

A Trust Fund Approach for Accelerating the Demonstration and Adoption of CCS

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Outline of Talk

- The need for full-scale CCS deployment
- Why the urgency?
- Options for accelerating CCS deployment
- A CCS Trust Fund approach
- Where do we go from here?

Premise

- Coal-based power plants will continue to provide the major share of electricity demand for decades to come
- Large reductions in CO₂ emissions from such plants are urgently needed to address global climate change
- Only CCS has promise to enable significant continued use of coal while addressing global climate change

*The need for full-scale
CCS deployment*

Deployment is Needed to . . .

- Establish the reliability and true cost of CCS in utility applications at commercial scale, for:
 - Alternative technologies (PC, IGCC; new, retrofit)
 - Different coal types (bituminous, sub-bit, lignite)
 - Different geological settings
- Establish the legal and regulatory requirements for geological sequestration at significant scales
- Reduce future cost of CCS via learning-by-doing plus sustained R&D

The Good News

- A variety of CCS projects are underway or planned in different parts of the world

But ...

- Only a small number of coal-fired power plant projects are currently funded at large-scale
- Full funding is still uncertain (to differing degrees) for most/all(?) proposed large projects

Source: MIT, 2008

| Project Name | Location | Feedstock | Size MW | Capture Process | CO2 Fate | Start-up |
|--------------------------|-----------|--------------|-------------|-----------------|-----------|-----------|
| Total Lacq | France | Oil | 35 | Oxy | Seq | 2008 |
| Vattenfall Oxyfuel | Germany | Coal | 30/300/1000 | Oxy | Undecided | 2008 |
| AEP Alstom Mountaineer | USA | Coal | 30 | Post | Seq | 2008 |
| Callide-A Oxy Fuel | Australia | Coal | 30 | Oxy | Seq | 2009 |
| GreenGen | China | Coal | 250/800 | Pre | Seq | 2009 |
| Williston | USA | Coal | 450 | Post | EOR | 2009-15 |
| NZEC | China | Coal | Undecided | Undecided | Seq | 2010 |
| E.ON Killingholme | UK | Coal | 450 | Pre | Seq | 2011 |
| AEP Alstom Northeastern | USA | Coal | 200 | Post | EOR | 2011 |
| Sargas Husnes | Norway | Coal | 400 | Post | EOR | 2011 |
| Scottish& So Ferrybridge | UK | Coal | 500 | Post | Seq | 2011-2012 |
| Naturkraft Kårstø | Norway | Gas | 420 | Post | Undecided | 2011-2012 |
| ZeroGen | Australia | Coal | 100 | Pre | Seq | 2012 |
| WA Parish | USA | Coal | 125 | Post | EOR | 2012 |
| Coastal Energy | UK | Coal/Petcoke | 800 | Pre | EOR | 2012 |
| UAE Project | UAE | Gas | 420 | Pre | EOR | 2012 |
| Appalachian Power | USA | Coal | 629 | Pre | Undecided | 2012 |
| Wallula Energy | USA | Coal | 600-700 | Pre | Seq | 2013 |
| RWE npower Tilbury | UK | Coal | 1600 | Post | Seq | 2013 |
| Tenaska | USA | Coal | 600 | Post | EOR | 2014 |
| BP Rio Tinto Kwinana | Australia | Coal | 500 | Pre | Seq | 2014 |
| UK CCS project | UK | Coal | 300-400 | Post | Seq | 2014 |
| Statoil Mongstad | Norway | Gas | 630 CHP | Post | Seq | 2014 |
| RWE Zero CO2 | Germany | Coal | 450 | Pre | Seq | 2015 |
| Monash Energy | Australia | Coal | 60 k bpd | Pre | Seq | 2016 |
| Powerfuel Hatfield | UK | Coal | 900 | Pre | EOR | Undecided |
| ZENG Worsham-Steed | USA | Gas | 70 | Oxy | EOR | Undecided |
| Polygen Project | Canada | Coal/Petcoke | 300 | Pre | Undecided | Undecided |
| ZENG Risavika | Norway | Gas | 50-70 | Oxy | Undecided | Undecided |
| E.ON Karlshamn | Sweden | Oil | 5 | Post | Undecided | Undecided |

The Bad News

CCS Project Cancellations, 2007–2008

| Project | Location | Technology | CCS Type | Developers |
|------------|----------|-------------------|---------------|--------------------|
| FutureGen | USA | 275 MW coal IGCC | Pre-/ Aquifer | FG Alliance, DOE |
| Clean Coal | Canada | 450 MW lignite PC | Oxy-/ Geol. | SaskPower + others |
| Peterhead | UK | 475 MW gas IGCC | Pre-/ EOR | BP, SSE |
| Halten | Norway | 860 MW gas NGCC | Post-/ EOR | Statoil, Shell |

*No certainty that currently proposed projects
will be fully funded and completed as planned*

Why the urgency?

Remember the Good Old Days ? (One year ago !)

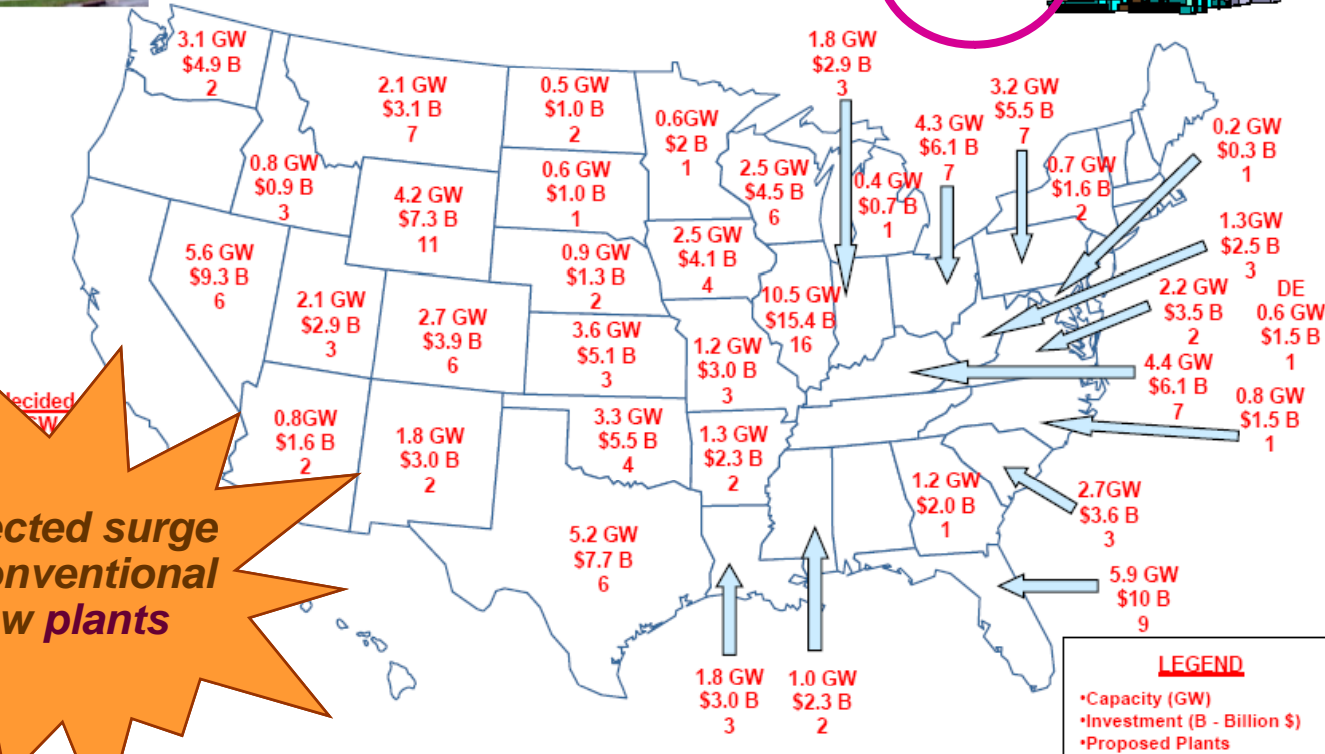
Coal's Resurgence in Electric Power Generation



Equivalent Power
for
90 Million Homes

Proposed New Plants

151 Plants
90GW
\$ 145 Billion



**Expected surge
of conventional
new plants**



OSAP 5/1/2007

What a Difference a Year Makes

JUSTICES SAY E.P.A. HAS POWER TO ACT ON HARMFUL GASES

Agency Can't Avoid Its Authority — Rebuke to Administration

By LINDA GREENHOUSE
 WASHINGTON, April 2 — In one of its most important environmental decisions in years, the Supreme Court ruled on Monday that the Environmental Protection Agency has the authority to regulate heat-trapping gases in automobile exhaust. The court further ruled that the agency could not sidestep its authority to regulate the greenhouse gases that contribute to global change unless it could prove scientific uncertainty or refusal to act. The Supreme Court's decision, which has the potential to have far-reaching effects on the Clean Air Act, even if it did, it would not constitute an authority for the environmental agency to regulate auto emissions, but it would certainly face further legal challenges to do so. Writing for the majority, Justice John Paul Stevens said the

Citing Global Warming, Kansas Denies Plant Permit

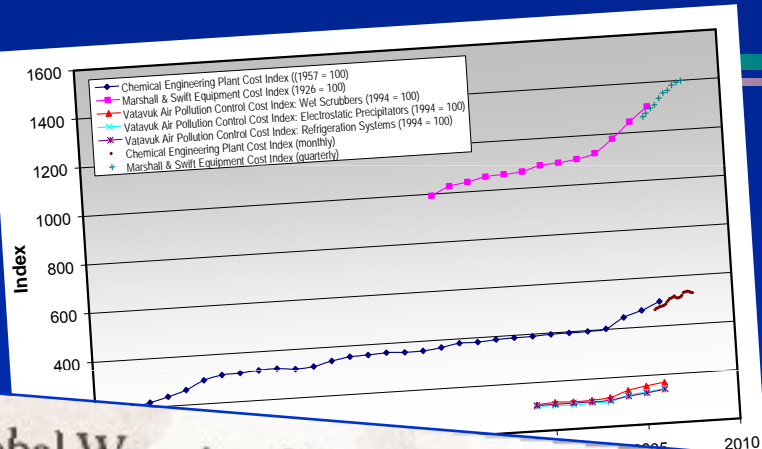
By MATTHEW L. WALD
 A Kansas regulator has turned down a permit for a large coal-fired power plant solely because of the global warming gases it would emit. The decision is the first instance of a state denying a permit on the basis of global warming concerns, according to environmental groups. The decision is a setback for the coal industry, which has been pushing for a permit to build a new plant in Kansas. The decision is also a victory for environmental groups, which have been fighting to prevent the plant from being built. The decision is a clear signal that global warming is a real concern for state regulators.

Leading Wall Street Banks Establish The Carbon Principles

Guidelines to strengthen environmental and economic risk management in the financing and construction of electricity generation

creating uncertainty in financial markets. Leading financial groups are now downgrading coal stocks and requiring utilities seeking funding for coal plants to include a cost for carbon emissions when proving economic

The Carbon Principles are the first of their kind in the United States. These Principles are a new approach to evaluating and addressing carbon risks in the financing of electricity generation. The need for these Principles is driven by the risks faced by the power industry as utilities, independent producers, regulators, lenders and investors deal with the uncertainties around regional and national climate change policy.

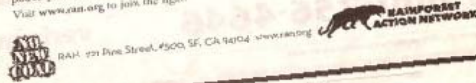


Opposition to conventional coal has become more vocal

There are over 150 new coal-burning power plants currently on the drawing board. Let's keep them there.

Don't fund global warming. Stop investment in all new coal-burning power plants.

Coal-burning power plants are the world's largest greenhouse gas polluters and a direct threat to our future. Yet prominent financial institutions, including JPMorgan Chase, Goldman Sachs, Citigroup, Morgan Stanley, Merrill Lynch, Credit Suisse and Lehman Brothers, are eager to finance their construction. We think it's every dollar invested in coal is a dollar that could be invested in energy efficiency and wind and solar power. Help us make sure these coal-burning power plants are never built. Tell Wall Street that investing in coal is simply too risky. Visit www.anti.org to join the fight.



THE NEW YORK TIMES OP-ED FRIDAY, MARCH 23, 2007



A group of potential builders look over the proposed site of a coal-fired plant near Great Falls, Mont. Below, Richard D. Libbert owns the Windweaver Ranch near the planned site, is a vocal, and unusual, opponent of the power plant.

Strangers as Allies

Fight Against Coal Plants Is Creating Diverse Partnerships

By SUKAN MORAN
EAT FALLS, Mont. — Richard D. Libbert turned his back against a hard-to-see foe the other day, adjusted his black fedora across golden fields of ripening wheat and said, "I'm against coal." It's a simple statement, but it's also a message that has spread far beyond the borders of his small town. Libbert's message is more vocal than the grass roots movement here. I learn about global warming and watch the drought affect farmers and gardeners and hear about the energy crisis. I see that it's not just the coal-burning power plants that can help with some development. Besides, it's not the coal-burning power plants that can help with the drought.



Richard D. Libbert, owner of the Windweaver Ranch, is a vocal, and unusual, opponent of the power plant.

Libbert, despite his anti-union reputation as a retired Army sergeant who travels to South America to fight in Iraq, has become an example of a rising phenomenon in the West. An increasingly vocal, potent and widespread anti-coal movement is developing here. Environmental groups that have long opposed new power plants are being joined by ranchers, farmers, retired homeowners, and even operators and even religious groups. Activists say the increasing diversity of these coalitions is making them more effective.

"You're seeing a convergence of people who previously never worked together or even talked to each other," said Anna Hedges, program director of the Montana Environmental Information Center, which is spearheading three lawsuits aimed at blocking construction of the power plant near Great Falls. "They're saying these coal plants don't make any sense, whether from an economic or environmental or property-rights standpoint." Power companies concede that anti-coal coalitions are indeed becoming more effective — and they describe that as a threat to the reliability of the nation's electric grid. In their view, building more coal-burning power plants is the most realistic way to meet the rising demand for electric power. "It's clear new coal-fired generation is running into roadblocks," said Rick

Want to Stop Global Warming? Stop Coal.

Why?

Because coal is the only fossil fuel plentiful and inexpensive enough to fuel the power plants that will be needed to meet the world's growing demand for electricity.

What's the plan?

The 2007 Challenge, a global coalition of more than 100 environmental groups, is calling for a 25% reduction in global CO2 emissions by 2012.

Doesn't this require new technology?

No. In 1975 to 1985, we were able to reduce energy consumption and emissions by 15% without any new technology.

Why can't we just replace our energy intensity by 25% by now, like many are advocating?

The US has reduced its energy intensity by 25% since 1975, but it's still growing by 2% a year. That's why we need to reduce our energy intensity by 25% by 2012.

What about China?

The US is urging the European Union to reduce its CO2 emissions by 20% by 2012. The US is also urging China to reduce its CO2 emissions by 20% by 2012.

We can Stop Global Warming.

If we stop building coal-fired power plants, phase out existing coal plants and immediately reduce the energy consumption and emissions of the Building Sector, we can avoid the worst consequences of climate change.

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We can Stop Global Warming. If we stop building coal-fired power plants, phase out existing coal plants and immediately reduce the energy consumption and emissions of the Building Sector, we can avoid the worst consequences of climate change.

If we begin now, we make it, the numbers are on our side. If we wait, even a few years, this window of opportunity is lost.

What can I do, the coal lobby is so powerful! Make your voice heard. Write them that the American people are very concerned about global warming. Write's editor at the planet will do what they can to be seen.

If enough Americans make their voice heard, we will stop building coal plants and phase out existing coal plants. They will do what it takes to protect our future, taking for a least power on coal and reducing by 2007. The 2007 Challenge. Not all the energy giant world's nations that can help meet the challenge (World Bank, ICA).

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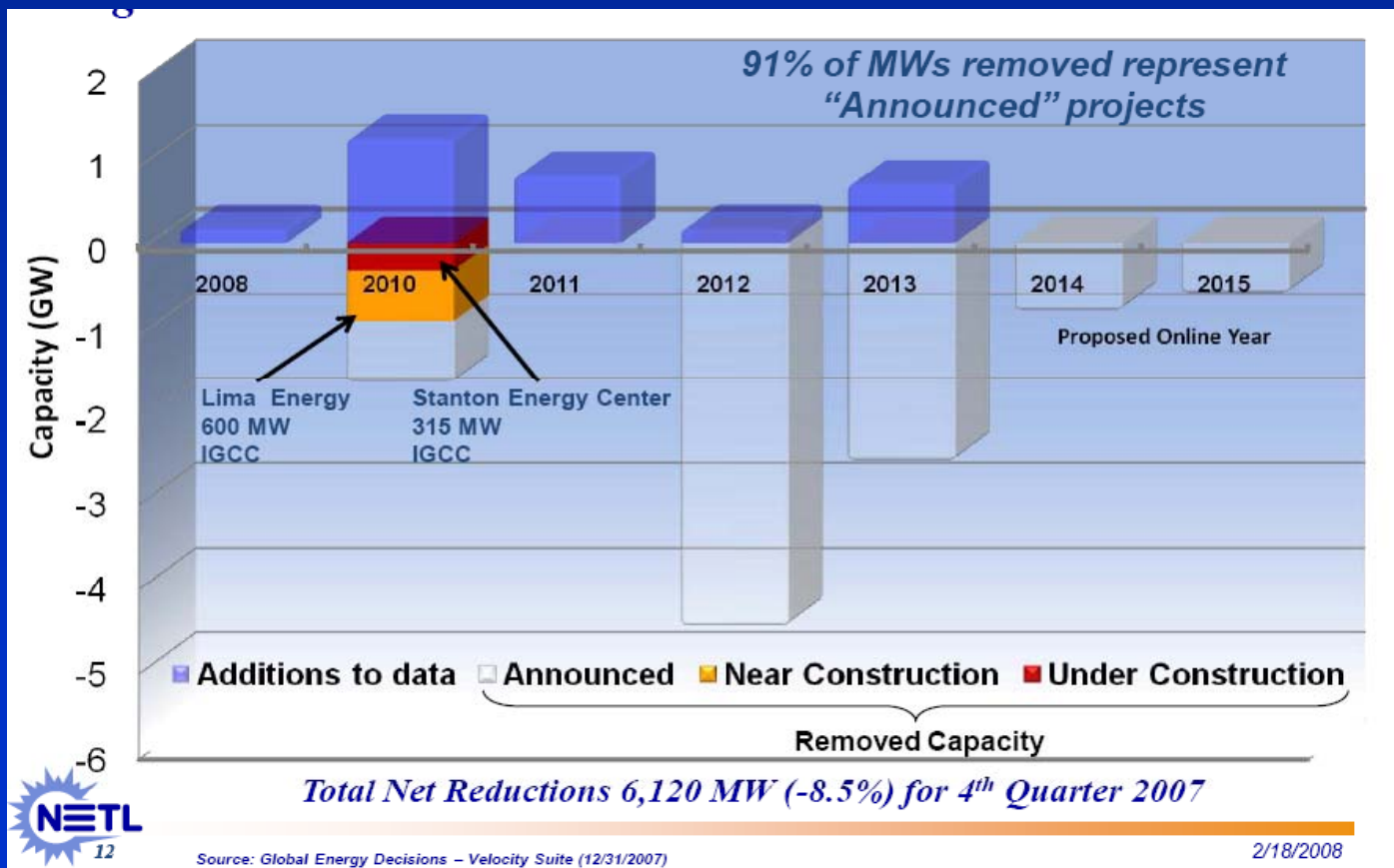
Edited by: The 2007-Challenge.org

Architecture 2030 info@architecture2030.org www.architecture2030.org

THE NEW YORK TIMES FRIDAY, SEPTEMBER 28, 2007

Many Projects Now Being Cancelled

Changes in projected U.S. capacity in 4th quarter 2007



The U.S. Outlook

- It will be very difficult—and perhaps impossible—to undertake large new coal-fired power projects that do not include CO₂ capture and sequestration
- Reserve margins soon will be compromised in several parts of the country if no new plants built

So ...

- *Learning sooner rather than later what CCS really costs, and how well it really works in full-size utility applications, is an urgent priority !*

*How can we accelerate funding
of large-scale CCS projects?*

Options for Accelerating CCS

- Expand traditional “technology policy” options (e.g., tax credits, subsidies, etc.)
(as in Energy Policy Act, USDOE CCTI program, etc.)
- Set new regulations requiring CCS (e.g., generator CO₂ performance standards)
(as in California CO₂ stds, NSPS for major pollutants, etc.)
- Adopt sufficiently stringency cap-and-trade program w/ CCS bonus allowances and/or a tech. fund (e.g., from auction of allowances)
(as in Lieberman-Warner bill and others.)
- Establish a CCS Trust Fund with fees used to pay full added cost of early CCS projects
(proposed here; under consideration by Congress and EPA)

— *Focus of this study is on the Trust Fund option* —

Why a Trust Fund ?

Advantages of a CCS Trust Fund

- Can raise large amounts of money via small fees on the use of coal for power generation
(historical gov't. incentives are insufficient and not reliable)
- Not coupled to stringent CO₂ reduction mandate — can start rapidly with well-defined revenues
(accelerates learning and significantly reduces future costs)
- Can ensure that funds will benefit payees
(all coal-based entities benefit, making fees more tolerable)
- Can ensure reliable multi-year funding stream
(avoids annual appropriation process by imposing fees not taxes)
- Managed by independent (or quasi-public) entity
(can employ private-sector standards for contracting and hiring)

Examples of U.S. Trust Funds

- *The Highway Trust Fund.* Created to finance interstate highway system; supported by automotive fuel taxes
- *Abandoned Mine Reclamation Fund.* Projects administered through the U.S. Department of Interior Office of Surface Mining
- *Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources.* Fund managed by a consortium of stakeholders (called RPSEA) under DOE oversight
- *Tobacco Master Settlement Agreement.* Payments and outlays managed by a private entity (National Association of Attorneys General)
- *The Propane Education and Research Council.* A privately administered fund created to support industry R&D and outreach

Lessons Learned from Past Programs

- Self-financing is necessary for costly programs
- Clear objectives must be established, and fees should terminate once objectives are reached
- Avoid the annual federal appropriations process (to ensure reliability of funding; impose fees not taxes)
- Use an independent or quasi-public entity (allows private-sector contracting and hiring standards)

How Would It Work for CCS ?

- A CCS Trust Fund would be established to pay the full incremental costs of installing and operating CCS systems at a selected number of coal-based plants
- Costs would be supported by a fee on coal-based (or other types of) electricity generation or fuel use
- The Fund would be managed by an independent (quasi-public) group that would select, fund and manage appropriate projects to meet program goals
- Results and experience would be shared widely
- The Fund would terminate after a fixed period of time

Proposed Program Elements

- **CO₂ Sources:**
 - Commercial power generation units ($\sim 400 \text{ MW}_{\text{net}}$)
 - Optional storage-only projects at large industrial sources with high-purity CO₂ vents (e.g., ethanol plants, ammonia and fertilizer plants, natural gas processing plants, etc.)
- **Incremental costs to be covered:**
 - Capital costs to install capture equipment
 - Reimburse loss of net generation capacity
 - Additional plant O&M costs (~ 5 years)
 - CO₂ transport and injection costs (~ 5 years)

What Would It Cost?

- Total incremental cost of building and operating CCS at a 400 MW_{net} plant—including cost of the “energy penalty” (replacement power) plus CO₂ transport and aquifer storage costs for 5 years:

≈ 0.7 to 1.0 billion USD
per project

- Cost of additional projects using existing CO₂ from industrial sources (compression, transport, storage)
≈ 100 million USD per project (based on 2 MtCO₂/yr for 5 yrs)

Average Initial Cost of Projects


(Millions of 2006 U.S. dollars per ~400 MW plant)

| Per Plant Incremental Costs of CCS | Based on New Plants | Based on Plant Retrofits |
|---|----------------------------|---------------------------------|
| Capital Costs | | |
| - Capture equipment | \$210 | \$250 |
| - Net capacity loss | \$185 | \$360 |
| Plant O&M Costs | \$150 | \$150 |
| Transport, Storage; Admin. | \$190 | \$190 |
| TOTAL (per plant) | \$735 | \$950 |

Source: Kuuskraa, 2007

Total costs and fees evaluated for two program levels

Smaller-Scale Program

- **Scope:** 10 power plants (different plant types, coals, capture systems, storage sites); +5 industrial sites; ~10-year program
- **Objectives**
 - Establish true cost and reliability of CCS options
 - Obtain design and integrated CCS operating experience
 - Develop public and regulatory experience with CCS
- **Cost**
 - \$8-10 billion: \$0.4 to \$0.5 per MWh (~\$1B/yr)
(based on current coal-fired generation and a 10-yr program)
 - *Increase for average residential household* \approx  per day

Larger-Scale Program

- **Scope:** 30 power plants (multiple “generations” of plants and CCS technologies); +10 industrial sites; 10–15 year program
- **Additional Objectives**
 - Significantly reduce CCS costs and generation losses
 - Build public confidence in technology and regulations
 - Reduce emissions by 100 MtCO₂/yr by end of program
- **Cost**
 - \$23–30 billion: \$1.2 to \$1.5 per MWh (\$2–3B/yr)
(based on current coal-fired generation and a 10-yr program)
 - *Increase for average residential household ≈*



Program Design Issues

- Administrative structure of the Fund
- Who pays the fee?
 - Only coal-fueled units?
 - Only fossil-fuel based generation?
 - All electricity providers/purchasers?
 - Only units with CO₂ above a specified level or rate?
- What mix of projects to support (and when)?
 - Technologies (PC, IGCC; pre-, post, oxyfuel)
 - Plant vintages (new, retrofit, repower)
 - Coal types (bituminous, sub-bituminous, lignite)
 - Sequestration sites & type (aquifers, EOR; regional mix)
- Options for cost-sharing, re-payment, etc.

Pew Center Evaluation Criteria

Policy options evaluated based on their:

- Effectiveness in reducing emissions
- Cost and cost-effectiveness
- Familiarity (precedents)
- Equity (regions, firms, technology)
- Ease of implementation
- Timing of implementation
- Linkage to other policies
- Impact on utility coal use

Details Described in Recent Reports (Available at: www.pewclimate.org)



Recent Support

- “Congress should immediately create a CCS Early Deployment Fund... The quasi-governmental Fund would ... generate \$1 billion annually [to] cover the additional costs of CCS for at least 5 to 10 full-scale early commercial demonstrations of various technologies [at mainly] coal-based electricity generators.”
– *Recommendation of the USEPA Advanced Coal Technology Work Group (an independent advisory group), January 2008*
- “Reps. Rick Boucher (D-VA), John Murtha (D-PA), and Nick Rahall (D-WV) are drafting legislation that would create a multi-billion dollar fund to encourage the use of CCS technology at power plants. Under the plan, a small fee would be imposed on electricity users and the proceeds would be kept outside of the Congressional appropriations process.”
– *Van Ness Feldman, Washington, DC, April 2008*

Where do we go from here ?

Take-Home Messages

- There is an **urgent** need to demonstrate at **large scale** a range of integrated CCS technologies at coal-based power plants (>10 projects at >100 MW_e)
- Current government and industry programs do not provide the level of funding that is required
- We need to aggressively pursue additional options to raise roughly \$10–30 billion to support selected and carefully-timed projects over the next 10–15 years
- A CCS Trust Fund supported by fees on electricity generation merits attention as an option for doing this quickly and effectively

Comments Welcomed

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