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Feasibility and Carbon Capture and Sequestration: Will Commercial Deployment of Carbon Capture and Sequestration Pass the Test

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FEASIBILITY AND CARBON CAPTURE AND SEQUESTRATION: WILL COMMERCIAL DEPLOYMENT OF CARBON CAPTURE AND SEQUESTRATION PASS THE TEST?

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The United States' government has developed a policy that supports the use and deployment of commercial level carbon capture and sequestration as a method for reducing carbon emissions from major electricity generating sources. The Environmental Protection Agency must determine which current provisions of the Clean Air Act are best used to regulate greenhouse gases and then apply the feasibility principle to determine what level of emissions reductions will be required. The Clean Air Act will be, at best, a clumsy tool for regulating greenhouse gases, and the feasibility determinations that the Environmental Protection Agency will have to make in setting the technology-based standards under the Act are inexact and time consuming. In order for America to act efficiently and effectively to address climate change causing greenhouse gas emissions and to put in place innovative technology, such as carbon capture and sequestration, new legislation should be enacted which establishes a new statutory regime for the regulation of these chemicals and a new, less discretionary process for putting innovative and highly effective emissions reducing technologies in place.

I. INTRODUCTION

Increasingly, implementation of methods for managing the greenhouse gas ("GHGs")[2] emissions that cause climate change[3] is

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a hot topic of discussion for America and the world.[4] Considering the technological complexities and cost of reducing GHG emissions and America's broader policy objectives of reducing the effects of climate change, attaining a balance between existing regulation and new policies[5] is a critical step in properly implementing effective emissions reductions.

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[2] "Greenhouse gases are gases that effectively trap some of the Earth's heat that would otherwise escape to space. Greenhouse gases are both naturally occurring and anthropogenic. The primary greenhouse gases of concern directly emitted by human activities include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride." Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886, 18,888 (Apr. 24, 2009) (to be codified 40 C.F.R. pt. 1) [hereinafter Proposed Endangerment].

[3] Climate change is the change in global climatic cycles due to the build-up of GHGs emitted by humans. Daniel Brian, *Regulating Carbon Dioxide Under the Clean Air Act as a Hazardous Air Pollutant*, 33 COLUM. J. ENVTL. L. 369, 370 (2008). The results of these changed cycles include increased drought, rising sea levels, increased tropical cyclone activity and ferocity, and higher average temperatures. Maxine Burkett, *Just Solutions to Climate Change: A Climate Justice Proposal for a Domestic Clean Development Mechanism*, 56 BUFF. L. REV. 169, 174 (2008). Greenhouse gases "become well mixed globally in the atmosphere and their concentrations accumulate when emissions exceed the rate at which natural processes remove greenhouse gases from the atmosphere." Proposed Endangerment, *supra* note 2, at 18,888.

[4] From the U.S.'s reluctance to signing on to the Kyoto Protocol to the recent House passage of the American Clean Energy and Security Act, H.R. 2454, climate change issues have grown ever more prevalent in America and around the world. *See, e.g.*, Alexandra B. Klass and Elizabeth J. Wilson, *Climate Change and Carbon Sequestration: Assessing a Liability Regime for Long-Term Storage of Carbon Dioxide*, 58 EMORY L.J. 103, 103 (2008).

[5] The existing legal framework under which GHG emissions may be regulated is the Clean Air Act. 42 U.S.C. §§ 7401–7671q (2006). Programs that may be applicable to GHG regulation are the Prevention of Significant Deterioration, 42 U.S.C. §§ 7470–7479 (2006), and the National Ambient Air Quality Standard. 42 U.S.C. §§ 7408–7409 (2006); *see infra* Part V.A. Proposed legislation, such as the American Clean Energy and Security Act ("ACES"), would create a new regulatory framework for GHG emissions. American Clean Energy and Security Act, H.R. 2454, 111th Cong. (2009).

The feasibility principle guides the balancing of factors when determining what level of emissions reductions may be possible.[6] Under the current statutory regime, the Clean Air Act's Prevention of Significant Deterioration program would likely apply.[7] Language such as "best" and "achievable" are what would guide the Environmental Protection Agency's standard-setting decisions.[8] These terms are broad and could lead to any number of standards being set. The feasibility principle guides the application of this standard by providing both a ceiling and a floor for what the standard may demand.[9]

The aim of this Recent Development is to consider the technology and policy that must be in place prior to the Environmental Protection Agency ("EPA") or another federal agency finding that commercial deployment of carbon capture and sequestration ("CCS") is a feasible means of reducing carbon dioxide ("CO_2") emissions. Part II provides a background of recent actions by the Supreme Court and United States Congress on CO_2 emissions. Part III discusses the technology as it stands today, specifically, the scientific and economic barriers to large-scale implementation of CSS. Part IV examines EPA's historical and current implementation of "feasibility." Finally, Part V addresses how current statutory language might apply to commercial deployment of CCS[10] in the United States and the policy considerations that follow. As federal agencies determine the feasibility of commercial deployment of emissions reducing technologies under the Clean Air Act ("CAA"), new federal legislation, such as the American Clean Energy and Security Act,

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6 David M. Driesen, *Distributing the Costs of Environmental, Health, and Safety Protection: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform*, 32 B.C. ENVTL. AFF. L. REV. 1, 17–18 (2005).

7 *See infra* Part IV.B.

8 *See, e.g.*, 42 U.S.C. § 7479(3) (2006) (defining the standard "best available control technology").

9 Driesen, *supra* note 6 at 41–42.

10 ACES defines "commercial capacity" for CCS technology as "appl[ying] the carbon capture and sequestration technology to the flue gas from at least 200 megawatts of the total name plate generating capacity of the unit." American Clean Energy and Security Act, H.R. 2454 § 115, 111th Cong. (2009).

may be required to ensure proper implementation of innovative technologies.

II. BACKGROUND

In the groundbreaking case *Massachusetts vs. EPA*,[11] the United States Supreme Court substantively weighed in on the issue of climate change for the first time. The petitioners in this case were a collection of states and non-profit organizations who requested that the EPA regulate new automobile emissions standards under § 202 of the CAA.[12] The majority opinion declared that, to date, the scientific evidence indicates that climate change is a real and current phenomenon.[13] As a result of this decision, the EPA released a proposed endangerment finding for GHGs.[14] This proposed finding would list GHGs as air pollutants under the definition of air pollutant in § 302 of the CAA.[15] Once this agency finding is final,[16] the EPA may be obligated to promulgate regulations for GHG emissions on stationary sources

[11] 549 U.S. 497 (2007).

[12] *Id.* at 505.

[13] *Id.*

[14] Proposed Endangerment, *supra* note 2 at 18,886. As part of this same process, the EPA has issued a proposed regulation for emissions standards for new automobiles. *Id.*

[15] Proposed Endangerment, *supra* note 2 at 18,886. The definition of air pollutant under § 302 applies to both mobile sources, at issue in *Massachusetts v. EPA*, and stationary sources of GHG emissions under § 108, § 111, and § 165. 42 U.S.C. § 7602(g) (2006) (defining air pollutant for provisions of the CAA that do not contain their own definition of that term, including the sections listed above). Mobile sources are "any class or classes of new motor vehicles or new motor vehicle engines." 42 U.S.C. § 7521(a)(1) (2006). "The term 'stationary source' means any building, structure, facility, or installation which emits or may emit any air pollutant." Standards of performance for new stationary sources, Clean Air Act, 42 U.S.C. § 7411(a)(3) (2006).

[16] Before making a regulatory decision under the CAA, such as an endangerment finding for GHGs, the EPA must publish its proposed rule in the Federal Register, grant time for the public to comment on the proposal, and respond to all significant comments. Only then can it finalize the rule. 42 U.S.C. § 7607(d)(2)–(7) (2006).

of carbon dioxide and greenhouse gases, such as electricity generating units and industrial factories.[17]

The U.S. Congress has taken up the issue of climate change.[18] In June 2009, the U.S. House of Representatives passed the American Clean Energy and Security Act ("ACES"), H.R.2454, which has vast implications for GHG emissions in the United States through provisions including national energy efficiency standards,[19] a GHG cap-and-trade program,[20] and funding for communities that will be directly impacted by the effects of climate change.[21] A draft of the Senate's companion bill was introduced by Senators Boxer and Kerry in September 2009,[22] with floor debate on the issue possible in fall 2009, though it is more likely to occur in spring 2010.[23] This proposed legislation would

[17] *See, e.g.*, Prevention of Significant Deterioration (PSD): Reconsideration of Interpretation of Regulations that Determine Pollutants Covered by the Federal PSD Permit Program, 74 Fed. Reg., 51,535, 51,537 (Oct. 7, 2009) (to be codified at 40 CFR pt. 52); EPA Fact Sheet—Reconsideration of Former Administrator Johnson Interpretive Memo on Definition of Pollutants Covered Under the Clean Air Act, Sept. 30, 2009, http://www.epa.gov/nsr/ fs20090930 guidance.html (last visited Nov. 2, 2009) (on file with the North Carolina Journal of Law & Technology).

[18] *See, e.g.*, John Kerry and Lindsay Graham, *Yes We Can (Pass Climate Legislation)*, N.Y. TIMES, Oct. 10, 2009, WK11 New York Edition, http://www.nytimes.com/2009/10/11/opinion/11kerrygraham.html (on file with the North Carolina Journal of Law & Technology).

[19] H.R. 2454 §§ 101, 171–75, 201–19.

[20] H.R. 2454 §§ 311, 321, 331.

[21] H.R. 2454 §§ 451–82.

[22] Clean Energy Jobs and American Power Act, S. 1733, 111th Cong. (2009). The Kerry-Boxer bill was debated in Senate committees through the month of November, 2009. *See, e.g.*, Juliet Eilperin, *Boxer: Climate Bill Markup Will Go Forward Tuesday, With or Without GOP*, THE WASHINGTON POST, Nov. 2, 2009, http://voices.washingtonpost.com/capitol-briefing/2009/11/boxer_climate_bill_markup_will.html (on file with the North Carolina Journal of Law & Technology).

[23] David B. Finnegan and Roger W. Patrick, *US Senate Energy and Natural Resources Committee Adopts Wide-Ranging Energy Bill; Clean Energy Leadership Act of 2009*, Mondaq Business Briefing, August 13, 2009, http://www.mondaq.com/article.asp?articleid=84686 (on file with the North Carolina Journal of Law & Technology).

lead to economic constraints on sources of GHG emissions[24] that are defined as regulated entities in the bills,[25] creating a system in which there will be a unit price per ton on GHGs released into the atmosphere.[26]

As carbon regulation looms,[27] either through regulatory mechanisms under current statutory structure or through new legislation,[28] the coal utility industry, which is one of the largest sources of CO_2 emissions in the United States,[29] is developing technologies to keep this fuel source a viable option.[30] Power companies are exploring options such as changing to more efficient fuel sources for old electricity generating units. For example, natural gas may be used to produce electricity while emitting less CO_2 per unit of energy produced.[31] Industry is also

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[24] Common sources of GHG emissions include electricity generating units and industries which use fossil fuels for combustion purposes. Inventory of U.S. Greenhouse gas Emissions and Sinks:

1990–2007, EPA 430-R-09-004, ES-6 (April 15, 2009). Additional sources of GHG emissions include landfills, fertilizer producing entities, and commercial animal production facilities. *Id.*

[25] H.R. 2454 § 312.

[26] Kate Sheppard, *Everything You Always Wanted to Know About the Waxman-Markey Energy/Climate Bill—In Bullet Points*, GRIST, June 8, 2009, http://www.grist.org/article/2009-06-03-waxman-markey-bill-breakdown/ (on file with the North Carolina Journal of Law & Technology).

[27] *See infra* Part V.

[28] Jessica Leber and Christa Marshall, *Climate Bill Drifts Into a Potomac Fog*, N.Y. TIMES, Sept. 17, 2009, http://www.nytimes.com/cwire/2009/09/17/17 climatewire-climate-bill-drifts-into-a-potomac-fog-96749.html (on file with the North Carolina Journal of Law & Technology).

[29] Eric Williams, et al., *A Convenient Guide to Climate Change Policy and Technology* 36 (Nicholas Institute for Environmental Policy Solutions and The Center on Global Change, Duke University, Working Paper CCPP 07-02 July 2007). Coal-fired power plants in the U.S. "generate approximately fifty percent of electricity and produce eighty-five percent of electricity-generated carbon dioxide (CO_2) emissions." *Id.*

[30] George R. Offen, *EPRI—Meeting the Challenge of Affordable, Coal-Based Electricity Generation in a Carbon-Constrained World*, CARBON CAPTURE JOURNAL, March–April 2009, at 7.

[31] Williams, *supra* note 29, at 37–40.

exploring new technologies, which burn fuel more efficiently and thus more cleanly.[32]

One of the primary ways the coal utility industry hopes to reduce emissions is through the capture and storage of emissions.[33] CCS is a process by which the emissions from a source,[34] primarily CO_2, are captured and stored indefinitely in geologic formations.[35] CCS could potentially reduce a given source's CO_2 emissions by eighty percent to ninety-five percent[36] and could contribute to projected international CO_2 emissions reductions by nineteen percent.[37] The risks, of course, are great.[38] For instance, accidental leakage of stored CO_2 could create localized risks to the

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[32] *See, e.g.*, Kenneth J. Stier, *Dirty Secret: Coal Plants Could Be Much Cleaner*, N.Y. TIMES, May 22, 2005, http://www.nytimes.com/2005/05/22/business/yourmoney/22coal.html (on file with the North Carolina Journal of Law & Technology). Integrated gasification combined cycle is a technology that turns traditional fossil fuels into hydrogen gas, which is then used in highly efficient combustion and electricity production. Williams, *supra* note 29, at 69.

[33] Congress has provided funding for commercial carbon capture and sequestration research in the Stimulus Bill passed in 2009, American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 1131, 123 Stat. 115, 325 (to be codified at 26 U.S.C. § 45Q), and the House of Representatives provided an extensive framework for establishing a national public-private cooperative research program to promote commercial CCS in the American Clean Energy and Security Act of 2009. H.R. 2454 § 114.

[34] It is a power plant in this case, but theoretically, any stationary source could have its carbon emissions captured. Paul W. Parfomak and Peter Fogler, CARBON DIOXIDE (CO_2) PIPELINES FOR CARBON SEQUESTRATION: EMERGING POLICY ISSUES, CRS ORDER CODE RL33971, at 1 (Apr. 19, 2007).

[35] *See infra* Part III.

[36] Parfomak and Fogler, *supra* note 34, at 1.

[37] Victor B. Flatt, *Paving the Legal Path for Carbon Sequestration from Coal*, 19 DUKE ENVTL. L. & POL'Y F. 211, 212–13 (2009).

[38] Klass and Wilson, *supra* note 4, at 118–19.

environment and public health[39] and reverse any climate benefit gained from capture and sequestration.[40]

Despite the fact that commercial capacity[41] for CCS is, at best, years away,[42] Congress and industry are moving forward with research and development of this technology.[43] For example, Congress included one billion dollars of funding to promote CCS research in the stimulus bill in 2009.[44] Most recently, ACES, passed by the House of Representatives in June 2009, includes

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[39] *Id.* at 118–19 ("[V]ery high concentrations (greater than [thirty percent]) CO_2 may cause immediate human death from asphyxiation; prolonged exposure to high concentrations of CO_2 (above [three percent] concentration) may cause a variety of negative health effects. Slow CO_2 seepage into the near subsurface could also harm flora and fauna, and potentially cause local disruptions of ecology or agriculture.") (internal citations omitted).

[40] *Id.* at 118 ("With respect to global climate change, small surface leaks may be tolerated, but excessive CO_2 leaking into the atmosphere (greater than 0.01%–1% per year) will diminish the climate benefits from sequestration . . . . The risks from CCS are associated with both the sheer volume of injected material and the specific properties of CO_2. CCS risks will vary throughout the life-cycle of a CCS project and are affected by local and regional geology and site history. These risks will likely decrease after injection ceases, as formation buoyancy pressures naturally decrease.").

[41] Commercial capacity refers to large electricity-generating units. These power plants are generally referred to by their capacity in megawatts of electricity produced. ACES defines "commercial capacity" for CCS technology as "applying the carbon capture and sequestration technology to the flue gas from at least 200 megawatts of the total name plate generating capacity of the unit." H.R. 2454 § 115.

[42] *See, e.g.*, Keith Johnson, *King Coal: Waxman-Markey Bill Opens Door to Dirty Coal*, WALL ST. J. BLOGS: ENVIRONMENTAL CAPITAL, http://blogs.wsj.com/environmentalcapital/2009/04/06/king-coal-waxman-markey-bill-opens-door-to-dirty-coal/ (on file with the North Carolina Journal of Law & Technology) (opposing the policy reliance on CCS) and Fact Sheet, National Mining Association, Carbon Capture and Sequestration (on file with the North Carolina Journal of Law & Technology) (explaining the timeline from current stages of research to commercial deployment).

[43] *See* Offen, *supra* note 30.

[44] American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 1131, 123 Stat. 115, 325 (to be codified at 26 U.S.C. § 45Q).

extensive provisions for research and incentives to industry to implement the technology early.[45]

III. CCS TECHNOLOGY

There are many ways in which carbon may be sequestered,[46] but this Recent Development will focus on geologic CCS. CCS technology allows for the capture of the emissions from a "stationary source,"[47] the purification and concentration of the CO_2 in those emissions, and the transportation and storage of "supercritical CO_2"[48] in an appropriate geologic formation for hundreds to thousands of years.[49] If this sounds too simple to be true, it is. Each step takes technical precision and occurs at non-negligible cost.[50]

A. *Capture, Purification, and Concentration*

When CO_2 comes out of the smoke stack of an average electricity-generating unit, it comprises only fourteen to fifteen

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[45] Section 114 of ACES establishes a public-private partnership, Carbon Storage Research Corporation ("Corporation"), to promote deployment of CCS technologies. The Corporation receives funding through annual assessments on electric utilities and distributes and manages grants for research to promote commercial-scale CCS demonstration sites. H.R. 2454 § 114(b). The Corporation may collect between $1 and $1.1 billion each year through assessments. H.R. 2454 § 114(d)(1)(B). ACES instructs the Corporation to distribute 50% of its grants to entities that have employed CCS technology in advance of any grant awarded under this bill. H.R. 2454 § 114(c)(4). In doing so, the bill rewards these so called "early movers" and promotes early deployment of commercial-scale CCS technology. *See id.*

[46] Williams, *supra* note 29, at 230–40. For example, carbon may be sequestered through biological functions in forests and oceans. *Id.*

[47] *See supra* note 15.

[48] Williams, *supra* note 29, at 243–44 ("At pressures above 73 atmospheres and temperatures above 31.1° C, CO_2 exceeds its critical point and enters the supercritical phase, a homogenous state that has properties midway between those of a gas and liquid.") (internal citations omitted). *Id. See also infra* note 62.

[49] *See, e.g., id.* at 241; Edward Rubin, et al., *Technical Summary*, *in* IPCC SPECIAL REPORT ON CARBON DIOXIDE CAPTURE AND STORAGE 17, 25 (Bert Metz et al. eds., 2005) [hereinafter IPCC SPECIAL REPORT].

[50] *See infra* Parts II.A–C.

percent of the concentration of the emissions.[51] While it is technically possible to transport and sequester that gas stream in its entirety, the process is cost-prohibitive.[52] Storing the entire stream of emission, without concentrating and removing the CO_2, would result in transporting and storing at least eighty-five percent more volume than required for simply storing CO_2. Thus, it is necessary to capture and concentrate a pressurized stream of CO_2 for transportation.[53]

The upfront costs of retrofitting an existing coal-fired power plant or constructing a new plant with the technology to capture, clean, and pressurize its emission stream for geologic storage are great.[54] The technology to capture CO_2 from a stream of emissions is used in multiple industrial sites for purification of other gases such as hydrogen and natural gas.[55] Currently, technology exists allowing for carbon capture in one of three ways: post-combustion,[56] pre-combustion,[57] and oxyfuel combustion.[58]

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[51] IPCC SPECIAL REPORT, *supra* note 49, at 25. The majority of gasses that make up the rest of the emissions are nitrogen oxides and other common atmospheric compounds. *Id.*

[52] *Id.*

[53] *Id.*

[54] *Id.* at 27. "CO_2 capture increases the cost of electricity production by 35–70% . . . for [a natural gas combined cycle] plant, 40–85% . . . for a supercritical [pulverized coal] plant, and 20–55% . . . for an [integrated gasification combined cycle] plant. Overall, the electricity production costs for fossil fuel plants with capture (excluding CO_2 transport and storage costs) ranges from 0.04–0.09 [United States' dollar per kilowatt hour], as compared to 0.03–0.06 [United States' dollar per kilowatt hour] for similar plants without capture." *Id.*

[55] *Id.* at 25. "Applications separating CO_2 in large industrial plants, including natural gas treatment plants and ammonia production facilities, are already in operation today. Currently, CO_2 is typically removed to purify other industrial gas streams." *Id.*

[56] *Id.* In a post-combustion system, the stream of gases emitted after the fuel is burned is forced through a liquid solvent, resulting in a concentration and purification of the emissions. See *id.*

[57] *Id.* In a pre-combustion system, the fuel source is processed "with steam and air or oxygen to produce a mixture consisting mainly of carbon monoxide and hydrogen." Another mixture is then combined with the carbon monoxide to produce a pure stream of hydrogen, which can be used as a fuel source for electricity production, and pure CO_2, which can be processed and stored. *Id.*

Each has its benefits and costs, and use of one technology over another depends on site-specific characteristics.[59] Once an emission stream has been captured, it must be purified and compressed.[60] In its "supercritical"[61] state, after purification and compression, CO_2 acts neither entirely as gas nor as liquid and is transportable to the injection site.[62]

Anywhere from ten to forty percent additional energy is required to capture and compress a stream of CO_2.[63] With this energy consumption additional to the amount used to produce electricity without carbon capture, total emissions would still be reduced by as much as eighty to ninety percent.[64] The additional energy required for capturing CO_2 emissions and preparing them for transportation and storage, then balances out with the emissions savings.[65] In the current regulatory scheme, there is no additional cost put on carbon emissions.[66] If that changes and a regulatory scheme is enacted which puts a cost on carbon,[67] then the economic

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[58] *Id.* The third method for capturing CO_2 from an emissions source is oxyfuel combustion. This process uses "oxygen instead of air for combustion of the primary fuel to produce a flue gas that is mainly water vapourand CO_2." The emissions from this type of combustion have a very high concentration of CO_2, and treatment for removal of water vapor and other pollutants is necessary before transport and storage. *Id.*

[59] *Id.* For example, "[p]re-combustion would be used at power plants that employ integrated gasification combined cycle (IGCC) technology." *Id.*

[60] *Id.*

[61] Williams, *supra* note 29, at 243.

[62] *Id.* In order to be transported through pipeline, CO_2 must be at 100 atmospheres of pressure. *Id.* Since CO_2 reaches its supercritical state at any pressure above 73 atmospheres, CO_2 must be in a supercritical state in order to be transported via pipeline. *Id.*

[63] IPCC SPECIAL REPORT, *supra* note 49, at 25.

[64] *Id.*

[65] *Id.*

[66] *See supra* Part II, discussing *Massachusetts v. EPA*. "Carbon," in this sense, includes other GHGs as well. *See, e.g.*, H.R. 2454 § 311. There are accepted "equivalency" values established for other GHGs that can be used to gauge the impact on the environment of such chemicals compared to the impact of carbon. *Id.*

[67] For example, ACES, passed by the House of Representatives this June, would enact such a scheme. H.R. 2454 Title III. It has been suggested that the cap-and-trade provisions of ACES would put a cost on carbon of approximately

scales may tip in favor of limiting the amount of CO_2 in emissions.[68] Other technological considerations, such as fuel source[69] and newer combustion technology,[70] reduce CO_2 emissions in coal-fired power plants.[71] A combination of CCS technology and other efficiency measures should be considered when determining the appropriate way to limit CO_2 releases in the atmosphere.[72] By increasing efficiency at the power plant, in transmission, and at points of consumption, costs incurred to comply with GHG emissions reduction regulations could be at least partially offset.[73]

B. *Transportation*

While supercritical CO_2 can be transported by truck, boat, or train, the least expensive transportation method is via pipeline.[74] Least expensive is perhaps a misleading phrase, though. Depending on the diameter of the pipeline, it can cost anywhere from many hundreds of thousands of dollars per mile to over a million and a half dollars per mile.[75] Costs included in this range are purchase of rights-of-way, pipeline construction, and materials.[76] These costs can increase if the pipeline must be sited

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twenty dollars per ton. David Serchuk, *Calculating the True Cost of Carbon*, FORBES.COM, June 3, 2009, http://www.forbes.com/2009/06/03/cap-and-trade-intelligent-investing-carbon.html (on file with the North Carolina Journal of Law & Technology).

[68] *Id.*

[69] IPCC SPECIAL REPORT, *supra* note 49, at 39.

[70] *Id.* at 26.

[71] *Id.*

[72] Interview by Steve Inskeep with Steven Chu, Energy Secretary, U.S. Dep't of Energy, National Public Radio, Morning Edition, September 14, 2009, transcript *available at* http://www.npr.org/templates/transcript/transcript.php?storyId=112755481.

[73] *Id.*

[74] Williams, *supra* note 29, at 244.

[75] *Id.* at 245. According to this CCPP report, pipeline that is sixteen inches in diameter can cost $704,000 per mile, and pipeline 36 inches in diameter can cost $1,584,000 per mile. *Id.* "Steel cost accounts for a significant fraction of the cost of a pipeline, so fluctuations in such cost (such as the doubling in the years from 2003 to 2005) could affect overall pipeline economics." IPCC SPECIAL REPORT, *supra* note 49, at 30.

[76] IPCC SPECIAL REPORT, *supra* note 49, at 30.

through heavily populated or physically unstable areas such as wetlands.[77]

Pipeline siting and construction is not new technology,[78] and the transportation of CO_2 should pose little in the way of a technological challenge.[79] It has been proposed that existing natural gas pipeline rights-of-way be used to site CO_2 pipelines[80] and that industrial emitters cooperate to construct a nationwide CO_2 pipeline.[81] Such a coordinated effort would reduce costs to individual emitters and would create a more efficient transport mechanism to possibly distant storage sites.[82]

C. *Sequestration/Storage*

Sequestration of CO_2 requires injection into an appropriate geologic formation and trapping the CO2 in that formation for hundreds to thousands of years. Injection of supercritical CO_2 into geologic formations is a common practice in the industrial practice of enhanced oil and natural gas recovery.[83]

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[77] *Id.*

[78] *Id.* at 26.

[79] Williams, *supra* note 29, at 244. "Unique engineering and safety considerations for CO_2 piping projects include: CO_2 must be completely dehydrated to prevent carbonic acid formation and degradation of the pipeline. Supercritical CO_2 physical and chemical properties necessitate the use of specific materials and sealants." *Id.* at 244.

[80] It is no small feat to acquire the necessary rights-of-way to construct an interconnected, nationwide pipeline network. Jonas Monast, From Carbon Capture to Storage: Designing an Effective Regulatory Structure for CO_2 Pipelines, 8 (Nicholas Institute for Environmental Policy Solutions and The Center on Global Change, Duke University, Working Paper CCPP 08-05 December 2008). Using an existing network for as much of the citing as possible would greatly reduce risk and cost to investors. Williams, *supra* note 29, at 246. Of course, emitters coordinating in such an effort would then have to negotiate usage with the current owners of the natural gas pipeline rights-of-way. *Id.* Alternatively, the federal government could coordinate such efforts through policy changes, funding, or other methods. *Id.*

[81] Williams, *supra* note 29, at 246.

[82] *Id.*

[83] IPCC SPECIAL REPORT, *supra* note 49, at 19.

Three primary geologic formations seem appropriate for sequestration and storage of CO_2.[84] Unminable coal seams, depleted oil and natural gas fields, and saline aquifers all provide possible storage capacity for captured CO_2.[85] Research on the possible implications of each formation is currently underway.[86] Many sites that are appropriate for coal-fired power plants are in reasonable proximity to geologic formations that are possibly appropriate for CO_2 storage,[87] so site selection for future power plant construction could play a big role in the economic impact of CCS on each plant. In the U.S., the Appalachian Basin, the Midwest, and Gulf Coast regions contain identified geologic formations appropriate for sequestration of carbon.[88]

Of additional concern is the longevity of the storage potential at each site. If the purpose of implementing CCS technology is to reduce emissions as a way to address global climate change, then the sequestered carbon must remain stored for hundreds, if not thousands of years.[89] To date, the longest running research facility with commercial CCS capacity[90] has been operational for thirteen years.[91] The scientific data upon which the CCS research projects are based indicate chemical processes which should take thousands of years to conclude, thus trapping the injected CO_2 for at least that

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[84] *Id.* at 31.
[85] *Id.* at 25.
[86] Offen, *supra* note 30, at 7.
[87] IPCC SPECIAL REPORT, *supra* note 49, at 25.
[88] Williams, *supra* note 29, at 243–44. These regions contain both depleted oil and natural gas fields and unminable coal seams. *Id.*
[89] *See generally* Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886, 18,888 (April 24, 2009) (to be codified 40 C.F.R. pt. 1). The amount of time that CO_2 remains in the atmosphere is on the order of up to hundreds of years. *Id.* In order to effect the changes already occurring, future CO_2 emissions that are sequestered need to remain trapped for that amount of time. *Id.*
[90] The Sleipner Project in Norway has been operational since 1996. IPCC SPECIAL REPORT, *supra* note 49, at 201–02. The site injects 3000 tons of carbon a day into a saline aquifer. *Id.*
[91] *Id.* at 201.

long.[92] While all indications are that CO_2 is remaining where it is put,[93] it is premature to say the data are complete.[94]

IV. TECHNOLOGY-BASED STANDARDS AND THE FEASIBILITY PRINCIPLE

A. *Technology-Based Standards*

Technology-based standards are emissions control levels established by the EPA on a particular technology's achievable level of emissions reductions.[95] Once the EPA establishes a technology-based standard for a statutory provision, all regulated entities in the relevant class of industry should meet the emissions reduction achievable under that standard.[96] These kinds of standards are found in both the Clean Water Act[97] and the CAA.[98]

Technology-based standards were first incorporated into the CAA in the 1970 amendments to § 111.[99] Prior to that date, implementation of emissions reductions were based on increasing levels of federal involvement in state programs.[100] In 1955, "Congress initially responded to the problem of air pollution by offering encouragement and assistance to the States."[101] After several rounds of amendments,[102] Congress included the § 111

[92] *Id.* at 32.

[93] Williams, *supra* note 29, at 246–47.

[94] Currently, data have been collected for just more than a decade. In order for CCS to achieve climate change related-goals, the CO_2 will have to remain underground for hundreds to thousands of years. *See, e.g.*, IPCC SPECIAL REPORT, *supra* note 49 at 204–05 (explaining the status of CCS pilot projects and raising questions currently unanswered about sequestration technology).

[95] Patricia Ross McCubbin, *The Risk in Technology-Based Standards*, 16 DUKE ENVTL. L. & POL'Y F. 1, 2 (2005); Driesen, *supra* note 6, at 17–18.

[96] *See, e.g.*, McCubbin, *supra* note 95, at 2; Portland Cement Ass'n v. Ruckelshaus, 486 F.2d 375, 389 (D.C. Cir. 1973).

[97] 33 U.S.C. §§ 1251–1387 (2006).

[98] 42 U.S.C. §§ 7401–7671q (2006).

[99] 42 U.S.C. § 111(a)(1) (2006). Section 111 of the CAA establishes the New Source Performance Standard which regulates emissions from new stationary sources of criteria pollutants. 42 U.S.C. § 111 (2006).

[100] McCubbin, *supra* note 94, at 2.

[101] Train v. Nat. Res. Def. Council, Inc., 421 U.S. 60, 63 (1975).

[102] *Id.* at 63–64.

standards in the New Source Performance Standards provisions of the CAA.[103] In making this shift to technology-based standards, Congress set guidelines by which the EPA would regulate emissions reductions and achieve environmental and public health benefits.[104]

As will be discussed in Part V, of particular interest in considering GHG regulation and possible implementation of CCS is the CAA's "best available control technology" requirement ("BACT").[105] BACT sets a maximum level of emissions for each pollutant based on the emission-reducing ability of the technology that the EPA deems the "best available."[106] In setting BACT, the EPA must consider "energy, environmental, and economic impacts and other costs."[107]

B. *Applying the Feasibility Principle to Technology-Based Standards*

"Feasible" is defined as both "capable of [being] accomplished or brought about" and to "deal with successfully."[108] The definition also includes "possible."[109] The feasibility principle relates to the EPA's BACT determinations in that it "provides guidance [as EPA] decide[s] how much pollution reduction to

[103] 42 U.S.C. § 111.

[104] *See generally* Driesen, *supra* note 6, at 18 (discussing Congress's use of technology-based standards to guide administrative agencies' decision making).

[105] *See infra* Part V.A. Under current regulatory provisions, the EPA is most likely to regulate GHG emissions through the Prevention of Significant Deterioration ("PSD") program. Under PSD, the BACT standard would apply. EPA Fact Sheet—Reconsideration of Former Administrator Johnson Interpretive Memo on Definition of Pollutants Covered Under the Clean Air Act, http://www.epa.gov/nsr/fs20090930guidance.html (last visited Nov. 1, 2009) (on file with the North Carolina Journal of Law & Technology); Robin Bravender, *EPA Air Chief Offers 'No Apologies' for Greenhouse-Gas Permitting Rule*, N.Y.TIMES, Oct. 7, 2009, http://www.nytimes.com/gwire/2009/10/07/07greenwire-epa-air-chief-offers-no-apologies-for-greenhou-73773.html (on file with the North Carolina Journal of Law & Technology).

[106] *See* 42 U.S.C. § 7479(3) (2006).

[107] *Id.*

[108] AMERICAN HERITAGE COLLEGE DICTIONARY 499, (Houghton Mifflin Company, 3rd ed. 1997).

[109] *Id.*

demand."[110] When reading the term "best available demonstrated control technology," it is not necessarily clear how to determine what is "best" and what is "achievable."[111] The concept of feasibility, therefore, guides the application of the BACT standard by providing both a ceiling and a floor for what the standard may demand.[112] The standard cannot be stringent enough to force most or many of the regulated entities to close their doors, nor can it be so lenient as to allow pollution to continue at the pre-regulation rates.[113] The former would not be "reasonable"; the latter would not be "the best."

During the debates on the 1970 Amendments to the CAA, members of Congress recognized the possibility that new standards could lead to plant shutdowns.[114] Congress also recognized the importance of improving public health and established strict technology-based standards.[115] Since the implementation of these standards, the courts have interpreted the CAA's technology-based standards with great deference to the EPA.[116] In *Lignite Energy Council v. EPA*,[117] the D.C. Circuit noted that "[b]ecause section

[110] Driesen, *supra* note 6, at 18.

[111] Driesen, *supra* note 6, at 21. "It is hard to understand what the. . .'best' technology available refer[s] to, if not [for] the feasibility principle. The concept of achievability suggests that reductions obtainable only through widespread shutdowns are not achievable. And the concept of maximizing achievable reductions should mean that technically achievable reductions not having economic impacts closing plants should be required under these provisions." *Id.*

[112] *Id.* at 41–42.

[113] *Id.*

[114] Union Elect. v. EPA, 427 U.S. 246, 258–59 (1976) (discussing the Congressional intent when amending the CAA in 1970).

[115] *Id.*

[116] *See, e.g.*, Train v. Nat. Resources Def. Council, Inc., 421 U.S. 60 (1975); Union Electric v. EPA, 427 U.S. 246 (1976); Lignite Energy Council v. EPA and Natural Gas Supply Ass'n, 198 F.3d 930, 933 (D.C. Cir. 1999).

[117] *Lignite Energy Council*, 198 F.3d at 933. The Petitioners in this case challenged the EPA's implementation of CAA § 111, New Source Performance Standards, for nitrogen oxide emissions from electricity generating units as too restrictive. *Id.* Petitioners argued that EPA chose a more expensive technology when setting the technology-based emissions standard, and that the industry could reach nearly the same result with less expensive technologies. The Court

111 does not set forth the weight that should be assigned to each of [the enumerated factors that the EPA must consider when setting a technology-based standard],[118] we have granted the agency a great degree of discretion in balancing them."[119] In a concurring opinion in *Union Electric v. EPA*, Justice Powell reasoned that Congress could not have meant to impose a standard so strict so as to force certain critical utilities to shut down.[120] He noted that Congress established a clear intention to protect the public welfare through the 1970 CAA Amendments, but he could not believe that Congress would find it reasonable to force compliance when adherence to the standards established therein could lead to no electricity supplied to a major metropolitan area.[121] He concluded that feasibility must play some role in the EPA's discretion in setting the technology-based standard.[122]

The court in *Essex Chemical Corp. v. Ruckelhaus*[123] described the level of discretion the EPA has in setting a technology-based standard in terms of reasonableness.[124] "An achievable standard is

granted discretion to the EPA and upheld the more expensive, more restrictive technology. *Id.*

[118] For BACT, those factors are "energy, environmental, and economic impacts and other costs." 42 U.S.C. § 7479(3) (2006).

[119] 198 F.3d at 933.

[120] *Union Electric*, 427 U.S. at 269 (Powell, J., concurring).

[121] *Id.* According to Justice Powell:

> Environmental concerns, long neglected, merit high priority, and Congress properly has made protection of the public health its paramount consideration. But the shutdown of an urban area's electrical service could have an even more serious impact on the health of the public than that created by a decline in ambient air quality. The result apparently required by this legislation in its present form could sacrifice the well-being of a large metropolitan area through the imposition of inflexible demands that may be technologically impossible to meet and indeed may no longer even be necessary to the attainment of the goal of clean air. . . . Congress, if fully aware of this Draconian possibility, would strike a different balance.

Id. at 270–72.

[122] *Id.* at 269.

[123] 486 F.2d 427 (D.C. Cir. 1973).

[124] *Id.* Petitioners in this case were operators of sulfuric acid plants and coal-fired power plants, and they were challenging the EPA's technology-based standard under CAA § 111. *Id.* The Petitioners argued that the EPA set a

one which is within the realm of the adequately demonstrated system's efficiency and which, while not at a level that is purely theoretical or experimental, need not necessarily be routinely achieved within the industry prior to its adoption."[125] This sort of guidance leads the EPA to a standard that may be reasonably achieved—in short, one that is feasible.[126]

In addition to applying the feasibility principle when balancing the "energy, environmental, and economic impacts and other costs"[127] associated with implementing a proposed standard, the EPA is subject to political pressures in favor of minimizing negative economic impact to industry.[128] Thus, despite great discretion from courts[129] and clear Congressional intent that public health be top priority,[130] the EPA often gives serious consideration to the number of firms that will be put out of business during the process of proposing standards.[131] Executive Order 12,291 adds political pressure that draws the EPA away from pure feasibility determinations when setting technology-based standards.[132] This order, signed originally by President Reagan and subsequently signed by every president since,[133] requires that all substantive agency action be cleared through the Office of Management and

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standard that had not been demonstrated in practice to achieve the emissions reductions that EPA claimed were required under the new standard. *Id.* The court found that "the system [on which the technology-based standard is set]... must be adequately demonstrated and the standard which must be achievable. This does not require that a sulfuric acid plant be currently in operation which can at all times and under all circumstances meet the standards; nor, however, does it allow the EPA to set the standards solely on the basis of its subjective understanding of the problem or "crystal ball inquiry." *Id.*

[125] 486 F.2d at 433–34.

[126] *Id.* at 433.

[127] 42 U.S.C. § 7479(3) (2006).

[128] Driesen, *supra* note 6, at 46.

[129] *See Essex Chemical Corp.*, 486 F.2d at 433; Lignite Energy Council v. EPA, 198 F.3d 930, 932 (D.C. Cir. 1999).

[130] *See* Union Elec. v. EPA, 427 U.S. 246, 258–59 (discussing the Congressional intent when amending the CAA in 1970).

[131] Driesen, *supra* note 6, at 43 n.249.

[132] Exec. Order No. 12,291, 3 C.F.R. 127 (1982).

[133] *See generally* Steven Croley, *White House Review of Agency Rulemaking: An Empirical Investigation*, 70 U. CHI. L. REV. 821, 821 (2003).

Budget (OMB).[134] The review of proposed regulation by the OMB is intended to "reduce the burdens of existing and future regulations, increase agency accountability for regulatory actions, provide for presidential oversight of the regulatory process, minimize duplication and conflict of regulations, and insure well-reasoned regulations."[135] The result, however, is a cost-benefit analysis of all regulations promulgated and major actions taken by federal agencies, in this case the EPA.[136] Thus, despite the intent of Congress in establishing a strict set of standards to protect the public's health by controlling emissions of pollutants into the air, the estimated economic cost of any proposed technology-based standard weighs heavily in the balance against any possible benefit to society.[137]

V. FEASIBILITY OF CCS

A. *Applying a Technology-Based Standard to GHGs*

Since *Massachusetts v. EPA*, the EPA has indicated that it will most likely attempt to regulate stationary sources of GHGs under the CAA's Prevention of Significant Deterioration ("PSD")[138] program.[139] In April 2009, the EPA published its proposed

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[134] Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (Feb. 18, 1981).

[135] *Id.*

[136] Driesen, *supra* note 6, at 79. "While an agency must justify decisions taken under feasibility mandates in terms of feasibility, cost-benefit considerations will generally govern its negotiations with the Office of Management and Budget (OMB)." *Id.*

[137] *Id.* at 83.

[138] 42 U.S.C. §§ 7470–7479 (2006).

[139] Prevention of Significant Deterioration (PSD): Reconsideration of Interpretation of Regulations that Determine Pollutants Covered by the Federal PSD Permit Program, 74 Fed. Reg., 51,535, 51,537 (Oct. 7, 2009) (to be codified at 40 CFR pt. 52).

> On December 18, 2008, in order to address an ambiguity that existed in the federal PSD regulations, then-EPA Administrator Stephen Johnson issued a memorandum setting forth the official EPA interpretation regarding which pollutants were 'subject to regulation' for the purposes of the federal PSD permitting program.
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> . . .

endangerment finding for GHGs, stating that GHGs "in the atmosphere endanger the public health and welfare of current and future generations."[140] This finding, once final, will allow the EPA to move forward in regulating GHGs as an air pollutant under § 302 of the CAA.[141] In September 2009, EPA staff indicated that the EPA would also be moving forward to regulate GHG emissions from stationary sources, in addition to the currently-regulated mobile sources.[142] In October 2009, the EPA published a proposed rule for the possible regulation of GHGs emissions from stationary sources under PSD.[143] Under PSD, the technology-based standard for new sources is BACT.[144] As such, if no new legislation is proposed and EPA regulates the emissions of GHGs under current CAA provisions, the BACT standard would apply to new sources and sources emitting more than 25,000 tons of GHGs each year.[145] BACT requires the EPA to consider "energy, environmental, and economic impacts and other costs"[146] for each regulated source.[147] BACT requires the EPA implement emissions control technologies that are reasonably cost effective for the environmental and health

> The Memo was necessary after issues were raised regarding the scope of pollutants that should be addressed in PSD permitting actions following the Supreme Court's April 2, 2007 decision in Massachusetts v. EPA, 549 U.S. 497 (2007).

Id.

[140] Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act , 74 Fed. Reg. 18,886, 18,886 (Apr. 24, 2009) (to be codified at 40 C.F.R. pt. 1).

[141] *See supra* notes 8 and 10.

[142] EPA Fact Sheet—Reconsideration of Former Administrator Johnson Interpretive Memo on Definition of Pollutants Covered Under the Clean Air Act, September 30, 2009, *available at* http://www.epa.gov/nsr/fs20090930 guidance.html (on file with the North Carolina Journal of Law & Technology); Bravender, *supra* note 105.

[143] Prevention of Significant Deterioration (PSD): Reconsideration of Interpretation of Regulations that Determine Pollutants Covered by the Federal PSD Permit Program, 74 Fed. Reg., 51,535, 51,537 (Oct. 7, 2009) (to be codified at 40 CFR pt. 52).

[144] 42 U.S.C. § 7479(3) (2006).

[145] *Id.*

[146] *Id.*

[147] *Id.*

benefits they achieve.[148] PSD applies only to new and modified sources of emissions.[149] If the EPA pursues regulation of GHGs under PSD, all existing sources of GHG emissions will remain unregulated until such time as they undergo major modification.[150]

B. *Applying the Feasibility Principle to Commercial Capacity CCS*

All of this raises the ultimate question: will commercial CCS be feasible as the best achievable technology for controlling CO_2 emissions from stationary sources? To determine if CCS is an "achievable" technology, it must first be determined if CCS could successfully capture and permanently store CO_2 emissions from power plants.[151] This question must be asked strictly from an engineering perspective.[152] As described in Part III, the technologies required for capture and transport are all available.[153] Multiple forms of technology exist and are regularly used in other industries to implement the end result of capturing CO_2 emissions, purifying them, and transporting them to an injection site.[154] As discussed above in Part III, injection of supercritical CO_2 into geologic formations is a common in the industrial practice of enhanced oil and natural gas recovery.[155] Therefore, all steps up to and including storage of CO_2 are within the reach of current technology and are feasible. The question yet to be answered with regard to long term technical feasibility of commercial CCS is whether these geologic formations into which CO_2 is injected will

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[148] *See, e.g.*, McCubbin, *supra* note 95, at 15; Part IV.B.

[149] EPA Fact Sheet—Reconsideration of Former Administrator Johnson Interpretive Memo on Definition of Pollutants Covered Under the Clean Air Act, September 30, 2009, *available at* http://www.epa.gov/nsr/fs20090930guidance.html.

[150] Brian, *supra* note 3, at 388, 405–06.

[151] *See generally* Driesen, *supra* note 6, at 11–13.

[152] *Id.* If a technology will not work or will not meet the emissions reductions necessary to meet the regulatory goal, then that technology will not be feasible. *Id.*

[153] *See supra* Parts III.A–B (discussing the industrial uses of CO_2 capture for enhanced oil and gas recovery).

[154] *See id.*

[155] IPCC SPECIAL REPORT, *supra* note 49, at 19.

contain this huge volume for hundreds to thousands of years.[156] The scientific data upon which the CCS research projects are based indicates chemical processes which should take thousands of years to conclude, thus trapping the injected CO_2 for at least that long.[157] Data indicate that positive results for successful storage are likely, though results are inconclusive at this time.[158]

Assuming that permanent storage of injected CO_2 is possible, the next step in the feasibility determination must be to estimate the effectiveness of the proposed technology in terms of meeting the regulatory goal.[159] Is it the "best"? The goal in this case would be reduction of CO_2 emissions from electricity generating units significant enough to affect climate change.[160] The data indicate that CCS can reduce CO_2 emission to between eighty and ninety percent.[161] It is beyond the scope of this Recent Development to determine how great GHG reduction must be to make a difference in climate change,[162] however, a CO_2 emissions reduction of eighty to ninety percent from the second largest source of emissions in the United States falls well within the estimates of required GHG emissions reduction necessary to achieve America's climate change goals.[163]

The third and last step in a feasibility analysis is to determine if the benefit expected through implementation of the technology is worth the cost to the industry and the nation.[164] The feasibility of

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[156] *See supra* note 89 (discussing the longevity of carbon in the atmosphere).

[157] IPCC SPECIAL REPORT, *supra* note 49, at 32.

[158] Offen, *supra* note 29, at 7.

[159] *See, e.g.*, McCubbin, *supra* note 94, at 11–14.

[160] *See, e.g.*, Flatt, *supra* note 37, at 213–14; IPCC SPECIAL REPORT, *supra* note 49, at 19.

[161] IPCC SPECIAL REPORT, *supra* note 49, at 25.

[162] *See, e.g.*, H.R. 2454 § 311 (establishing a process by which the U.S. Congress can monitor international progress in GHG emissions reductions). Because the United States has no jurisdiction outside its own borders, it cannot induce other nations to reduce their GHG emissions without making dramatic reductions domestically. *Id.* (adding § 701(a)(6) to the CAA).

[163] *Id.* (adding § 702 to the CAA).

[164] *See, e.g.*, McCubbin, *supra* note 95, at 11–14 (explaining how the "best practicable technology" and "best conventional technology" standards weigh both costs and risk reduction benefits of a technology).

CCS should be considered in the context of the reason GHG regulation is pending in the first place: the potentially vast reach of the effects of climate change, both geographically[165] and across social and economic strata, should place an extremely heavy weight in favor of implementing strict regulations on GHG emission sources.[166] For risks to public health and welfare so great,[167] the balance here may tip in favor of finding even a very expensive technology feasible.[168]

However, one must consider the cost of implementing CCS technology at the commercial level, and one must give this factor the weight the EPA would likely give it when setting a BACT standard.[169] A detailed economic analysis of the electricity producing industry is beyond the scope of this Recent Development. However, the system for distributing costs to consumers in the electricity industry allows companies to pass on a large portion of the expected rate increases,[170] and thus, the electricity generating industry would not expect large numbers of

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[165] *See* Burkett, *supra* note 3, at 174. It is projected that climate change will impact communities across the globe. *Id.* Of course, sea level rise is an immediate concern for millions of people, as is the melting of glaciers and changing arctic seasons, but increased changes in arid conditions are also of concern. *Id.*

[166] *See generally* McCubbin, *supra* note 95, at 34.

[167] *See infra* note 168.

[168] *See, e.g.*, McCubbin, *supra* note 94, at 34. "[I]n one of its first regulations [promulgated under the Hazardous Air Pollutant program, § 112 of the CAA,], for example, EPA expressly cited the relatively high toxicity of chromium to justify more stringent—and therefore more costly—regulation of large chromium electroplaters. Although the technology on which it planned to base the emission standards had 'very high costs of control compared to the associated chromium emission reductions,' those high costs of control were 'reasonable' according to the Agency when weighed against, among other things, the 'high toxicity of chromium,' which was 1500 times more toxic than benzene." *Id.* (internal citations omitted).

[169] *See supra* Part IV.B (discussing the political pressures which make the EPA give heavy weight to the cost of a technology when setting a technology-based standard).

[170] *See* IPCC SPECIAL REPORT, *supra* note 47, at 27 ("Overall, the electricity production costs for fossil fuel plants with capture (excluding CO_2 transport and storage costs) ranges from 0.04–0.09 US$/kWh, as compared to 0.03–0.06 US$/kWh for similar plants without capture.").

plant shut downs.[171] The political pressure to implement a less expensive technology for reducing GHG emissions would be great.[172] Congress can help ease this burden by establishing a clear policy of support for research and development of CCS. Such a policy could include funding pilot CCS projects through legislation, which would allow Congress to help offset some of the costs to industry.[173] Congress can go farther by offering financial incentives for individual project implementation, again reducing the cost and increasing the feasibility of CCS.

Assuming, then, that CCS would be found to be "best" and "achievable" if EPA applied the feasibility principle when setting a BACT standard for CO_2 emissions, it remains to be seen whether regulation of this technology will be enacted under the current statutory framework or if Congress will pass legislation to implement commercial deployment of CCS technology.[174] The CAA's PSD is a cumbersome tool for implementing GHG reductions as only new or modified sources would be subject to regulation.[175] Moreover, the EPA has been reluctant to move forward with promulgating such rules under the CAA. For example, the EPA has long been under pressure to regulate GHG emissions from mobile sources, but did not take the steps necessary to do so until forced through litigation.[176] The petitioners in *Massachusetts vs. EPA* "were asking the Court to give them through litigation what they had failed to achieve from

[171] *See generally* CONGRESSIONAL BUDGET OFFICE, THE ESTIMATED COSTS TO HOUSEHOLDS FROM THE CAP-AND-TRADE PROVISIONS OF H.R. 2454 (June 19, 2009) (discussing the increased cost of energy per household due to the proposed cap-and-trade system in ACES). Industries other than electricity generation, however, may not have the same sort of rate distribution. If CCS was established as BACT, the economic burden on these other industries may be great enough to cause plant closures.

[172] *See supra* Part IV.B.

[173] *See generally* Offen, *supra* note 30, at 7 (reporting on projects to develop carbon capture technologies conducted by the Electrical Power Research Institute).

[174] Bravender, *supra* note 105 (reporting on the EPA's decision to propose a green house gas emission reduction rule in the absence of federal legislation).

[175] Arnold W. Reitze, Jr., *Federal Control of Carbon Dioxide Emissions: What are the Options?*, 36 B.C. ENVTL. AFF. L. REV. 1, 8 (2009).

[176] *Id.* at 2.

lobbying the legislative or the executive branch,"[177] namely, that the EPA find that climate change is harmful to the public and that GHGs cause climate change.[178] While the EPA has since made the required determinations,[179] it is reasonable to question whether the EPA would take similar steps towards regulating GHG emissions from stationary sources in a timely manner.[180]

Alternatively, if the current statutory framework is unwieldy and EPA action too slow, Congress could provide support for this technology and could base the regulation of CCS on scientific evidence and broad policy considerations through legislation. In doing so, Congress could implement laws that take effect within specific timeframes, thus addressing the issue of America's GHG emissions reductions directly.[181] For example, ACES proposes the removal of much of EPA's discretion in setting atmospheric GHG levels and in determining when to implement CCS technology.[182]

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[177] *Id.*

[178] *Id.*

[179] Proposed Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886 (Apr. 24, 2009).

[180] *See generally* Reitze, *supra* note 175, at 2. Once mandated by the Supreme Court (2007), it took the EPA two years to publish proposed regulations to regulate GHG emissions from mobile sources. Those regulations are not yet final. The determinations the EPA will have to make and the rules it will have to promulgate (if it regulates GHG emissions from stationary sources) could take at least that long again. *Id.*

[181] At no time during the implementation or multiple amendments to the CAA was climate change contemplated by law makers. *Id.* This law is simply not written to address the problems caused by GHGs. *Id.* In order to avoid using this dull and ill-suited tool, Congress needs to craft a precise and explicit law to implement dramatic reductions in GHG emissions. *Id* at 32.

[182] ACES would create an incentives program, beyond Corporation grants for "early movers" (*see supra* note 44), to promote CCS technology deployment through the allocation of bonus allowances. H.R. 2454 § 115(c)(3). For the years 2014 to 2017, this program would receive two percent of all allowances. H.R. 2454 § 115(e). From 2018 to 2050, ACES increases that to five percent of all allowances. H.R. 2454 § 115(e).

Domestic electricity generating units ("EGUs") fueled by at least fifty percent coal or petcoke, with nameplate capacity of at least 200 megawatts, which permanently capture and store at least fifty percent of their emissions, and are in compliance with all permits, are eligible for the bonus allowance allocations for

The bill also provides incentives for power plants that implement CCS technology as soon as possible.[183] The benefit of regulating CCS under a cap-and-trade program like the one proposed in ACES is that it takes GHG level determinations out of the discretion of the EPA or regulating agency.[184] By giving the EPA a strict framework within which to implement CCS, Congress can promote a federal policy in support of this technology, providing funds for research and development and establishing a deadline for industry-wide implementation.[185] The EPA would have little to do other than implement Congress's explicit charge.[186]

The one decision left to EPA discretion in ACES' CCS provisions can be found in § 311, which states, "the Administrator may extend the deadline for compliance by a covered [electricity generating unit] by up to [eighteen] months if the Administrator makes a determination, based on a showing by the owner or operator of the unit, that it will be technically infeasible for the unit to meet the standard by the deadline."[187] This clause, while reasonable enough on its face, may provide enough leeway to

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the first 10 years of operation. H.R. 2454 § 115(b). EGUs permitted between 2009 and 2015 will be discounted some value for the amount of time they operated without CCS technology in place, H.R. 2454 § 115(e)(2), and EGUs permitted after 2015 will not be able to receive bonus allowances unless at least fifty percent of emissions are captured as soon as operation commences. H.R. 2454 § 115(e)(3). Non-electricity generating industry is also eligible for up to fifteen percent of allowances, under specific criteria. H.R. 2454 § 115(f).

Phase I provides bonus allowances for the first 6 gigawatts of generating capacity to install CCS technologies. H.R. 2454 § 115(c)(1). Once this threshold is met, Phase II of the program becomes effective. H.R. 2454 § 115(d)(1). ACES directs the EPA to promulgate a regulation to determine the appropriate way to distribute allowances in Phase II. H.R. 2454 § 115(d)(2). The bill suggests reverse auctions as the preferred method of distribution in Phase II and creates a competitive bidding system for the value of bonus allowances. H.R. 2454 § 115(d)(3). In creating a competitive system for distribution of allowances in Phase II, ACES provides incentives for entities to employ CCS technologies earlier rather than later in order to reap the benefits of Phase I's more valuable allowances.

[183] *See supra* note 182.

[184] *See, e.g.*, the levels proposed in ACES § 311 (adding § 721 to CAA).

[185] *See, e.g.*, H.R. 2454 §§ 114–15.

[186] H.R. 2454 § 116(a).

[187] *Id.* (adding § 812(b)(3) to CAA).

forestall CSS implementation for quite some time.[188] It is unclear from the language of the bill if the extension is renewable or if it is available to each operator only once.[189] Additionally, if CCS is deemed infeasible for one applicant at the time of application for extension, might there be a rush of other applicants also wishing to postpone the implementation of CCS? Another question raised by this language is how many eighteen month extensions the EPA may grant.

VI. CONCLUSION

If the EPA is left to regulate GHGs under the CAA, it is likely to do so under PSD. PSD is a blunt tool for addressing GHG emissions reductions as that program applies only to new and modified sources. Additionally, under PSD, the EPA would set the BACT standard for GHG emission by applying the Agency's discretion using the feasibility principle as a guide. If this is the route used to regulate GHG emissions, then implementation of CCS is questionable. It is a costly technology that is still in the research and development stage.

If, however, Congress passes new legislation specifically tailored to GHG emissions reduction, such as ACES, it could include provisions to promote deployment of CCS, such as financial support for research and development of the technology and a specific timeline for deployment of commercial CCS. Under such a scheme, the EPA would have stricter bounds and less discretion, thus increasing the likelihood that CCS and other innovative and costly GHG emissions reducing technologies will be developed and deployed for commercial use.

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[188] *Id.*
[189] *Id.*