

# Comments on “A Research Program for Promising Retrofit Technologies”

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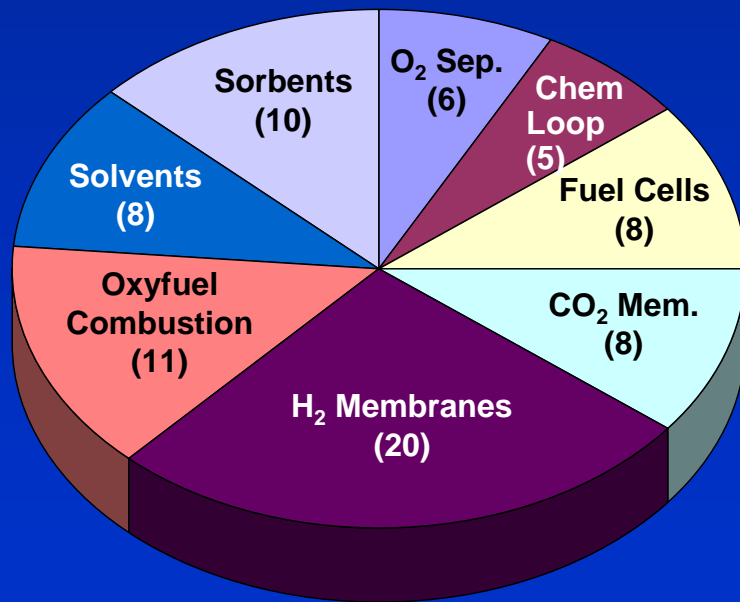
For discussion at the

MIT Symposium on Retro-Fitting of Coal-Fired Power Plants  
for CO<sub>2</sub> Emission Reductions  
Cambridge, Massachusetts  
March 23, 2009

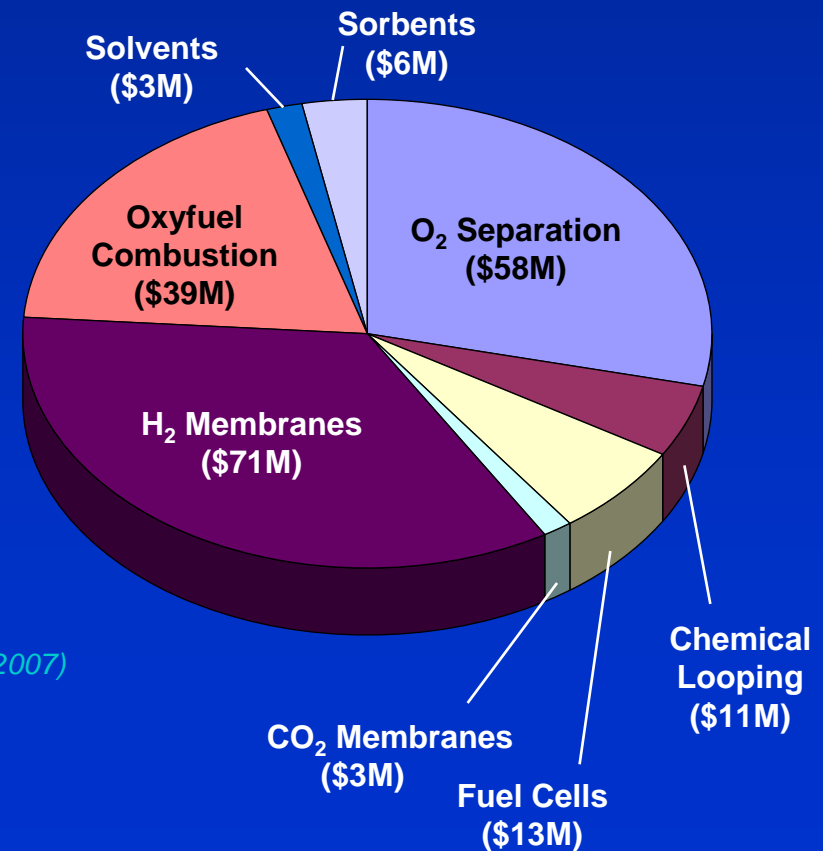
# USDOE Carbon Capture R&D

(76 projects in early 2007)

8 technology areas



\$205M over 3.3 yrs, avg



(Source: NETL, 2007)

*Back in the 1980's*

# What's Hot ...

In-Duct Injection

Limestone Injection  
Multi-Stage Burners (LIMB)

Copper Oxide Process

IGCC

NOXSO Process

LIDS

SOX-NOX-ROX-BOX

PFBC

Regenerative  
FGD Systems

Chemical Coal Cleaning

Electron Beam Process

Dry Scrubbing

Slagging Combustors

...and

# What's Not

*A utility company view of post-combustion SO<sub>2</sub> capture systems*

E.S. Rubin, Carnegie Mellon



## Scrubbers described, examined and rejected.

The Environmental Protection Agency recommends that electric utilities install "stack gas scrubbers" to control sulfur-oxide emissions and meet the standards that have been set.

### WHAT IS A "STACK GAS SCRUBBER"?

There are many "stack gas scrubber" systems. All have been tested. Some—the most promising—more than others.

Simply stated, the scrubber is designed to eliminate most of the sulfur-oxide emissions by creating, in a chamber, a violent rainstorm of water laced with huge quantities of a chemical, limestone or lime for instance.

### WHAT DOES CAREFUL EXAMINATION REVEAL?

Problems. Horrendous problems. Scrubber systems do remove sulfur-oxides. But in the process all of them are plagued with one or more problems that make them unreliable and impractical for a major electric utility.

Many scrubber systems produce a by-product that clogs the operation or erodes or corrodes the mechanism. Faults that cause shut downs. An impossible situation for an electric utility that must have a reliable power supply operation that will work all day, every day.

If the system doesn't clog and shut down it creates massive amounts of sludge. Some—like the most popular and most studied system, the wet lime or limestone scrubber—do both.

To understand the vastness of the amount of ground-polluting sludge produced, consider this: If limestone scrubbers were applied to a 12,000 megawatt coal-fired system they would in only five years produce enough of this "oozy gook" to destroy and cover 10 square miles of America to a depth of 5 feet. How's that for a system that's supposed to solve pollution problems?

If it doesn't have either of these major faults chances are it will have some of

several less dramatic problems. And chances are it hasn't been tested at a coal-burning plant.

### WHAT MAKES AMERICAN ELECTRIC POWER REJECT SCRUBBERS?

The problems revealed. The score card on scrubber tests. Time and time again proven too unreliable, too impractical for electric utility use.

But a greater overriding reason is the sincere belief that there are better ways to solve the sulfur-oxide emission problem.

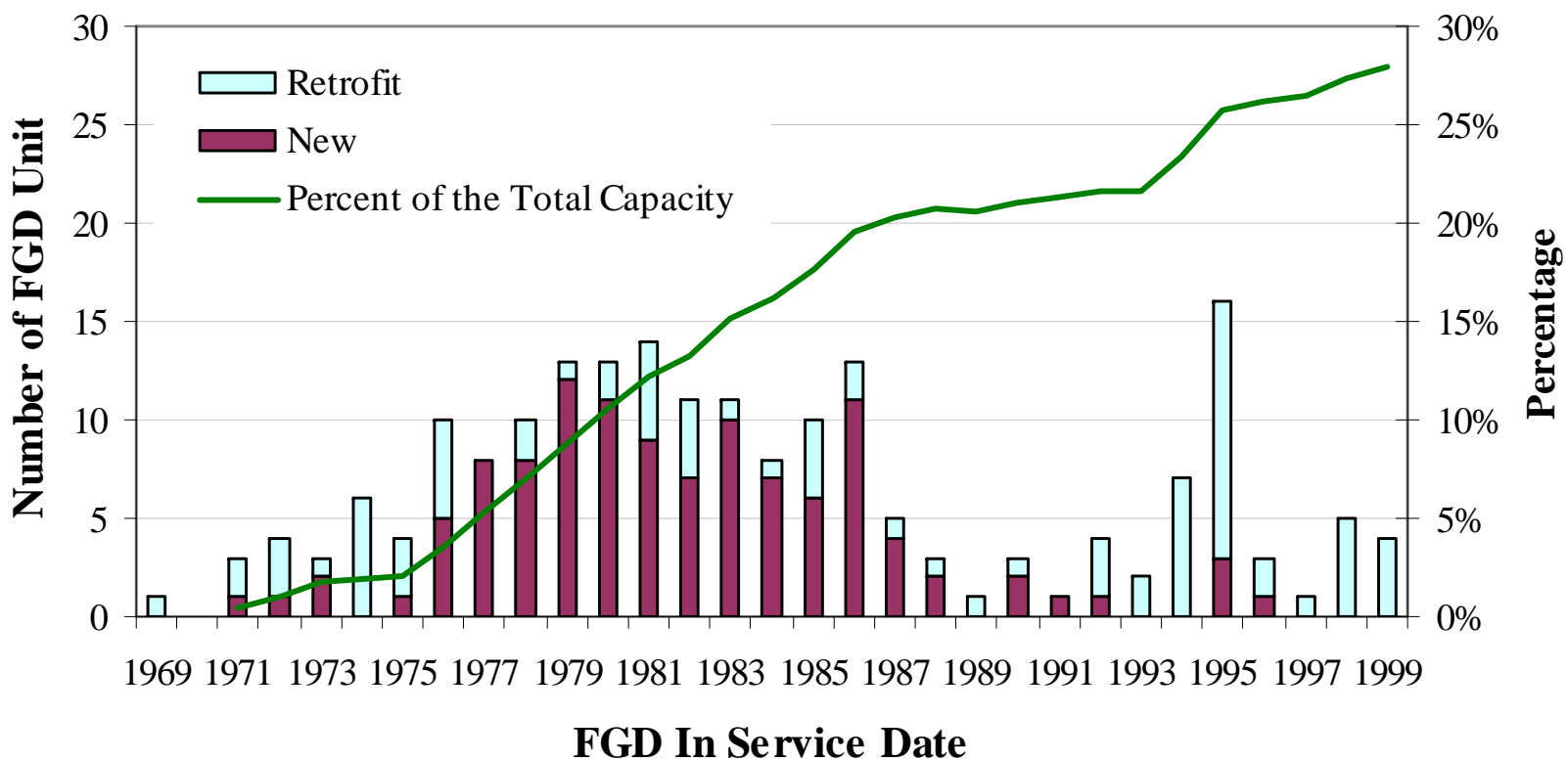
One way is to release the enormous reserves of U.S. Government-owned low sulfur coal in the West. And at the same time continue the investment of time, energy and money in the development of the technology to clean high-sulfur coal before it is burned.

Such a positive program, we think, is in the best interest of the people we serve and the country we live in.

### American Electric Power System

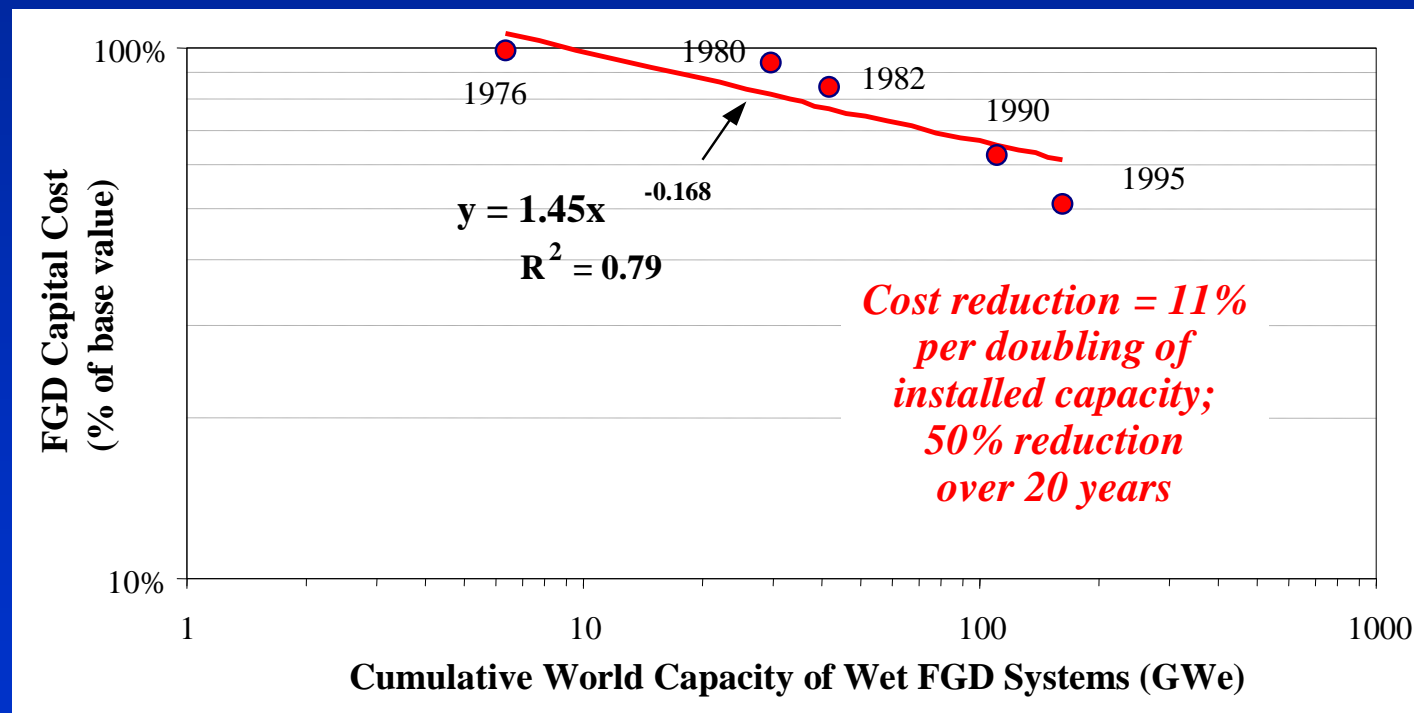
Appalachian Power Co., Indiana & Michigan Electric Co., Kentucky Power Co., Kingston Power Co., Michigan Power Co., Ohio Power Co., Western Electric Co.

# Growth in U.S. FGD Capacity



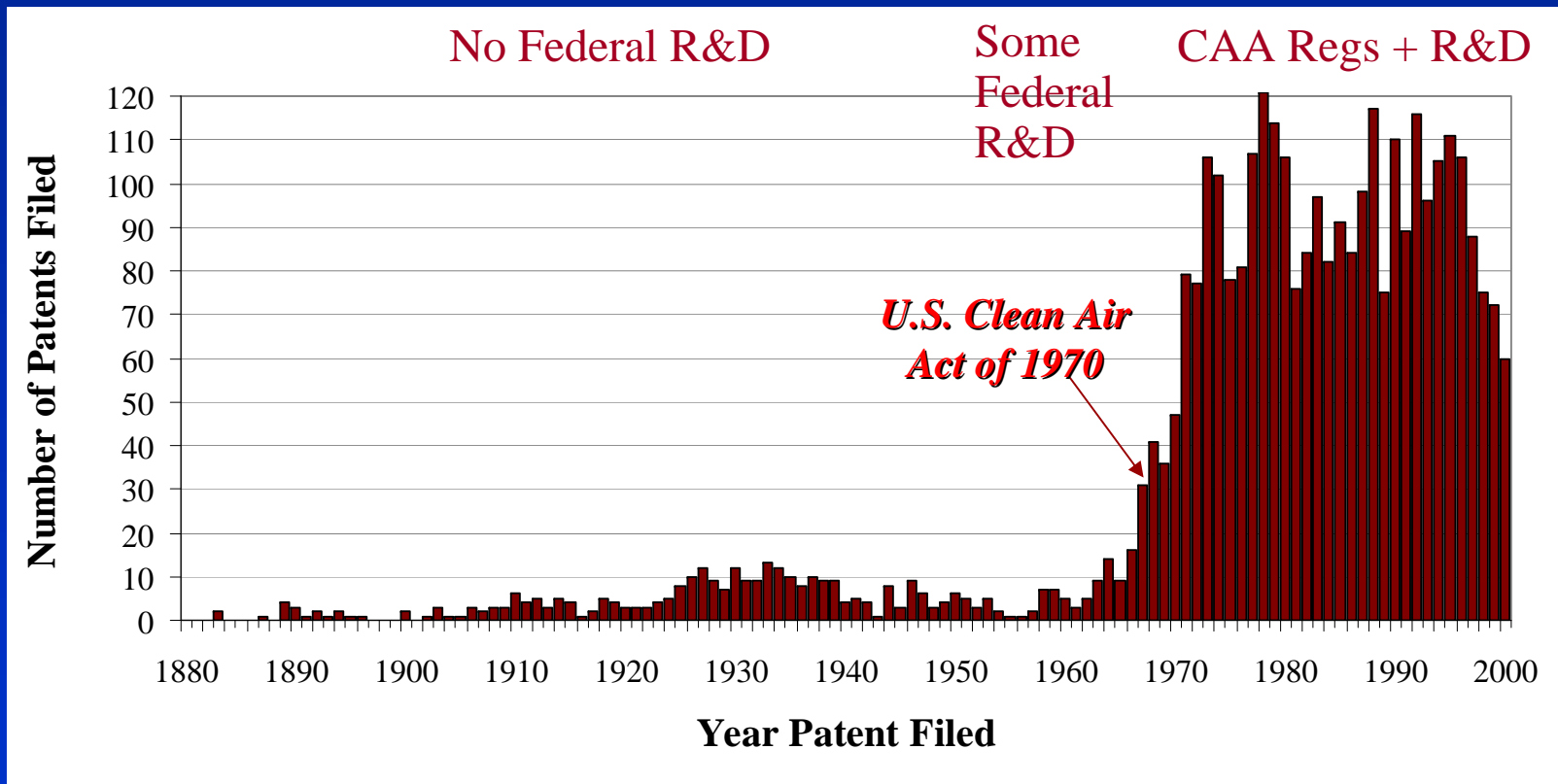
# Significant declines in cost as FGD technology is deployed

## *Experience Curve for Wet Limestone FGD Systems*



*(Based on 90% SO<sub>2</sub> removal, 500 MW plant, 3.5% S coal)*

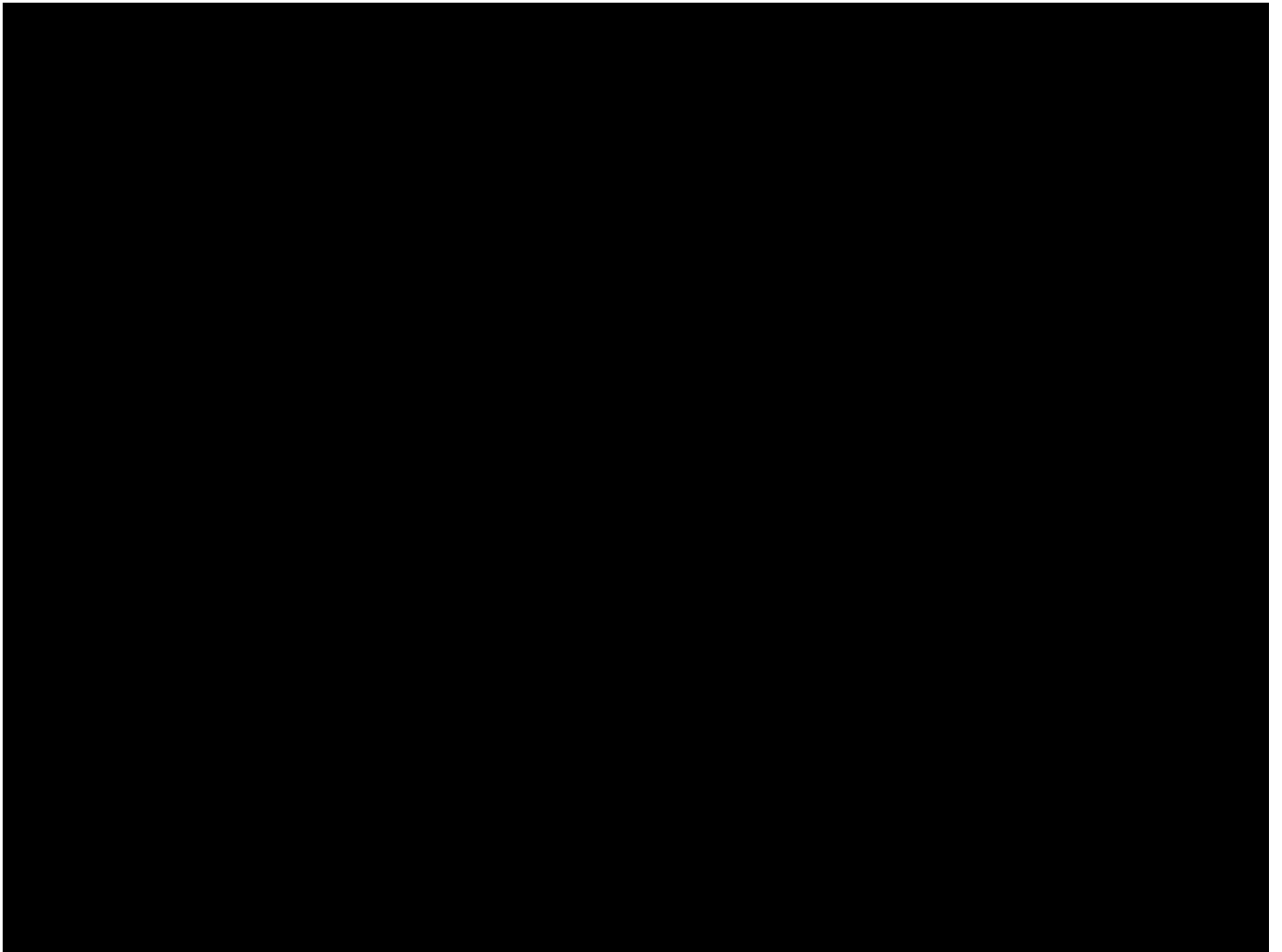
# U.S. Patenting Activity in SO<sub>2</sub> Control Technology



*Regulatory policies stimulated innovations that reduced emissions ...*

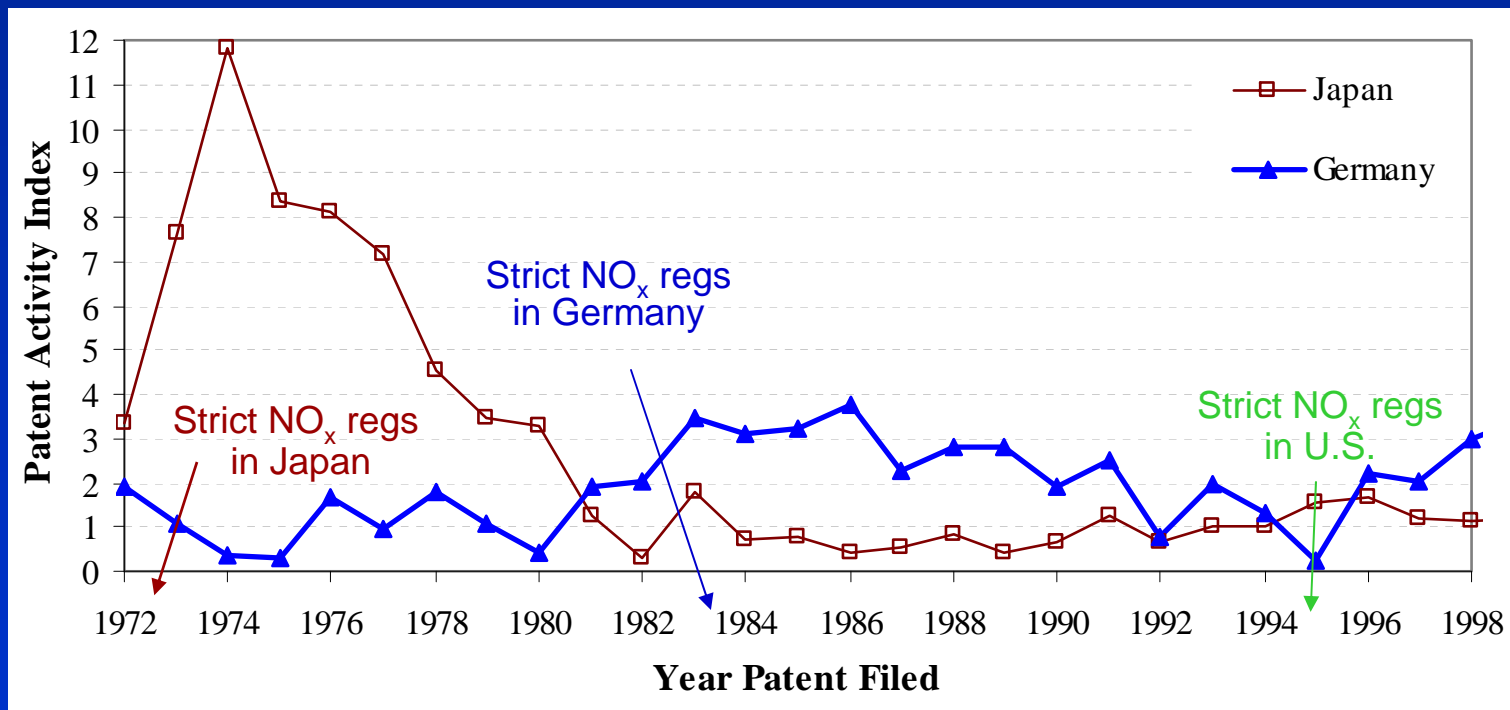
# How to Get “Over the Horizon Technology”

- Create a market for CCS—performance standards can do this (other policy approaches also may, or may not)
- Pursue continual improvements to current technology (not just R&D on new “breakthrough” options)
- Give it some time (a decade or more)
- Even with better, cheaper capture systems, CCS retrofits will not make economic sense for many existing subcritical units



# Innovations in post-combustion NO<sub>x</sub> control coincided with strict emission regs

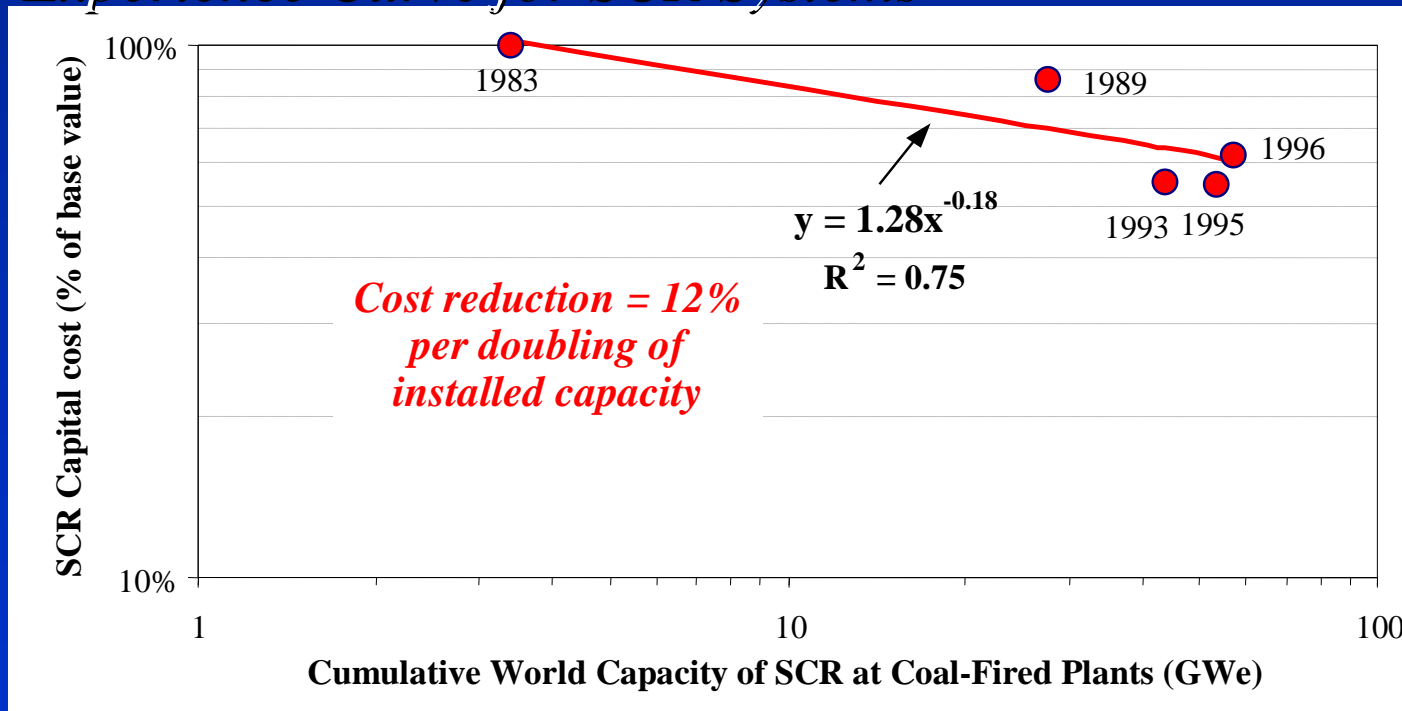
*Patenting Activity Index for Flue Gas NO<sub>x</sub> Control*



*Index for U.S. remained flat over this period at ~1*

# Historical Cost Reductions for Post-Combustion NO<sub>x</sub> Control

## Experience Curve for SCR Systems



*(Based on 80% NO<sub>x</sub> removal, 500 MW plant, medium S coal)*