DRAFT

CARBON CAPTURE AND SEQUESTRATION: EPA'S TECHNOLOGY AVAILABILITY DETERMINATIONS NEED TO BE REPRODUCIBLE

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> *"In light of the issues we identified, we believe that...Carbon Program goals may not be achieved without implementation of corrective actions. Specifically, projects may not be completed, deliverables might not be received, job creation will not meet anticipated targets...."*
>
> – DOE, Office of Inspector General, "Audit Report: DOE's Industrial Carbon Capture and Storage Program," March 2013.[1]

> "*To date, there are no commercial ventures in the United States that capture, transport, and inject industrial-scale quantities of CO2....*"
>
> – Congressional Research Service, September 30, 2013.[2]

Issue: Are Carbon Capture and Sequestration (CCS) Technologies Available?

For coal-fired power plants, and the consumers who depend on them, the defining issue at the center of EPA's Proposed Rule on greenhouse gas emissions from electricity generating units (RIN 2060-AQ91) is whether technologies to capture and store CO_2 are "available" as defined by the Clean Air Act Amendments (CAAA). If EPA determines that CCS technologies are available, then utilities will be required to install such equipment on new/revamped coal-powered generating stations.

The term *Best Available Control Technology* (BACT) is defined in the CAAA but it is EPA's job to decide whether or not a developing environmental technology is available. EPA's discretion in making BACT determinations is primarily regulated by two laws:

1. The Clean Air Act as amended which defines BACT; and

2. The Data Quality Act (DQA)[3] which sets enforceable quality standards for EPA information disseminations– including their BACT determinations.

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[1] Department of Energy, Office of Inspector General, "Audit Report: The Department of Energy's Industrial Carbon Capture and Storage Program Funded by the American Recovery and Reinvestment Act," March 2013, p. 15, http://energy.gov/sites/prod/files/2013/04/f0/OAS-RA-13-15_0.pdf.

[2] Peter Folger, Congressional Research Service, "Carbon Capture and Sequestration: Research, Development, and Demonstration at the U.S. Department of Energy," (CCS RD&D) September 30, 2013, Summary. http://www.fas.org/sgp/crs/misc/R42496.pdf.

[3] See, http://www.foreffectivegov.org/node/3479.

This paper will:

1. Discuss CCS technologies and their availability, based on recent federal data;

2. Review how the CAAA defines BACT; and

3. Place EPA's BACT determinations within the reproducibility requirements of the DQA.

What Is Carbon Capture and Sequestration?

The Congressional Research Service (CRS), in its CCS *Primer*, explains that "[C]arbon capture and sequestration (or storage)—known as CCS—is a physical process that involves capturing manmade carbon dioxide (CO_2) at its source and storing it before its release to the atmosphere."[4]

CRS also notes that the reason why CCS technologies are of interest to policy makers is not because CCS technologies are ready to be deployed, but rather because the "promise of CCS lies in the potential for technology to capture CO_2 emitted from large, industrial sources...."[5]

> *For CCS to succeed at reducing CO_2 emissions from a significant fraction of large sources in the United States, CO_2 capture technology would need to be deployed widely. Widespread commercial deployment will likely depend on the cost of capturing CO_2.*
>
> – Congressional Research Service, 10/21/13

An integrated industrial CCS system would include three core "steps: (1) capturing CO_2 and separating it from other gases; (2) purifying, compressing, and transporting the captured CO_2 to the sequestration site; and (3) injecting the CO_2 in subsurface geological reservoirs or storing it in the oceans."[6]

It is the "capture" portion of the CCS process that is the crux in determining its availability. As CRS has explained that "[u]nlike the other two components of CCS, transportation and geologic storage, the first component of CCS—CO_2 capture—is almost entirely technology-dependent."[7]

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[4] Peter Folger, Congressional Research Service, "Carbon Capture and Sequestration (CCS): A Primer," (Primer) July 16, 2013, p. 1. http://www.fas.org/sgp/crs/misc/R42532.pdf.

[5] Folger, Technology Assessment, p. 1.

[6] Folger, Primer, p.1.

[7] Peter Folger, Congressional Research Service, "Carbon Capture: A Technology Assessment," (Technology Assessment) October 21, 2013, p. 1. https://www.fas.org/sgp/crs/misc/R41325.pdf.

CRS does also note, however, that "transportation and sequestration costs, while generally much smaller than capture costs, could be very high in some cases."[8] CRS further explains that the magnitude of transportation and sequestration cost levels would "depend, in part, on how long it would take to reach an agreement on a regulatory framework to guide long-term CO_2 injection and storage, and on what those regulations would require."

A report from EPA's Environmental Financial Advisory Board (EFAB) to the agency discussing one component of sequestration costs, the financial assurance costs, made clear the magnitude of those costs when they stated,

> "*After an extensive review of the existing regulations for SDWA wells, in particular Class I and Class II wells, and RCRA facilities, the Board concluded that the RCRA and the SDWA financial assurance requirements for Class I wells rather than SDWA Class II wells provide the best model for establishing financial assurance requirements for new Class VI wells* [for geologic sequestration of carbon dioxide gas streams.] *The financial assurance requirements for Class I wells closely resemble the RCRA regulations.*"
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> Letter from Environmental Financial Advisory Board to EPA Assistant Administrator, Office of Water, March 31, 2010. [Emphasis added] http://www.thecre.com/pdf/20100601_FinancialAssuranceUndergroundCarbonSequestrationMarch2010.pdf

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[8] Folger, Technology Assessment, p. 1.

How Does the CAAA and EPA Define Best Available Control Technology?

The statutory definition of BACT is complex and takes into account "economic impacts and other costs" along with engineering, environmental and other factors. The complete definition of BACT is available at 42 USC § 7479(3).[9]

EPA's BACT processes are implemented both directly and through guidance to states. CRS examined the specific question of "What Is EPA's Role in Determining BACT?" and explained that the "EPA procedure for determining BACT (required for federally run programs, encouraged for EPA-approved, state-run programs) is a fairly straightforward 'top-down' process" which is described in the CRS report.[10] The second and the fourth of the five steps outlined in the CRS report are worthy of particularly attention for understanding whether a technology is considered available.

> ***Eliminate Technically Infeasible Control Options****—control options need to be either demonstrated on a like facility or determined to be both available and applicable in the particular case. If not, the option is eliminated from the list.*
>
> – Congressional Research Service description of BACT Determination

> ***Eliminate Options that Fail Energy, Environmental, or Economic Criteria****—the permitting agency has discretion in weighting the three statutory criteria for exclusion.*
>
> – Congressional Research Service description of BACT Determination

The second of EPA's tasks in making a BACT determination described by CRS is for the agency to eliminate from consideration those control options which have yet to "demonstrated" on a similar facility or determined to be both available and applicable in the given instance under consideration.

The fourth of the five steps outlined by CRS is the one in which EPA is to make sure that BACT determinations are economically reasonable. In discussing the portion of EPA's guidance to states on making delegated BACT determinations, CRS explains that EPA told states that "[i]n conducting the energy, environmental and economic impacts analysis, permitting authorities have 'a great deal of discretion' in deciding the specific form of the BACT analysis and the weight to be given to the particular impacts under consideration."[11]

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[9] Available at http://www.law.cornell.edu/uscode/text/42/7479.

[10] Larry Parker, James E. McCarthy, "EPA's BACT Guidance for Greenhouse Gases from Stationary Sources," ("BACT") Congressional Research Service, November 22, 2010, p. 3, *available at* https://www.fas.org/sgp/crs/misc/R41505.pdf.

[11] Parker and McCarthy, BACT, p. 14.

As we will see in the discussion of the DQA's reproducibility requirements below, that EPA's discretion in BACT determinations, while significant, is limited by statutory quality constraints implemented by the White House Office of Management and Budget (OMB) and EPA.

Are CCS Technologies Commercially Available?

Although CRS said that, to date, "there are no commercial [CCS] ventures in the United States" they also said that one "project, the Kemper County Facility, has received $270 million from DOE under its Clean Coal Power Initiative Round 2 program, and is slated to begin commercial operation in May 2014."[12] The Kemper project is a 582 MW IGCC [Integrated Gasification Combined Cycle] power plant that is currently under construction in Kemper County, Mississippi. The plant will include a CCS system designed to capture approximately 65 percent of the produced CO2."[13]

> "*The Kemper IGCC project, which received a $270 million federal grant and $412 million in federal tax credits, recently announced that it will miss its May 2014 completion deadline. Delays at the Kemper IGCC project have contributed to an almost $5 billion cost that is almost double the original estimated cost of around $2.8 billion.*"
>
> – Testimony of Anthony S. "Tony" Campbell
> President & CEO
> East Kentucky Power Cooperative
> *before* US House of Representatives.
> November 14, 2013

The Kemper project received, as was noted above, partial funding from the Department of Energy (DOE). DOE, as CRS explains, has a "CCS research, development, and demonstration (RD&D) program" with the "its vision of developing an advanced CCS technology portfolio ready by 2020 for large-scale CCS deployment."[14]

CRS noted that "EPA *asserts* that CCS technology is currently feasible and refers to a coal gasification project that is over 75% complete: the Kemper County Project."[15] [Emphasis added] The Kemper project, however, has experienced significant setbacks. For example, CRS notes that "the company announced that capital costs would be closer to $3.4 billion, approximately $1 billion higher than original cost estimates for the plant."[16]

[12] Folger, CCS RD&D, Summary.

[13] US Environmental Protection Agency, "Proposed Rule: Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units," RIN 2060-AQ91, signed on 9/20/2013, p. 28 of 463.

[14] Ibid.

[15] Folger, CCS RD&D, p. 9.

[16] Ibid., pp 9-10.

"*Since the original proposal, progress on Southern Company's Kemper County Energy Facility, an IGCC facility that will implement partial CCS, has continued, and the project is now over 75 percent complete.*"	"*Cost overruns at the Kemper Plant, however, have raised questions over the relative value of environmental benefits due to CCS technology compared to construction costs of the facility and its effect on ratepayers.*"
– US EPA , GHG Emission NPRM, Page 21 of 463, 9/20/2013	– Congressional Research Service, Summary, 9/30/2013

More recently, the President and CEO of a rural Kentucky power cooperative testified that the Kemper project is delayed and will not be ready by its previously anticipated May 2014 completion.[17] The delays in bringing CCS projects to fruition is not surprising since extensive delays are common for advanced industrial emission control technologies. On this point, CRS noted that "[i]n the case of SO_2 and NOx scrubbers, efforts typically took two decades or more to bring new concepts (such as combined SO2 and Nox capture systems) to the commercial stage."[18]

Kemper is not the only the CCS which is experiencing significant difficulties. CRS' report on CCS projects noted that "DOE's flagship CCS demonstration project, FutureGen, which has experienced delays and multiple changes of scope and design since its inception in 2003."[19]

CRS reviews the FutureGen project, including its changes in project direction, and states that it remains an open question as to "whether FutureGen represents a unique case of a first mover in a complex, expensive, and technically challenging endeavor, or whether it represents all large CCS demonstration projects once they move past the planning stage."[20]

[17] Testimony of Anthony S. "Tony" Campbell, before Subcommittee on Energy and Power, Committee on Energy and Commerce, US House of Representatives, November 14, 2013, *available at* http://www.nreca.coop/wp-content/uploads/2013/11/TonyCampbellTestimony111413.pdf p.4

[18] Folger, CCS RD&D, p. 9.

[19] Ibid, Summary.

[20] Ibid, p. 18.

Is EPA Right About CCS Availability?
The Need to Test EPA's BACT Determinations Through Reproducibility

The CRS report on EPA's BACT guidance document makes clear that the regulatory agency has significant discretion in making BACT determinations. EPA's BACT discretion, however, is not unlimited and is regulated by the *good government* laws that "regulate the regulatory process" including the Administrative Procedure Act and the DQA.[21]

The DQA was described by public policy researchers supported by the National Science Foundation (NSF) as "a radical change in regulatory policymaking"[22] and "one of the most significant regulatory reforms over the past twenty-five years."[23]

In addition to setting general requirements for the quality, objectivity, utility and integrity of virtually all Executive Branch information disseminations, the DQA sets particularly stringent requirements for the most important information the government disseminates, information which is *influential*. OMB states that influential information "means that the agency can reasonably determine that dissemination of the information will have or does have a clear and substantial impact on important public policies or important private sector decisions."[24]

EPA's agency-specific guidelines implementing the DQA go into considerable discussion regarding what the agency considers to be influential information. There is no doubt that EPA CCS BACT determinations will be influential information as they are unquestionably in support of a top Agency action.

> "*EPA will generally consider the following classes of information to be influential...*
>
> • *Information disseminated in support of top Agency actions (i.e., rules, substantive notices, policy documents, studies, guidance) that demand the ongoing involvement of the Administrator's Office and extensive cross-Agency involvement; issues that have the potential to result in major cross-Agency or cross-media policies, are highly controversial, or provide a significant opportunity to advance the Administrator's priorities. Top Agency actions usually have potentially great or widespread impacts on the private sector, the public or state, local or tribal governments. This category may also include precedent-setting or controversial scientific or economic issues.*"
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> – Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by the Environmental Protection Agency, p. 19.

[21] See, Five Governors of the Regulatory State, http://www.thecre.com/pdf/20110530_Governors_of_the_Regulatory_State.pdf.

[22] Ken Godwin, et al, "Lobbying and Policymaking," Sage/CQPress: Los Angeles, 2013, p. 63.

[23] Godwin, p. 70.

[24] OFFICE OF MANAGEMENT AND BUDGET, Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies, Effective Date: January 3, 2002. http://www.whitehouse.gov/omb/fedreg_reproducible.

Reproducibility: The Core Requirement for Influential Information

Reproducibility is at the heart of federal quality standards for influential information. OMB's government-wide information quality guidelines state that "OMB believes that a reproducibility standard is practical and appropriate for information that is considered 'influential', as defined in paragraph V.9 - that 'will have or does have a clear and substantial impact on important public policies or important private sector decisions.'"

EPA gives significant consideration to the agency's vigorous implementation of the law. The regulatory agency explains that,

> "*these Guidelines provide for the use of especially rigorous 'robustness checks' and documentation of what checks were undertaken. These steps, along with transparency about the sources of data used, various assumptions employed, analytic methods applied, and statistical procedures employed should assure that analytic results are 'capable of being substantially reproduced.'*"
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> – EPA Information Quality Guidelines, p. 47.

The Washington-based NGO, The Center for Effective Government[25] has published an in-depth analysis of the DQA and its implementing guidelines, including the reproducibility requirement provisions.[26] The Center for Effective Government explained reproducibility that "is applied differently for three types of 'influential' information...." With respect to the DQA's reproducibility requirement, the NGO states:

> *"For [influential] "analysis results" there must be 'sufficient transparency about data and methods that an independent reanalysis could be undertaken.' OMB adds that this means that 'independent analysis of the original or supporting data using identical methods would generate similar analytic results, subject to an acceptable degree of imprecision or error.' However, the transparency necessary to achieve this is not meant to 'override other compelling interests such as privacy, trade secrets, intellectual property, and other confidentiality protections.' In such cases where the public does not have access to data and methods, 'agencies shall apply especially rigorous robustness checks to analytic results and document what checks were undertaken.'"*
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> – Center for Effective Government http://www.foreffectivegov.org/node/3479

[25] See, http://www.foreffectivegov.org/about-us.

[26] See, Data Quality Act, Center for Effective Government, http://www.foreffectivegov.org/node/3479.

Is Reproducibility a Reasonable Requirement for BACT Determinations?

Reproducibility checks are applied to quantitative data, such as financial statements and scientific measurements. The issue may arise as to whether it is appropriate to apply reproducibility requirements to the results of an EPA determinative process, a process which provides the agency with a degree of discretion. The practicality and appropriateness of applying the DQA's reproducibility requirement to agency evaluations of unique situations, such as BACT availability determinations, is an issue worth serious consideration.

> "*As all of you know, of course, questions have been raised about the robustness of priming results. The storm of doubts is fed by several sources, including the recent exposure of fraudulent researchers, general concerns with replicability that affect many disciplines, multiple reported failures to replicate salient results in the priming literature, and the growing belief in the existence of a pervasive file drawer problem that undermines two methodological pillars of your field: the preference for conceptual over literal replication and the use of meta-analysis. Objective observers will point out that the problem could well be more severe in your field than in other branches of experimental psychology, because every priming study involves the invention of a new experimental situation.*" [Emphasis added]
>
> – Open Letter from Daniel Kahneman, September 26, 2012

A review of the scientific literature makes clear that applying reproducibility checks to analytic, *i.e.*, cognitive, analysis is not only appropriate but also necessary. EPA's guidelines makes explicit the agency's commitment to applying reproducibility requirements to analytic results. The literature, however, makes clear that analytic validity requires that reproducibility requirements even be applied to unique situations in which every study "involves the invention of a new experimental situation."

In an open letter to the psychiatric research community,[27] Nobel laureate economist Daniel Kahneman[28] highlighted how problems with replicability of major psychological experiments, including "multiple reported failures to replicate salient results" has contributed to a "storm of doubts" about the robustness of the experimental results. The letter placed particular focus on a specialized area of psychological research, social priming, which concerns how early responses to a stimulus influence subsequent responses.[29]

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[27] Daniel Kahneman, A proposal to deal with questions about priming effects, September 26, 2012, http://www.nature.com/polopoly_fs/7.6716.1349271308!/suppinfoFile/Kahneman%20Letter.pdf

[28] See, http://en.wikipedia.org/wiki/Daniel_Kahneman.

[29] A brief overview of the social priming issue may be found in the Abstract for a research project supported by the National Science Foundation (NSF) which explained that the "ultimate goal of this line of research is to test for a causal role of appraisal, or internal evaluations, in eliciting emotional experience, and to test a key premise of a process model by examining the effects of incidentally primed appraisals on emotion and emotion-related behaviors."

The challenges in replicating the results of priming studies did not stop Daniel Kahneman from issuing his challenge. The letter included a call for reproducibility testing which bluntly stated: "I believe that you should collectively do something about this mess."

> "*I believe that you should collectively do something about this mess. To deal effectively with the doubts you should acknowledge their existence and confront them straight on, because a posture of defiant denial is self-defeating. Specifically, I believe that you should have an association, with a board that might include prominent social psychologists from other field. The first mission of the board would be to organize an effort to examine the replicability of priming results, following a protocol that avoids the questions that have been raised and guarantees credibility among colleagues outside the field.*"
>
> – Open Letter from Daniel Kahneman,
> September 26, 2012

The research community responded affirmatively to Kahneman's challenge, successfully replicating many, but not all, classic experiments. A news article in *Nature* stated that "A large international group set up to test the reliability of psychology experiments has successfully reproduced the results of 10 out of 13 past experiments. The consortium also found that two effects could not be reproduced."[30]

The *Nature* news article explained that "[p]sychology has been buffeted in recent years by mounting concern over the reliability of its results, after repeated failures to replicate classic studies. A failure to replicate could mean that the original study was flawed, the new experiment was poorly done or the effect under scrutiny varies between settings or groups of people."[31] [Emphasis added]

The scientific literature demonstrates that it is both practical and necessary to apply a reproducibility requirement to the results of cognitive-based experiments, even those experiments that require "the invention of a new experimental situation." Thus, under the DQA and its implementing guidance, it is both practical and necessary for EPA to apply the reproducibility requirements for influential analytic results to their BACT availability determinations.

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http://nsf.gov/awardsearch/showAward?AWD_ID=0643248

[30] Ed Yong, "Psychologists strike a blow for reproducibility: Thirty-six labs collaborate to check 13 earlier findings," *Nature*, 26 November 2013, http://www.nature.com/news/psychologists-strike-a-blow-for-reproducibility-1.14232.

[31] Ibid.

CONCLUSIONS:
THE DQA, REPRODUCIBILITY AND EPA'S BACT AVAILABILITY DETERMINATIONS

1. EPA's BACT availability determinations are *influential* analytic results under the Data Quality Act.

2. EPA has an affirmative duty under their Information Quality Guidelines to ensure that their BACT determinations meet all DQA requirements, including those more rigorous checks that are applied to influential information.[32]

3. OMB and EPA guidance documents require the agency to apply reproducibility checks to influential information.

4. The scientific literature demonstrates the need to apply reproducibility checks to analyses of unique circumstances. The literature also demonstrates the practicality of applying reproducibility testing to analyses of subjective cognitive processes.

5. Ample CCS data exists to support the filing of a Data Quality Request for Correction against any EPA information disseminations indicating that the agency has determined that CCS technologies are BACT for industrial-scale coal-power generating plants.

"*The plan for the Many Labs project was vetted by the original authors where possible, was documented openly, and was registered with the journal Social Psychology and its methods were peer-reviewed before any experiments were done. The results have now been submitted to the journal and are available online. 'That sort of openness should be the standard for all research,' says Daniel Simons of the University of Illinois at Urbana–Champaign, who is coordinating a similar collaborative attempt to verify a classic psychological effect not covered in the present study. 'I hope this will become a standard approach in psychology.'*

Oppenheimer says that other disciplines could benefit from Many Labs' approach. 'Psychology isn't the only field that has had issues with replication in recent years.'"

– *Nature*, Psychologists strike a blow for reproducibility, 26 November 2013

[32] See, "Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by EPA," Section 7. Administrative Mechanism for Pre-dissemination Review," p. 29.