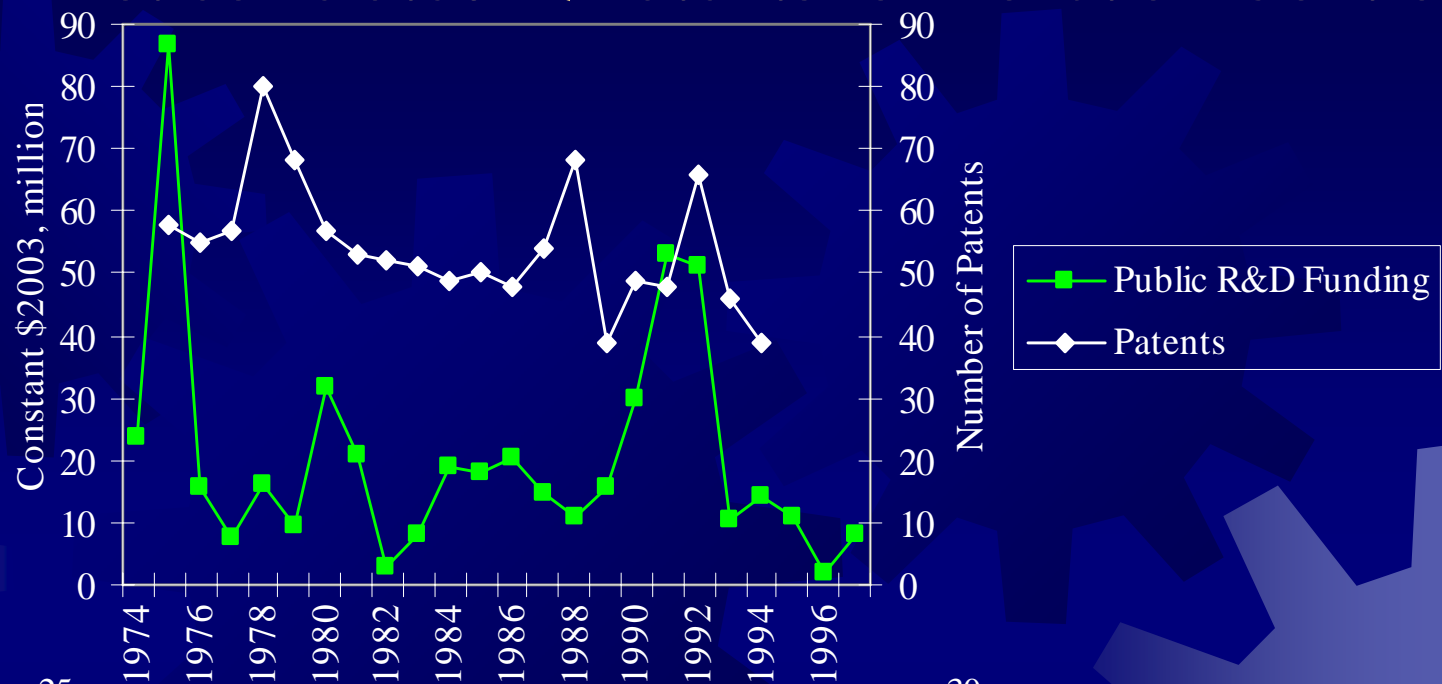
- Not as risky re: lapsing
- Not as much of a “pick winners” problem.
- Arguably better for inventor market expectations:
 - Standards usually get stricter



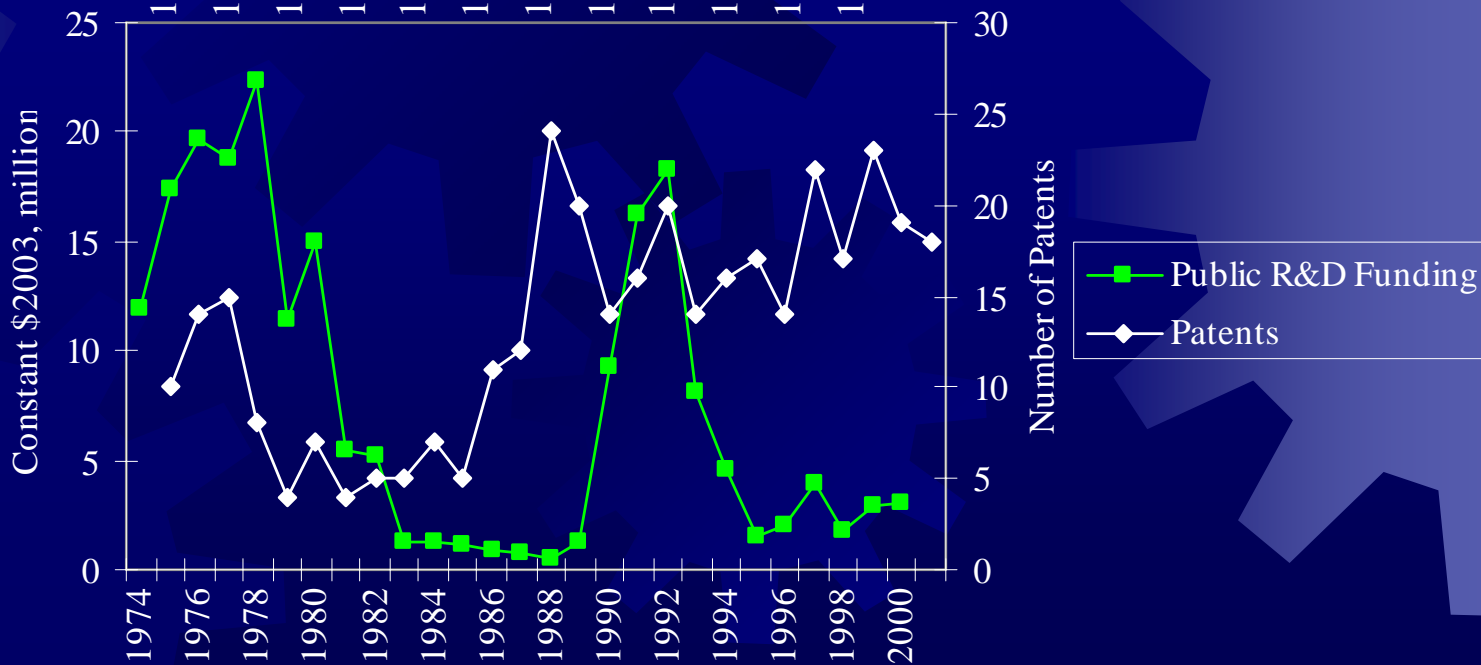
Thanks!

Public R&D not correlated w/Patents for Pollution Control

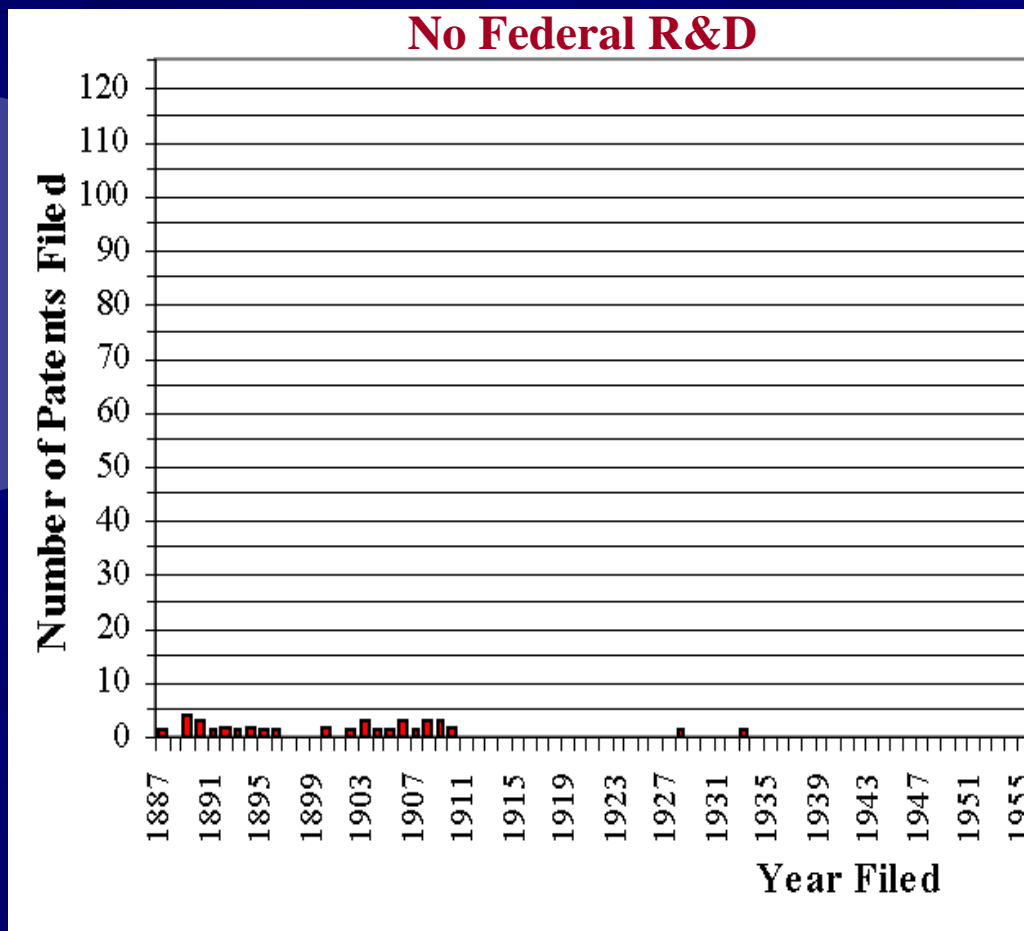
FGD
(SO₂)



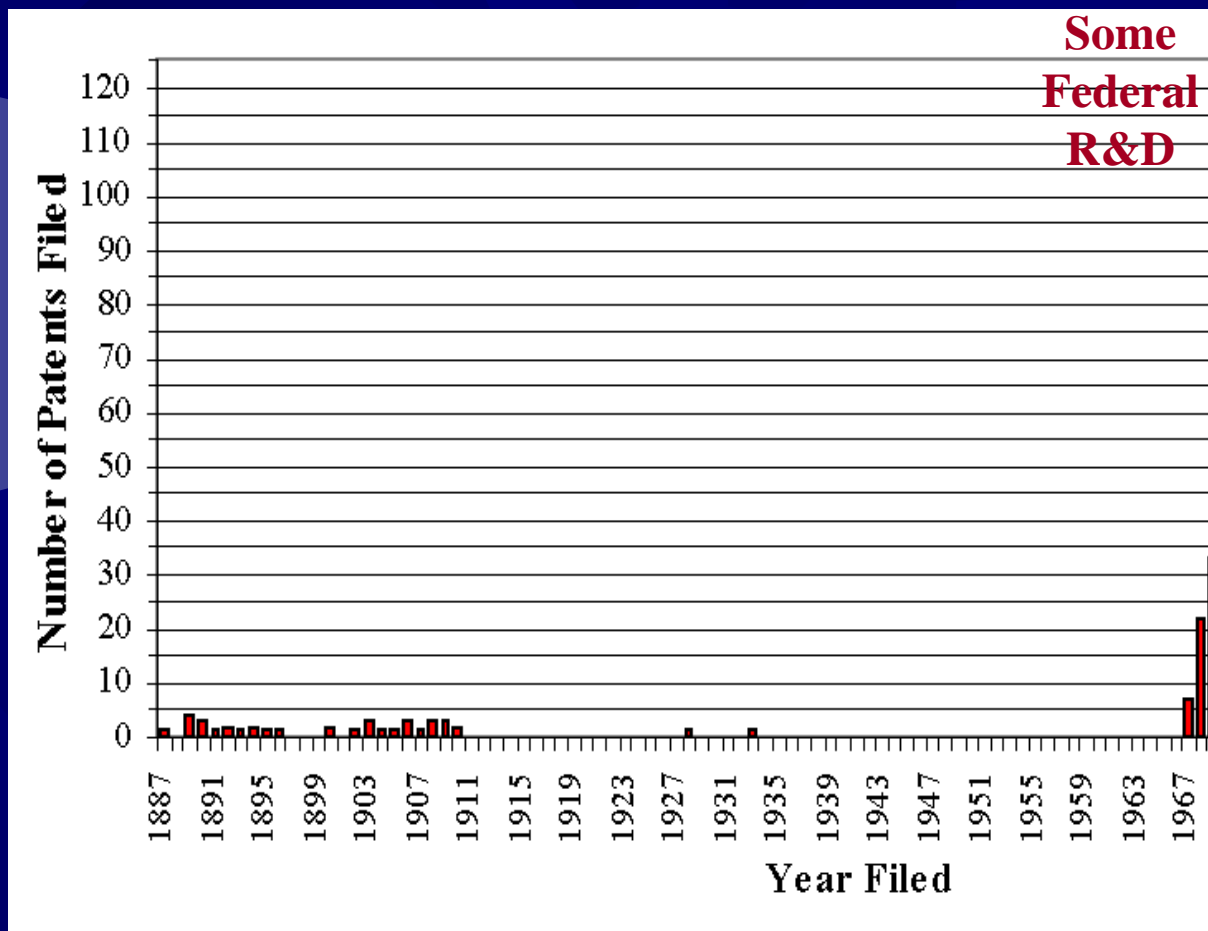
SCR
(NO_x)



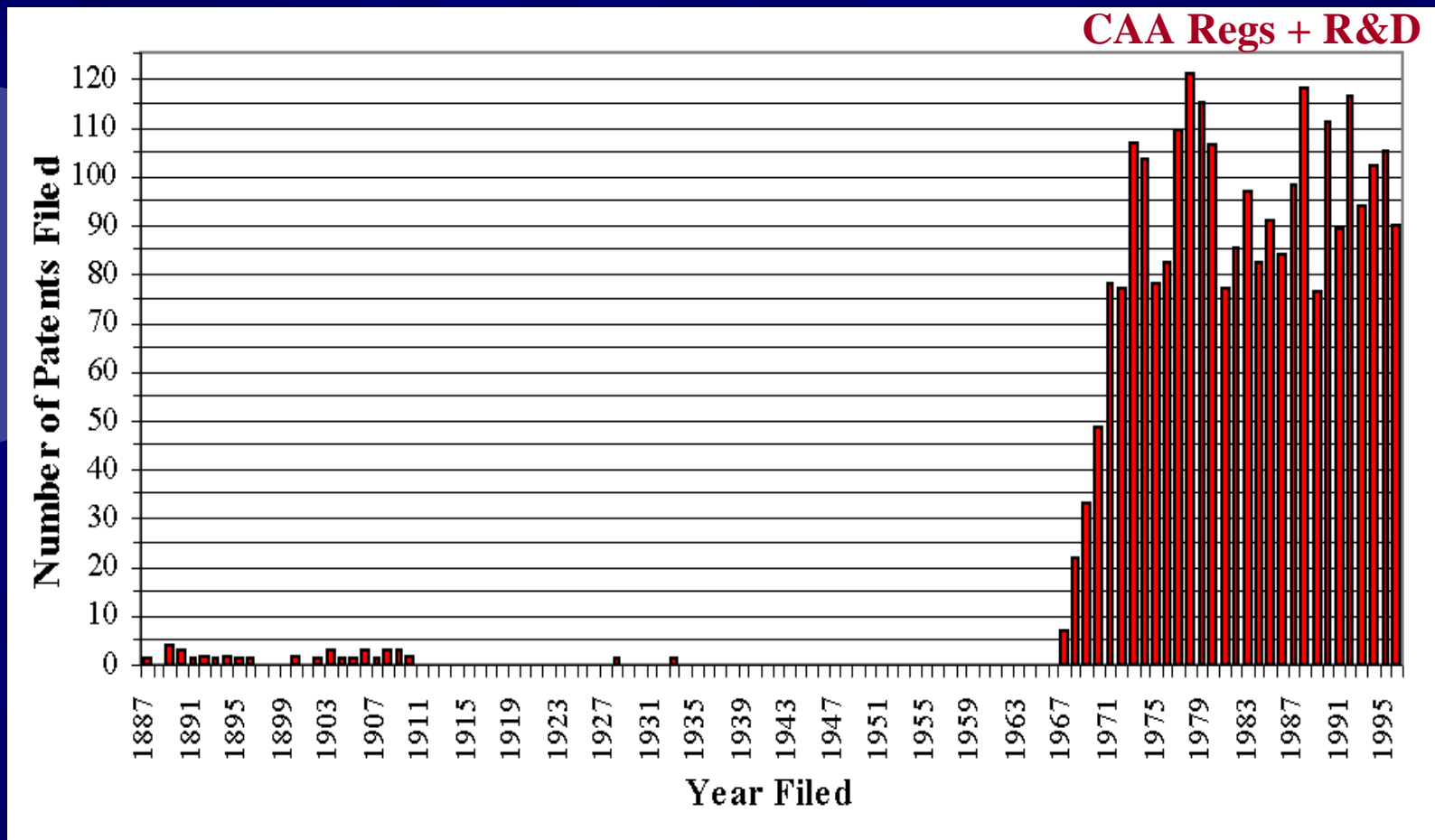
Public R&D better with Policy Creating Commercial Market



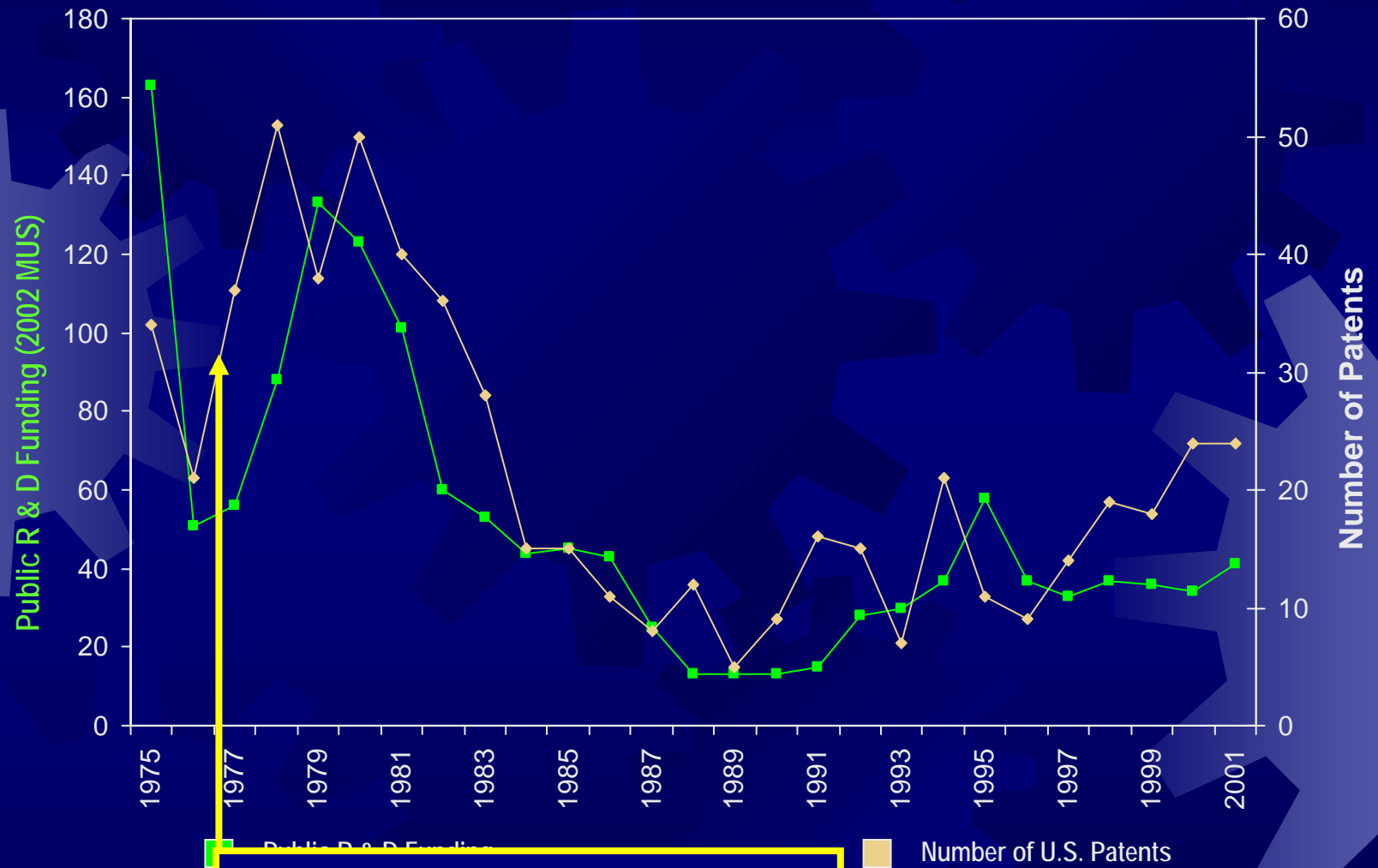
Public R&D better with Policy Creating Commercial Market



Public R&D better with Policy Creating Commercial Market



Public R&D Looks better with Alternative Generation, Except There's a Chicken-and-Egg Issue



Patents come first

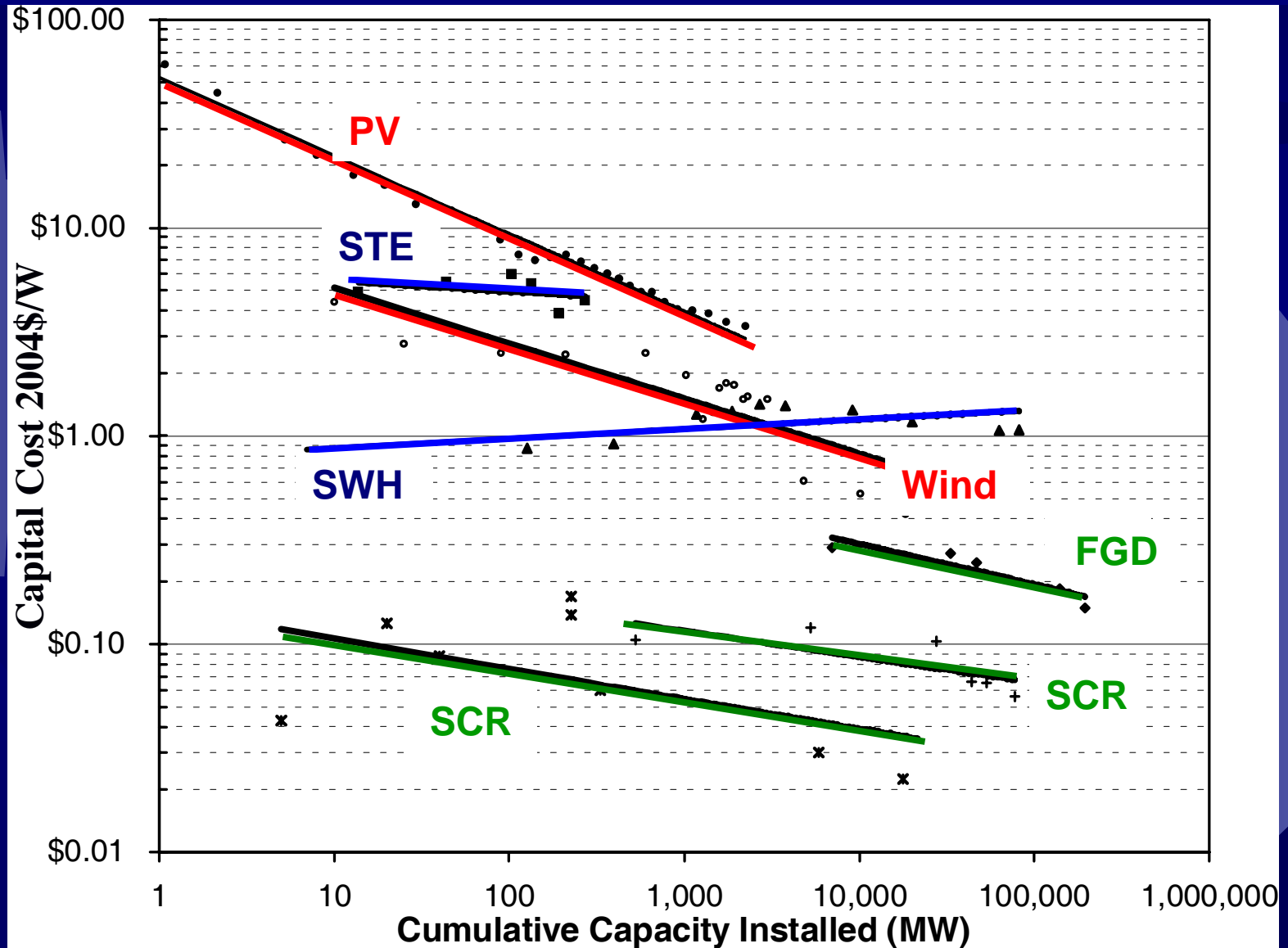
Subsidies run out at the same time that public R&D drops!



Advantages of standards...

- ✱ Expected to stay around or get stricter
- ✱ More certain than other policies
- ✱ Can be technologically neutral

Usually experience has positive innovative outcomes... but good to have courage



The searchers: Do not have the same roles or incentives

Private Sector

Public Sector

★ Suppliers

- ★ Invent and sell technologies
- ★ Compete w/alt. techs (& price of CTP credits)



★ Emissions sources

- ★ Adopt technologies (or buy credits)



★ Government

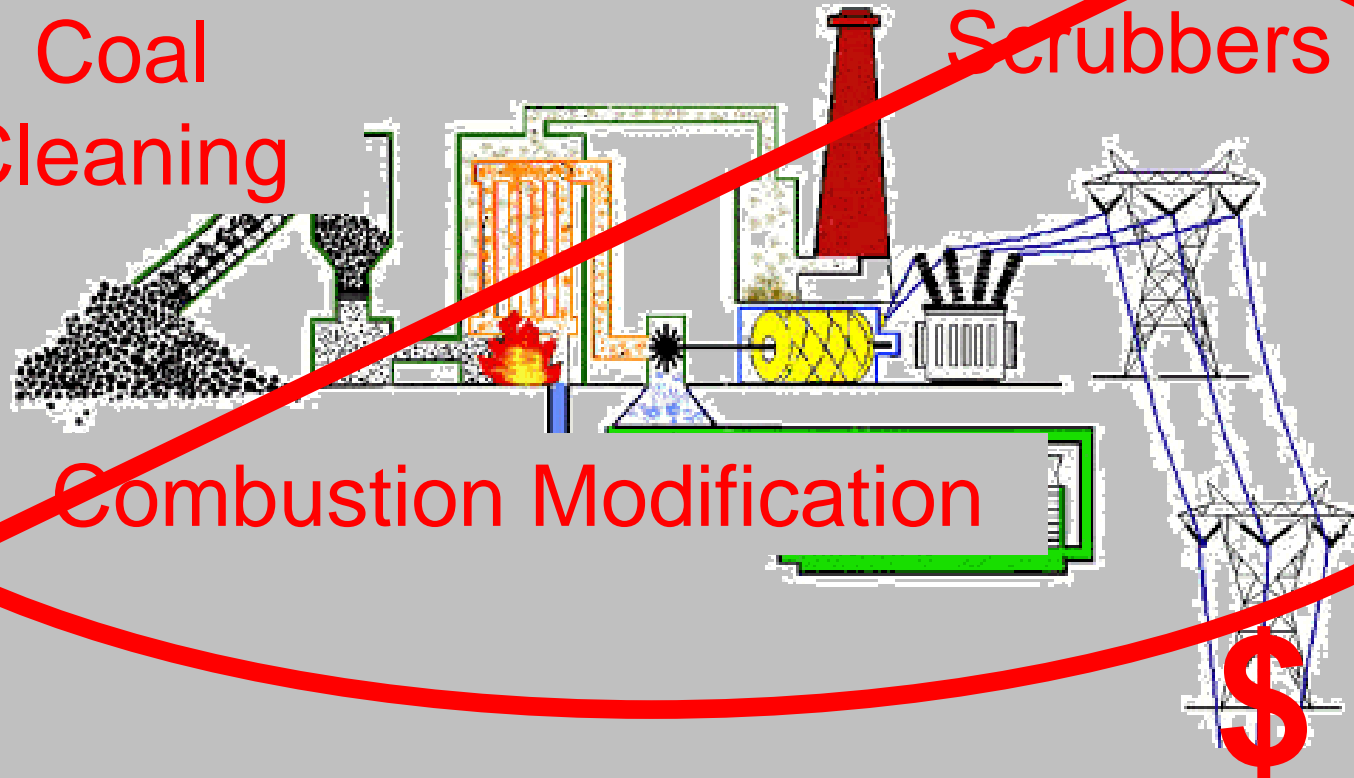
- ★ Passes laws, implements/enforces policies, conducts/does out R&D \$, etc.



About the Technologies

Coal
Cleaning

Scrubbers



Combustion Modification

\$

Buy Allowances





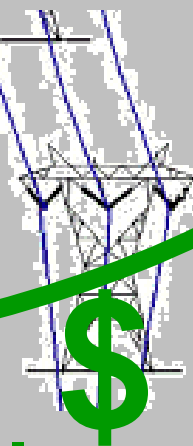
Options in a Traditional Pollutant CTP

**SO₂ – Coal
Cleaning**



**Scrubbers:
SO₂ – FGD
NO_x – SCR**

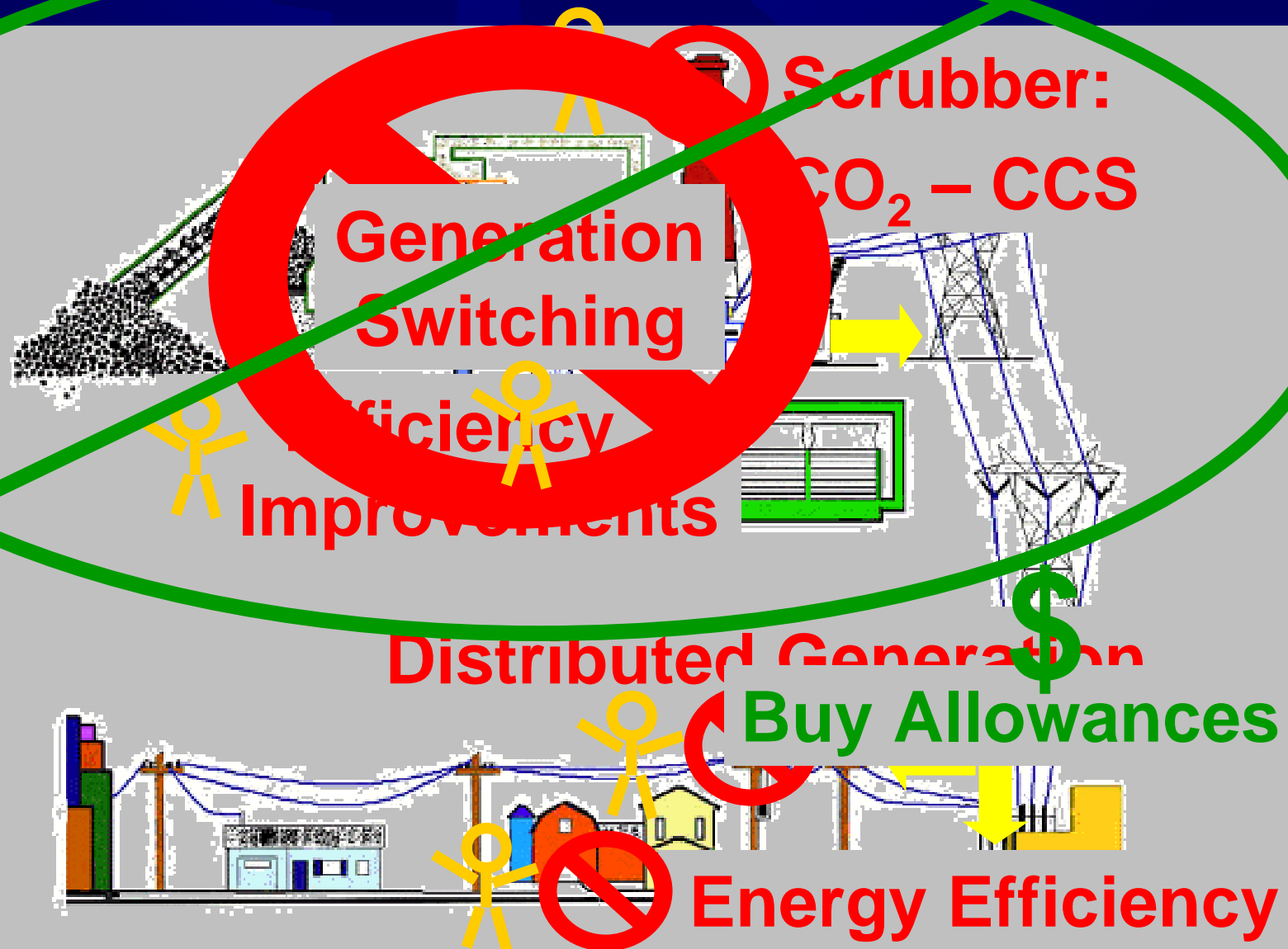
**Combustion Modification
NO_x – LNB, OFA**



Buy Allowances



Options in a Climate CTP



Options in a Climate CTP

