BEFORE

the

SUBCOMMITTEE ON ENVIRONMENT
AND THE SUBCOMMITEE ON ENERGY

of the

HOUSE COMMITTEE ON SCIENCE,
SPACE AND TECHNOLOGY

on

EPA'S PROPOSED NEW SOURCE PERFORMANCE STANDARDS FOR CARBON DIOXIDE FOR ELECTRIC GENERATING UNITS

TESTIMONY
OF
DAVID G. HAWKINS,

DIRECTOR, CLIMATE PROGRAMS,
NATURAL RESOURCES DEFENSE COUNCIL

MARCH 12, 2014

Summary

The United States and other large carbon-polluting nations urgently need to take sensible steps to create an affordable, reliable energy system that is compatible with protecting the climate.

The Clean Air Act, passed by Congress more than 40 years ago, allows EPA to set reasonable standards that can cut harmful carbon pollution. EPA has already adopted successful carbon pollution standards from cars and trucks, the second largest source of U.S. carbon pollution.

EPA has proposed standards for new coal plants that are based on carbon capture technology, which has been proven through use on other large industrial categories. Partial carbon capture can easily achieve EPA's proposed standard with costs that are within the range of alternative investments for new plant owners who may be considering options other than natural gas combined-cycle plants.

Carbon capture systems have three components, each of which has been operated in large-scale commercial use for decades: separation of carbon dioxide (CO2) from industrial gas streams; compression and transport of captured CO2 by pipeline; injection of compressed CO2 into geologic formations capable of retaining the gas until it has been converted through natural processes into a harmless mineral. EPA's assessment of the technical feasibility and economic reasonableness of the proposed standards rests on ample evidence and is fully consistent with the requirements of the laws Congress has written and the courts' interpretation of those laws.

Efforts to block EPA's sensible carbon pollution safeguards are bad policy. They would result not only in increased threats to human health and the environment; they would also reduce the prospects for developing and marketing carbon capture and storage systems that could be produced by American firms.

Chairmen and members of the Subcommittees, thank you for inviting me to present NRDC's views on the need for carbon pollution standards for fossil-fueled power plants and on the availability of technology to meet the standards recently proposed by the Environmental Protection Agency (EPA) under the Clean Air Act.

NRDC is a nonprofit organization with more than 400 scientists, lawyers and environmental specialists dedicated to protecting the environment and public health in the United States and internationally, with offices in New York, Washington D.C., Montana, Los Angeles, San Francisco, Chicago, and Beijing. Founded in 1970, NRDC uses law, science and the support of 1.4 million members and online activists to protect the planet's wildlife and natural environment, and to ensure a safe, healthy environment for all living things. NRDC's top institutional priority is curbing global warming and building a reliable, affordable and clean energy future.

We urgently need effective measures to cut dangerous carbon pollution from U.S. power plants and EPA is proceeding appropriately to use the authority Congress directed it to use in the Clean Air Act. Adopting sensible safeguards to cut carbon pollution is long overdue and must not be delayed longer.

Manmade "greenhouse gas" GHG pollution, including CO_2, is disrupting the climate that has supported the rise of modern civilization over the past 20,000 years. If we do not act now to cut these harmful pollutants, we will lock in dangerous changes to our climate system that will result in death, disease and misery for billions of people over hundreds of years into the future.

Because our climate has been so stable for so many centuries, we tend to forget how much our well-being depends on that stability. All of our lives are built around the climate that has prevailed for millennia as our communities have been settled and expanded. Our daily existence depends on the smooth functioning of numerous energy, transport, water supply, and waste water systems that have cost trillions to put in place. Nearly all of these complex engineered systems have been designed and constructed based on assumptions that the climate of the past is a reliable predictor of the climate of the future. Thus, we have standards to design against the "100-year flood" for example. But we can no longer assume that the 100-year flood event of the past will be the 100-year flood of the future. Climate change rules out that assumption as a basis for prudent decision-making.

The potential threats of a disrupted climate for infrastructure are huge. Just last week, two major reports on the extent of these threats were released: one by the U.S. Government Accountability Office (GAO)[1] and one led by the Oak Ridge National Laboratory.[2] The GAO report documents that numerous components of our energy system (including drilling platforms, refineries, pipelines, barges, railways, storage tanks, power plants, power lines, and substations) are vulnerable to a range of climate change impacts. GAO notes that "impacts to infrastructure may also be amplified by a number of broad, systemic factors, including water scarcity, energy system interdependencies, increased electricity demand, and the compounding effects of multiple climate impacts."

The Oak Ridge report contains a number of findings underscoring the threats posed by climate change to infrastructure and urban areas:

> "Regarding implications of climate change for infrastructures in the United States, we find that:
>
> - Extreme weather events associated with climate change will increase disruptions of infrastructure services in some locations.
> - A series of less extreme weather events associated with climate change, occurring in rapid succession, or severe weather events associated with other disruptive events may have similar effects.
> - Disruptions of services in one infrastructure will almost always result in disruptions in one or more other infrastructures, especially in urban systems, triggering serious cross-sectoral cascading infrastructure system failures in some locations, at least for short periods of time
> - These risks are greater for infrastructures that are:
>   - Located in areas exposed to extreme weather events
>   - Located at or near particularly climate-sensitive environmental features,

---

[1] U.S. G.A.O., "Climate Change – Energy Infrastructure Risks and Adaptation Efforts," GAO-14-74. http://www.gao.gov/assets/670/660558.pdf

[2] U.S. Department of Energy, "Climate Change and Infrastructure, Urban Systems, and Vulnerabilities," http://www.esd.ornl.gov/eess/Infrastructure.pdf

such as coastlines, rivers, storm tracks, and vegetation in arid areas

- Already stressed by age and/or by demand levels that exceed what they were designed to deliver
- These risks are significantly greater if climate change is substantial rather than moderate

"Regarding implications of climate change for urban systems in the United States, we find that:

- Urban systems are vulnerable to extreme weather events that will become more intense, frequent, and/or longer-lasting with climate change
- Urban systems are vulnerable to climate change impacts on regional infrastructures on which they depend
- Urban systems and services will be affected by disruptions in relatively distant locations due to linkages through national infrastructure networks and the national economy
- Cascading system failures related to infrastructure interdependencies will increase threats to health and local economies in urban areas, especially in locations vulnerable to extreme weather events
- Such effects will be especially problematic for parts of the population that are more vulnerable because of limited coping capacities."[3]

The threats posed by a disrupted climate go far beyond impacts on infrastructure. They include adverse health impacts from disease, vectors, and heat stress. And they threaten food production through drought, floods, and disruption of pollinators.

Our political system may ignore these threats today but the natural systems we are disturbing will not pay attention to our politics. They will proceed to react to our continuing loading of the atmosphere with heat-trapping pollution, uninfluenced by any rationalizations we craft. More climate disruption will be locked in with every year that we fail to take it seriously.

Fortunately, the United States has the economic strength, technical know-how, and policy tools that can show the world we can address this threat in a manner that secures our economic future.

The Clean Air Act is one of those tools. In 2007 and again in 2011 the U.S. Supreme Court ruled that the Clean Air Act authorizes EPA to set sensible safeguards for CO2 and other GHG pollutants. EPA has already set GHG standards for new cars and trucks, with the cooperation of domestic and foreign

[3] DOE report, note 2, at viii-ix.

manufacturers. EPA is now in the process of developing standards for the largest U.S. source of CO2 pollution, fossil-fueled power plants.

Fossil-fueled power plants are also the largest CO2 source globally. We cannot protect ourselves from the harms of a severely disrupted climate system unless we set effective standards to limit carbon pollution from these plants.

As you know, EPA has proposed, and reproposed, CO2 standards for new natural gas and coal power plants. Under the Clean Air Act, EPA bases new source emission standards on the demonstrated capability of known technology, although source operators are free to use any approach they choose to meet the emission limits. Under the Act, EPA's standards must be based on a record that shows that two tests are met. First, the standards must be shown to be achievable using technologies that EPA has found to be demonstrated as technically feasible. Second, EPA must show that the costs of applying those technologies are reasonable. There are numerous cases interpreting these provisions in the context of previous New Source Performance Standards dating back to the early 1970s. As I will discuss, EPA's proposed CO2 standards for new fossil plants are based on showings that are fully in accord with the Act and the prior court rulings interpreting it.

In its recent reproposal, EPA based the proposed standard for new coal plants on currently available systems that capture CO2 from large industrial gas streams. Once captured, CO2 is compressed and transported, typically via pipeline, to geologic formations, where it can be permanently isolated from the atmosphere, eventually being converted back into a mineral form.

As I will discuss in more detail below, all aspects of these carbon capture and storage (CCS) systems have been demonstrated at commercial scale industrial facilities for decades. They have operated reliably over multi-year periods to capture, transport, and safely dispose of millions of tons of CO2. They can be readily applied at power plants, although until now, CCS has been used only to capture a fraction of CO2 emissions at about a dozen power plants, typically for sale to the food and beverage industry.

To date, the power sector has not used CCS broadly; but not because of any technical shortcomings. Rather, the sector has not applied CCS to full exhaust streams because of a policy failure. Up to now, there has been no national requirement to limit carbon pollution from power plants. CCS systems, like SO2 scrubbers, mercury controls, fine particulate controls, and nitrogen oxide controls, are not free. With rare exceptions, none of these other systems were used before there were regulatory requirements to control these pollutants. Congress wisely decided to give EPA the authority to impose clean air requirements to protect our health and welfare and this has resulted in trillions of dollars in benefits—exceeding compliance costs by a factor of 40 to 1.[4] Likewise, in the absence of any requirement to limit CO2 pollution from new or existing power plants, there has been simply no reason for owners and builders of power plants to install CCS systems.

Large coal-based power companies themselves have argued that they cannot finance CCS systems without federal CO2 standards. For example, in announcing the abandonment of a large-scale CCS project in 2011, the CEO of American Electric Power stated, "as a regulated utility, it is impossible to gain regulatory approval to recover our share of the costs for validating and deploying the technology without federal requirements to reduce greenhouse gas emissions already in place. The uncertainty also makes it difficult to attract partners to help fund the industry's share."[5]

As with other control technologies, there are some rare pioneers for CCS. Currently several plants that will include CCS are either under construction or in the advanced pre-construction stage. Southern Company's new Kemper County, Mississippi coal plant and the refurbished coal plant at the Boundary Dam site in Canada are examples of CCS-equipped coal power projects nearing the end of construction.

---

[4] See EPA Benefits and Costs of Clean Air Act reports at http://www.epa.gov/air/sect812/index.html

[5] http://www.aep.com/newsroom/newsreleases/Default.aspx?id=1704

The Summit Power project in Texas and the Hydrogen Energy project in California are examples of CCS-equipped projects in the advanced pre-construction stages.

Yet some industry critics of EPA's power plant carbon pollution proposal have argued that EPA cannot base a standard on CCS because it has not been used commercially at full scale on existing power plants. Congress wisely did not create such a Catch-22 obstacle under the Clean Air Act. Since, in many instances pollution control technology is not used in a particular industry until it is required, Congress did not write the Clean Air Act to bar EPA from basing standards on technology that was not yet in use in a particular industry. The Clean Air Act, adopted with strong bipartisan support, sets forth a sound policy for cleaning up pollution from large new industrial sources. EPA is directed to set New Source Performance Standards, which are to be set at a level that EPA can show are achievable as a technical matter and at reasonable cost. The Act does not compel EPA to put on blinders and look only at the prevailing practice in the industry it is attempting to clean up.

The courts have upheld EPA's authority under the Clean Air Act to base New Source Performance Standards for a given industrial category on technologies whose performance has been demonstrated at other industrial categories.[6] This is a common sense policy. If the law allowed a particular industry to immunize itself from requirements to use available, feasible control technologies just by refusing to adopt them voluntarily, the industry would be put in full control of whether it would ever have to improve its performance.

EPA's Proposed CO2 NSPS for Power Plants

Turning to EPA's proposal for new power plants, the agency considered several options for new coal plant CO2 limits, ranging from no CCS, partial CCS, and full (90%+ capture) CCS. EPA selected partial CCS as the basis for the proposed standard, after considering both technical and cost issues. EPA found that

[6] See, e.g., *Lignite Energy Council v. EPA*, 198 F.3d 930 (D.C. Cir. 1999).

partial CCS was well demonstrated at relevant industrial scales and that when applied to coal power plants, partial CCS would have reasonable economic impacts.

As to technical feasibility, the record shows ample evidence to support the finding that CCS is a technically viable system for new coal-fired power plants. EPA has recently published a Technical Support Document that provides an expanded summary of the real-world experience with all three elements of a full CCS system: separation/capture of CO2 from industrial gas streams; compression and pipeline transport of CO2; and injection of CO2 into secure geologic formations.[7]

CO2 Capture

EPA 's January 2014 Technical Support Document (TSD) notes that industrial CO2 capture experience dates back to the 1930s. It explains that there are three types of capture systems applicable to power plants: post-combustion capture; pre-combustion capture; and oxy-combustion. In the power sector itself, there exist three types of real-world experience: commercial small-scale capture systems at existing coal-fired power plants; demonstration projects at power plants; and larger-scale projects now under construction or in advanced planning and development. EPA's TSD mentions two U.S. coal-power plants that use commercial amine scrubbers to capture CO2 for sale to the food and beverage industry.[8] These markets are so small that only a small portion of each plant's flue gas is passed through the scrubbing system. But the technology is proven and is scalable to sizes needed for a new plant to meet EPA's proposed standard. As EPA points out, engineering studies, the Boundary Dam coal plant in Canada, (where the CO2 capture system for a refurbished 110MW unit has been completed on budget—

[7] US EPA, Technical Support Document, Jan 8, 2014, http://1.usa.gov/1l2qV7x
[8] EPA TSD at 18.

other parts of the unit refurbishment experienced some cost overruns), as well as a plant being developed by NRG Energy in Texas, demonstrate the scalability of such post-combustion systems.[9]

As an example of pre-combustion capture operating experience, there is the Dakota Gasification Company's Great Plains Synfuels plant in North Dakota. This plant, which gasifies coal and produces pipeline gas (methane) and other chemicals, captures its CO2 and pipelines it for injection into an oil field in Canada. As we know, methane is an increasingly popular fuel for combined-cycle power plants. Were the pipes at the Great Plains plant connected to a combined-cycle power plant we would have a large-scale operating example of a power plant using fuel derived from coal, where CO2 capture was applied. There are no technical issues presented by the fact that the gas in those pipes currently is distributed in the general gas supply network rather than running to a gas-fired generating unit directly.

These examples alone are sufficient under the Clean Air Act to demonstrate that CO2 capture is technically feasible for new coal power plants.

Experts in the power industry confirm the technical viability of CO2 capture at large power plants. For example, Mississippi Power Company stated the following to the Mississippi Public Service Commission in 2009 in its application for approval of its large new coal plant in Kemper County, Mississippi:

> "a process referred to as Selexol™ is applied to remove the CO2 such that it is suitable for compression and delivery to the sequestration and EOR process. … The carbon capture equipment and processes proposed in this Project have been in commercial use in the chemical industry for decades and pose little technology risk."[10]

In elaborating on the viability of CO2 capture for this plant, the Vice President of Mississippi Power Company testified to the Commission as follows:

---

[9] TSD at 18-19.

[10] Kemper County IGCC Certificate Filing at 18, MPSC Docket No. 2009-UA-0014. Filed, December 7, 2009. http://bit.ly/1dt3eUr

> "The carbon capture process being utilized for the Kemper County ICGC is a commercial technology referred to as Selexol™. The Selexol™ process is a commercial technology that uses proprietary solvents, but is based on a technology and principles that have been in commercial use in the chemical industry for over forty years. Thus, the risk associated with the design and operation of the carbon capture equipment incorporated into the Plant's design is manageable."[11]

Compression and Transport of CO2

There is no need to spend much time on this topic. It is beyond dispute that the technology to compress CO2 and transport it by pipeline in quantities pertinent to power plant operations is fully demonstrated, with decades of operational experience. As EPA's Technical Support Document notes, currently about 50 million metric tons of CO2 are transported annually in the U.S., through 3,600 miles of pipeline.[12] The sources of the CO2 do not include electric generating plants but that is immaterial to the question of the performance of this component of the CCS system.

Geologic Storage of CO2

The issue of whether large quantities of compressed CO2 can be safely placed for long-term storage in geologic formations is an important one and one which was a matter of substantial concern for me personally when I first examined the issue of CCS starting in 1997. I have devoted a considerable amount of time since then studying the literature and discussing the topic with a broad range of geologists. I also participated in a reviewer capacity in the IPCC's 2005 Special Report on Carbon Capture and Storage.[13]

---

[11] Phase Two Direct Testimony of Thomas O. Anderson at 22. Filed, December 7, 2009. http://bit.ly/1g1lHs0 . Additional examples of commercial offerings can be found in the Appendix attached to this testimony.

[12] EPA TSD at 25.

[13] IPCC, 2005 - Bert Metz, Ogunlade Davidson, Heleen de Coninck, Manuela Loos and Leo Meyer (Eds.), Carbon Dioxide Capture and Storage,
Cambridge University Press, UK.

In my judgment, the IPCC and EPA are correct in concluding that large-scale geologic storage is technically viable as a means of isolating CO2 from the atmosphere until it is eventually converted into mineral form. The basics are easily understood: first one needs a formation of porous rock into which the compressed CO2 can be injected, at a depth sufficient to keep the CO2 in a compressed state; then because CO2 is less dense than the fluids in the injection zone, there needs to be an impermeable rock formation above the injection zone; finally, the impermeable rock formation needs to be free from faults, fractures, or well bores that could provide pathways to the surface or overlying water supplies. A number of surveys have documented that formations meeting these criteria are abundant in the United States. For example, a study by researchers at DOE's Pacific Northwest National Laboratory found that 95% of the largest CO2 emitters in the U.S. (nearly all of them coal power plants) are located within 50 miles of a candidate CO2 storage formation.[14]

There is substantial commercial industrial-scale experience with CO2 injection into geologic formations, both in the U.S. and internationally. Most of the injected CO2 has gone into U.S. oil fields for enhanced oil recovery (EOR) but there are also a number of large CO2 injection projects in operation at dedicated CO2 storage sites: under the North Sea, the Barents Sea, Algeria, and Australia.[15]

Costs

Under the Clean Air Act and court decisions interpreting it, NSPS standards are authorized if the costs of compliance are shown to not be "excessive" or "unreasonable."[16]

---

[14] Dooley, J., et al. Carbon Dioxide Capture and Geologic Storage: A Key Component of a Global Energy Technology Strategy to Address Climate Change; Joint Global Change Research Institute, Pacific Northwest National Laboratory: College Park, MD, May 2006, 2006; p 67. See also the U.S. Geological Survey Carbon Atlas: http://co2public.er.usgs.gov/viewer/

[15] This experience is detailed in EPA's TSD at 26-29.

[16] See citations in EPA's 2014 proposed rule at 79 FR 1464, Jan. 8, 2014.

EPA's cost analysis demonstrates that the costs of complying with the proposed CO2 standards easily meet these tests: while more costly than natural gas power options, the standards can be met at costs that fall in the range of other generating plant options that the industry is building or planning to build. EPA's cost assessment starts with the observation that under current and expected market conditions, new natural gas combined cycle (NGCC) power plants would typically have lower electricity production costs (levelized cost of electricity) than new coal units, even if no CCS were required for the coal unit. But EPA notes that there might be instances where factors other than electricity production costs might cause investors or regulators to choose to build a coal plant or other non-NGCC power plant. Accordingly, EPA compared the projected cost (using Department of Energy reports) of a coal unit with CCS to a coal unit without CCS and to other non-NGCC options, such as nuclear, biomass, and geothermal power plants.

In its analysis, EPA concludes the projected costs of a coal plant with partial CCS would range from $92 to $110 per Megawatt-hour (MWh). This projected cost falls in the range for other non-NGCC options of $80 to $130 per MWh. EPA also compares the cost of a new coal unit with *no CCS* to a coal unit with partial CCS, finding that applying partial CCS would increase the power production costs[17] compared to the no-CCS case by 20% -- from $92 per MWh to $110 per MWh, if the CCS project received no revenues from the sale of CO2 for enhanced oil recovery (EOR). If the income from CO2 sales for EOR were included, the net production cost from the new CCS-equipped unit would range from $88 to $96 per MWh, depending on the price received for the captured CO2.[18]

---

[17] Power production costs are only a portion of a customer's bill. Typically, about 40% of the bill consists of transmission, distribution and administrative costs. Moreover, in most systems, any single new power plant is only a small part of the total generating fleet whose costs go into the customer rate base. Thus, the increase in a customer's rates will be smaller than the increase in production costs at a new power plant.

[18] US EPA, "Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units," at 240. http://www2.epa.gov/sites/production/files/201309/documents/20130920proposal.pdf

In sum, EPA's proposal for new coal plants is based on a careful review of industrial experience with large-scale CO2 capture technology. EPA has compared projected costs of a new coal unit applying partial CCS with several other generation options and concluded the additional power production costs are 20% or less. EPA found these costs to be reasonable, given the substantial reduction in emissions that partial CCS would achieve at a new coal unit and the importance of providing a policy framework to support the use of CCS if new coal units are built.

Efforts to Block EPA Carbon Pollution Standards

Unfortunately, there are continuing misguided efforts to block EPA from adopting sensible safeguards for dangerous carbon pollution from fossil power plants, most recently with House passage of Rep. Whitfield's bill (H.R. 3826) last week. From the perspective of coal advocates, the rationale for these attacks on the Clean Air Act appears to be that Congress can protect the volumes of coal consumed by the power sector by prohibiting EPA from setting any meaningful limits on carbon pollution from power plants. This tactic simply will not work.

A careful examination of the forces confronting the coal industry shows that handcuffing EPA cannot be a successful way to improve the lot of coal producers. Most U.S. coal use is in the power sector and the power sector has choices for the resources it uses. The bill passed by the House seems to ignore the obvious fact that power producers are not in business in order to burn coal. Their business interest is in cost-effectively supplying electricity resources; and their fuel and technology choices will be driven by market forces that together are much more powerful than the effects of Clean Air Act standards on power production prices.

The biggest drivers of the market's continuing shift away from coal in the power sector are –

- the comparatively lower costs of natural gas as a fuel,
- the comparatively lower capital costs of natural gas power plants,
- the expanded penetration of renewables like wind and solar,
- the success of demand side management in reducing both annual and peak demands for power,

- and the conviction in much of the investor community, that climate science and observed climate disruptions will lead to public demands for policies to limit carbon emissions, likely before investments in new or refurbished coal plants are recouped.

Ironically, the Whitfield bill would stop the improvement of the one technology that is essential if coal and natural gas are to continue to be a substantial energy resource: CCS. The bill cannot and will not do anything to deal with the fundamental issues facing the continued use of coal. If it became law (which it almost certainly will not), it would be at most only an anesthetic that might provide coal producers with some perceived short-term pain relief but at the cost of causing investors and government actors to turn their back on deploying CCS. This would leave the coal industry where it is today: unable and unwilling by itself to build CCS projects that provide cost-cutting practical experience at pertinent scales; and largely failing in its efforts to maintain sales to power sector customers who are increasingly not wedded to coal and thus quite apathetic about building CCS projects themselves.

Perhaps inadvertently, the bill essentially ensures that coal producers will have no chance of turning CCS into a real option for power sector investors. By telling coal producers' customers (power plant owners) that they can indefinitely avoid any meaningful EPA limits on carbon pollution by simply declining to pursue CCS projects, the bill eliminates any incentive for power producers to put their political and financial muscle into an effort to solve coal's carbon problem.

Indeed, if this bill were law, it would tell power plant owners that pursuing a CCS project would be against their narrow economic interests because it would speed the day when the handcuffs on EPA's authority would be removed.

Coal producers are profoundly wrong in betting that blocking the use of the Clean Air Act to deploy CCS would revive interest in coal as a new power plant option. The reality is that hamstringing EPA will not keep coal from continuing to lose market share in the U.S. Instead, it will cause the power sector to look elsewhere to hedge its bets against the implications of climate disruption. Some in the coal-producing sector may think one can deal with climate disruption by enacting laws decreeing that we shall ignore it. But based on my conversations with many leaders in the power sector, that is not a view shared by the people who will be deciding what investments to make in new and existing power systems.

Some claim that today there is a "war on coal," while others, considering the health and environmental costs inflicted by today's use of coal to make electricity, say it is a "war by coal." But these charges and countercharges will not get us where we need to go as a society. What all of us need, both coal promoters and coal critics, is a broader consensus on sensible steps we can take to put our energy system on a more sustainable course. I continue to believe that it is possible to forge a consensus that includes a role for coal, at least as our society transitions in an orderly manner to resources that will function reliably to power growth without disrupting the climate we depend on to sustain modern economies.

A bill passed by the House in 2009 demonstrates that it is possible to garner the support of many legislators far from "coal country" for policies that would give coal an opportunity to define a role for itself as a continuing part of the U.S. energy mix. That bill, authored by two Democrats from states not dependent on coal, included about $60 billion in financial support for deployment of CCS on coal-fueled power plants. It is worth noting as well, that many environmental organizations that believe coal use must be phased out quickly, nonetheless supported this legislation.

I am referring to the Waxman-Markey climate protection bill. It did not become law but it does stand as a reminder that it is possible to broaden political support among elected officials from around the country for policies that could in fact provide a pathway for coal to earn a continuing role as a significant U.S. energy resource.

The bill passed by the House last week would create a huge obstacle to reviving any potential consensus for incentives to deploy CCS. It is based on a fundamentally flawed strategy: that by barring EPA from considering practical, available technologies that can reduce power plant carbon pollution, Congress can spur new coal plant investments and keep old coal plants running indefinitely. Succeeding with this strategy would require investors, power company managers, and state utility regulators to deny both economic and climate risks.

A new coal plant without CCS is simply not equipped to manage the risks that it will face in the marketplace. Some coal producers may be able to persuade themselves that it makes sense to spend several billion dollars on a machine that will be the dirtiest new power option in the United States. But coal producers won't be building power plants. And the people who will be are not going to believe that this bill provides them a stable platform for investing billions in projects that won't even be on line for perhaps another decade. Power sector investors are increasingly learning from Wayne Gretzky: they are skating to where the puck will be, not where it is now. The Whitfield bill tries to tell them there is no puck and that just won't fly.

In sum, EPA's proposed carbon pollution standards are technically achievable and can be met at reasonable costs. The standards are essential to assure that coal-based power plants will be designed to be operable in a world where climate disruption demands that we minimize carbon pollution. Efforts to block EPA's Clean Air Act authority to cut carbon pollution are not just bad for public health and the environment. They are bad for America's economic future and for the prospects of making continued use of fossil fuels for power generation compatible with protecting the climate that human society depends on to thrive in the future.

APPENDIX:

COMMERCIAL OFFERINGS

PRE-COMBUSTION CAPTURE TECHNOLOGY

<u>Selexol</u>

The Selexol technology is a proven technology, licensed by UOP.

UOP Selexol™ Technology for Acid Gas Removal, © 2009 UOP LLC. All rights reserved.[19]

"Selexol Process Commercial Experience

- *Over 60+ operating units*
  - *[…]*
- *Multiple large units in engineering phase*
  - *[…]*

Selexol Process-Summary

- *The Selexol process is a proven licensed technology"*

"Phase Two Rebuttal Testimony Of Thomas O. Anderson On Behalf Of Mississippi Power Company Before The Mississippi Public Service Commission", Docket No. 2009-UA-0014[20]:

"[…] the market for carbon capture systems in synthesis gas stream applications is very mature. The Company is aware of at least 20 different CO2 control technologies that have been installed in over 250 industrial applications worldwide. Mr. Schlissel appears to have confused traditional coal plant technology where carbon capture would be "post-combustion," meaning the CO2 is removed from the flue-gas after it has been used in the production of electrical energy, with the Project's IGCC technology where the CO2 removal process will occur "pre-combustion," meaning the CO2 is removed from the gasifier's synthesis gas prior to being used to produce electrical energy. The CO2 capture market for pre-combustion synthesis gas applications is mature, robust and global."

---

[19] http://www.uop.com/?document=uop-selexol-technology-for-acid-gas-removal&download=1

[20] http://www.psc.state.ms.us/InsiteConnect/InSiteView.aspx?model=INSITE_CONNECT&queue=CTS_ARCHIVEQ&docid=246453

"Updated Design, Description and Cost of Kemper County IGCC Project", Mississippi Power Company, MPSC Docket No. 2009-UA-0014, Kemper County IGCC Certificate Filing, Filed Dec. 7, 2009[21]:

"In addition, a process referred to as Selexol™ is applied to remove the CO2 such that it is suitable for compression and delivery to the sequestration and EOR process. All of the CO2 capture systems are installed prior to combustion of the syngas in the gas turbines. Capturing CO2 pre-combustion is much more efficient and less costly than post-combustion. The carbon capture equipment and processes proposed in this Project have been in commercial use in the chemical industry for decades and pose little technology risk."

"The carbon capture process being utilized for the Kemper County ICGC is a commercial technology referred to as Selexol™. The Selexol™ process is a commercial technology that uses proprietary solvents, but is based on a technology and principles that have been in commercial use in the chemical industry for over forty years. Thus, the risk associated with the design and operation of the carbon capture equipment incorporated into the Plant's design is manageable."

Rectisol

The process dates from 1955, and is commercially proven and guaranteed.

"Acid Gas Removal by the Rectisol® Wash Process", Chemical Industry Digest, June 2013[22]:

"Rectisol was developed jointly by Linde and Lurgi in the late 50's and both companies are owning the IP rights. Easy to operate, very reliable, extremely high on-stream factor"

Linde Engineering website[23]:

---

21 http://www.psc.state.ms.us/InsiteConnect/InSiteView.aspx?model=INSITE_CONNECT&queue=CTS_ARCHIVEQ&docid=245160

22 http://www.linde-india.com/userfiles/image/2013_07_18_%20Rectisol%20Article%20in%20Chemical%20Industry%20Digest.pdf

23 http://www.linde-engineering.com/en/process_plants/hydrogen_and_synthesis_gas_plants/gas_processing_plants/rectisol_wash/index.html

"Rectisol can purify synthesis gas down to 0,1 vppm total sulfur (including COS) and CO2 in ppm range. Commercial scale RECTISOL wash units are operated worldwide for the purification of hydrogen, ammonia-, methanol syngas and the production of pure carbon monoxide and oxogases."

Hydrogen Energy International (a joint venture of BP and Rio Tinto) sought to develop a commercial CCS project with 90% carbon capture in California. In their feasibility study, they describe their assessment of the Rectisol process.

"HECA Feasibility Study, Report #23 – AGR Licensor Evaluation", February 7, 2010.[24]

"Key to the Licensors' success in meeting the minimum project requirements is their commercially proven experience. Both Licensors have over 50 Rectisol units in operations worldwide with extensive experience removing acid gas from syngas produced in both liquid and solid fuel gasifiers, including Shell and GE (Texaco) gasifiers. Both have designed nits with clean syngas specifications more stringent than HECA's hydrogen rich fuel gas specification for the manufacture of chemicals. Both have designed units to produce acid gas within the H2S concentrations specified by the HECA project from low rations of H2S/CO2 in the feed gas, and CO2 product streams with the HECA purity requirements. Both licensors do have different units in operation demonstrating each aspect of the product specification requirements.

Summit Power's Texas Clean Energy Project, a 40MWe gross IGCC project in Texas with 90% carbon capture will also use Rectisol.[25]

POST-COMBUSTION CAPTURE TECHNOLOGY

Shell-Cansolv

The small Canadian company, Cansolv developed a proprietary amine technology, and was bought up by Shell in Dec, 2008. Since then, Shell-Cansolv has expanded its capabilities and commercial offerings.[26] On CO2 capture in particular, **the company's website states that[27]:**

"[t]his patented technology is designed and guaranteed for bulk CO2 removal up to 90%"

---

[24] http://www.cpuc.ca.gov/NR/rdonlyres/538A0BA6-F6C9-495D-B13B-1399E446CDEC/0/23AGRLicensorEvaluation7Feb2010.pdf

[25] http://www.netl.doe.gov/publications/proceedings/10/co2capture/presentations/thursday/Barry%20Cunningham-FE0002650.pdf

[26] http://www.shell.com/global/products-services/solutions-for-businesses/globalsolutions/shell-cansolv/shell-cansolv-solutions.html

[27] http://www.shell.com/global/products-services/solutions-for-businesses/globalsolutions/shell-cansolv/shell-cansolv-solutions/co2-capture.html

In September, 2013, Shell-Cansolv and French engineering, procurement and construction firm, Technip, announced[28]:

"an agreement to leverage their respective expertise in marketing an end-to-end solution for Carbon Capture and Sequestration (CCS) projects. The agreement enables both Technip and Shell Cansolv to offer a full chain of engineering, procurement and construction (EPC) services for a post-combustion CO2 capture project to the power generation industry. The collaboration between two industry leaders will see Shell Cansolv capitalize from Technip's experience in the design, construction, and management of large EPC projects and its commercial global footprint. This new cooperation will also expand Shell Cansolv's international reach by giving the company a platform to offer its CO2 capture technology in increased scope as well as to new markets."

According to DLA Piper[29], "Engineering, Procurement and Construction (EPC) contracts are the most common form of contract used to undertake construction works by the private sector on large-scale and complex infrastructure projects. Under an EPC contract, a contractor is obliged to deliver a complete facility to a developer who need only turn a key to start operating the facility, hence EPC contracts are sometimes called turnkey construction contracts. In addition to delivering a complete facility, the contractor must deliver that facility for a guaranteed price by a guaranteed date and it must perform to the specified level. Failure to comply with any requirements will usually result in the contractor incurring monetary liabilities."

Saskpower's Boundary Dam CCS project, which is currently under constructions, is using the Shell-Cansolv process. SNC Lavalin is the EPC contractor there, and has to deliver the following process guarantees described in **"Inside Boundary Dam, The Carbon Capture Technology At The Heart Of The World's Largest Post Combustion CCS Project"; Devin Shaw, Manager – Strategic CCS Projects, January 23rd, 2014[30]:**

- *"Steam Consumption*
- *CO2 Removed (delivered for compression)*
- *Electricity consumption on critical equipment*
- *Solvent(s) & chemical consumption"*

[28] http://www.technip.com/en/press/technip-and-shell-cansolv-strengthen-co2-capture-technology
[29] http://www.dlapiper.com/files/Publication/18413b26-49b8-490e-acc6-3ff54faa55d7/Presentation/PublicationAttachment/1205e08d-e585-479d-ac17-42135efaf044/epc-contracts-in-the-power-sector.pdf
[30] http://wyia.org/wp-content/uploads/2014/01/devin-shaw.pdf

Mitsubishi Heavy Industries KM CDR Process/KS-1 Amine Solvent

Mitsubishi Heavy Industries (MHI) developed the Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process) for CO2 capture, which uses a proprietary hindered amine solvent, called KS-1. Commercial applications to date have been on fertilizer and chemical plants, with maximum capture capacity up to 450 tons per day (T/D). MHI has also developed a large-scale basic design package for a 3,000 metric T/D -single train capture unit.

According to MHI's website:

"[t]he package is now ready for delivery on demand under full commercial arrangements" for gas boilers.[31]

The KM CDR Process is used at Southern Company's Plant Barry coal-fired power plant in Mobile, Alabama. For the first stage of the project, 0.15 million tons of CO2 is being captured annually from a 25 MW slip stream. The captured CO2 is being sequestered in a saline reservoir at Denbury Resources' Citronelle Oil Field in Bucks, Alabama in partnership with the Southeast Regional Carbon Sequestration Partnership (SECARB).

"World's First Integrated CCS of Coal-fired Power Plant Emissions Begins"; Mitsubishi Heavy Industries America, Inc., Tuesday, September 18, 2012.[32]

"Through participation in the world's largest-scale CO2 capture project at Plant Barry, MHIA intends to show the high-level economic feasibility and reliability of MHIA's technology in the commercial-scale CO2 capture from coal-fired power plant flue gas, and looks to further its commercialization globally".

Econamine

"Fluor's Econamine FG Plus^{SM} Technology For CO2 Capture at Coal-Fired Power Plants"; Satish Reddy, Dennis Johnson, John Gilmartin; Presented at the Power Plant Air Pollutant Control "Mega" Symposium, August 25-28, 2008, Baltimore, Maryland.[33]

"Fluor's proprietary Econamine FG^{SM} technology is a proven, cost-effective process for the removal of CO2 from low-pressure, oxygen containing flue gas streams. The performance of the process has been successfully demonstrates on a commercial scale over the past 20 years.

Through rigorous laboratory and field tests, Fluor has made added several enhancement features to further reduce the process energy consumption. In conjunction with the Econamine FG^{SM} technology, these enhancement features are now available at the improved Econamine FG Plus^{SM} technology. Any

---

[31] https://www.mhi.co.jp/en/products/detail/km-cdr_largeplant.html
[32] http://www.mitsubishitoday.com/ht/display/ArticleDetails/i/9454
[33] http://www.fluor.com/SiteCollectionDocuments/EFG_forCO2CaptureatCoal-FiredPowerPlants-PPAP_Aug2008.pdf

combination of these enhancement features can be assembled in a custom-fit solution to optimize each and every CO2 capture application. Furthermore, the Econamine FG Plus^{SM} process offers an improved environmental signature and can be configured around tight area requirements.

Fluor has developed a pre-treatment process for applying EFG+ technology to coal fired power plants. The strategy consists of three options for polishing scrubbing and incorporates Fluor's experience in large FGD projects"

"Report to the Global CCS Institute, Final Front-End Engineering and Design Study Report"; Tenaska Trailblazer Partners, LLC, January, 2012.[34]

"Tenaska and Fluor achieved the goals of the CC Plant FEED study, resulting in:

- *A design which meets Tenaska and industry standards and notably so in the areas of safety (through incorporation of the findings from the hazard and operability study and air dispersion modeling) and environmental profile (through specification of the CO2 capture rate at and permitted air emissions in the design basis);*
- *Confirmation that the technology can be scaled up to a constructable design at commercial size through (1) process and discipline engineering design and computational fluid dynamics (CFD) analysis, (2) 3D model development, and (3) receipt of firm price quotes for large equipment;*
- *[…]*
- *Establishment of performance guarantees which, after the addition of an appropriate margin, were consistent with the expected performance in Fluor's indicative bid."*

[34] http://cdn.globalccsinstitute.com/sites/default/files/publications/32321/traiblazer-front-end-engineering-and-design-study-report-final.pdf