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By Electronic Submission to www.regulations.gov

Administrator Andrew Wheeler
U.S. Environmental Protection Agency
1200 Pennsylvania Avenue, NW
Washington D.C. 20460

Docket ID No. EPA–HQ–OAR–2013–0495

Re: COMMENTS ON PROPOSED RULE: REVIEW OF STANDARDS OF PERFORMANCE FOR GREENHOUSE GAS EMISSIONS FROM NEW, MODIFIED, AND RECONSTRUCTED STATIONARY SOURCES: ELECTRIC UTILITY GENERATING UNITS, 83 FED. REG. 65,424 (DEC. 20, 2018)

Dear Administrator Wheeler:

The Emmett Environmental Law & Policy Clinic at Harvard Law School (the "Clinic")[1] respectfully submits these comments on the amendments proposed in the Review of Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units, 83 Fed. Reg. 65,424 (Dec. 20, 2018) (the "Proposal"). For more than a decade, the Clinic has been researching and analyzing the technical and legal issues associated with the development of carbon capture and sequestration ("CCS") as a mechanism for reducing the adverse environmental and public health impacts of combusting fossil-fuels. For example, the Clinic has developed model legislation to help advance the development of CCS.[2] The Clinic's Director has, in addition, written extensively about CCS.[3]

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[1] About the Commenter: The Emmett Environmental Law & Policy Clinic works on a variety of local, national, and international projects covering the spectrum of environmental law and policy issues. The Clinic has published several white papers, submitted comments to EPA, and hosted workshops on various aspects of regulations and emissions standards for stationary sources, including carbon capture and sequestration in particular. In these comments, when we respond to a specific issue on which the Proposal has requested comment, we identify the numbered issue in bold font (e.g. (**Comment C-1**)).

[2] *See* WENDY B. JACOBS & DEBRA STUMP, PROPOSED LIABILITY FRAMEWORK FOR GEOLOGICAL SEQUESTRATION OF CARBON DIOXIDE, at A-1 (Nov. 2010), http://clinics.law.harvard.edu/environment/files/2015/08/appendix-carbon-capture-sequestration-ccs-liability-act-2010.pdf (Appendix A: CCS Liability Act of 2010).

[3] Wendy B. Jacobs & Michael Craig, *Carbon Capture and Sequestration*, *in* LEGAL PATHWAYS TO DEEP DECARBONIZATION IN THE UNITED STATES 713 (Michael B. Gerrard & John C. Dernbach eds., 2019); Wendy B. Jacobs, *Carbon Capture and Sequestration*, *in* GLOBAL CLIMATE CHANGE AND U.S. LAW 581 (Michael Gerrard & Jody Freeman eds., 2d ed. 2014).

Accordingly, the Clinic is well-informed about the technical, economic, and legal issues associated with CCS and bases these comments on that knowledge.

The Clinic urges the Environmental Protection Agency ("EPA") to uphold the existing 2015 Rule published at 80 Fed. Reg. 64,510 (Oct. 23, 2015) (the "2015 Rule") and also expand it to require the capture of a greater percentage of the carbon dioxide ("CO_2") emissions from new coal-fired power plants as well as to cover the capture of CO_2 emissions from natural gas combined cycle plants. EPA's determination in 2015 that the best system of emission reduction ("BSER") for newly constructed coal-fired steam generating units (i.e., "EGUs" or power plants) is partial CCS was not only justified then, but was a conservatively low capture requirement of only 16-23% of CO_2 emissions. Information, experience, and developments since 2015 amply demonstrate that the Rule could be expanded to require more CO_2 to be captured from new coal-fired units and to require CCS for new natural gas combined cycle units.

Despite President Trump's Executive Order 13,783, 82 Fed. Reg. 16,093 (Mar. 31, 2017), instructing EPA to revise the 2015 Rule and others because they allegedly burden the coal industry, coal is not now and will not for the foreseeable future be cost competitive with natural gas as a source of power regardless of whether the 2015 Rule remains in effect. Indeed, the Proposal itself acknowledges that few if any coal-fired plants will be built in the United States in the near future.[4] This forecast is supported by analyses of industry experts, including the International Energy Agency ("IEA") and U.S. Energy Information Administration ("EIA"),[5] as well as by utility industry leaders, such as American Electric Power, Duke Energy, and the Southern Company.[6] If any coal plants are to be built, however, EPA properly concluded in the 2015 Rule that the BSER is partial CCS.

The 2015 Rule comports with section 111 of the Clean Air Act ("CAA"). Section 111 requires that EPA set new source performance standards ("NSPS") at a level that reflects the "best system of emission reduction," "taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements." 42 U.S.C. § 7411(a). Under this standard, the "essential question" is whether "the technology would be available for installation in new plants."[7] The answer is clear: in many contexts and over many decades, all

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[4] 83 Fed. Reg. at 65,436.

[5] *See, e.g.*, U.S. ENERGY INFORMATION ADMIN., ANNUAL ENERGY OUTLOOK 2019 WITH PROJECTIONS TO 2050, at 92 (Jan. 24, 2019) ("[G]rowth in coal-fired generation is muted by the lack of new capacity additions because of the relatively-high capital costs compared with other fuels."), *available at* https://www.eia.gov/outlooks/aeo/pdf/aeo2019.pdf; *Fuels*, *World Energy Outlook 2018*, INTERNATIONAL ENERGY AGENCY, https://www.iea.org/weo2018/fuels/ ("[C]oal production peaked in 2014.") (last visited Mar. 18, 2019).

[6] *See* Taylor Kuykendall & Ashleigh Cotting, *Coal Plant Closings Double in Trump's 2nd Year Despite "End of War on Coal"*, S&P GLOBAL MARKET INTELLIGENCE (Nov. 28, 2018), https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/48671375 (reporting that AEP intends to retire 2.3 GW of coal capacity between 2018 and 2024 and has no plans to build more coal generation, and quoting Southern Company CFO Andrew Evans as saying that natural gas units are "displacing virtually all of our coal units in the dispatch curve"); *see also, e.g.*, DUKE ENERGY, 2017 CLIMATE REPORT TO STAKEHOLDERS 6 (2017) ("Looking ahead, by 2024 Duke Energy plans to retire nine more coal-fired generating units with a total capacity of 2,006 MW, and invest $11 billion over 2017-2026 in new natural gas-fired, wind and solar capacity."), *available at* https://www.duke-energy.com/_/media/pdfs/our-company/shareholder-climate-report.pdf.

[7] *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 391 (D.C. Cir. 1973).

facets of CCS have been demonstrated to be technically, geographically, and economically feasible. There is no basis in law or fact for rescinding the 2015 Rule. There are many bases for expanding it.

I. CCS IS TECHNICALLY FEASIBLE

As EPA correctly recognized when promulgating the 2015 Rule, CCS is a system of mature technologies that have been successfully deployed and operated for decades. Since 2015, there is more and stronger evidence that CCS is technically feasible. For example, the Petra Nova and Boundary Dam coal-fired power plants in Texas and Canada, respectively, have been in commercial operation and operating successfully with CCS for several years. As EPA articulated in its rulemaking in 2015 and again in its court defense of that rulemaking in 2016, partial CCS for coal-fired power plants "has been adequately demonstrated" and the standard set by the 2015 Rule is "achievable" by new coal-fired power plants.[8] Notably, the U.S. Departments of Energy and State not only recognize the feasibility of CCS but promote it as an essential part of the nation's energy future.

A. CCS Has Been Successfully Demonstrated in the United States and Around the Globe

Each component of carbon capture and sequestration for coal (and natural gas) fired power plants has been adequately demonstrated in many contexts and for many decades. (**Comment C-13**)

1. Carbon Capture

The technology for capturing CO_2 and separating it from a stream of gaseous emissions has been in use since the 1930s.[9] Not only has the capture technology been successfully utilized in various industrial and commercial applications for nearly a century,[10] but it has been successfully deployed at a variety of coal-fired power plants in the United States and elsewhere. Although EPA singled out five such facilities for discussion in the 2015 Rule, the Proposal ignores three of the five altogether. As to the other two, the Proposal raises anew questions that EPA had already addressed in 2015 and dismissed as not relevant to new sources (as opposed to sources that retrofit with CCS).

The 2015 Rule highlighted four coal-fired power plants in the United States and Canada that had successfully been capturing CO_2 emissions (and continue to do so). These plants are: Warrior

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[8] Standards of Performance for Greenhouse Gas Emissions From New, Modified, and Reconstructed Stationary Sources: Electric Utility Generating Units; Final Rule, 80 Fed. Reg. 64,510, 64,548 (Oct. 23, 2015); Respondent EPA's Initial Brief, *State of North Dakota v. EPA*, No. 15-1381 (filed D.C. Cir., Dec. 14, 2016) [hereinafter "EPA Brief"].

[9] Standards of Performance for Greenhouse Gas Emissions From New Stationary Sources: Electric Utility Generating Units; Proposed Rule, 79 Fed. Reg. 1,430, 1,479 (Jan. 8, 2014); EPA Brief, *supra* note 8, at 21.

[10] Kurt Zenz House et al., *Economic and Energetic Analysis of Capturing CO_2 from Ambient Air*, 180 PNAS 20,428, 20,428 (2011) ("In the 1930s, CO_2 was first commercially removed from ambient air in order to prevent the fouling of process equipment by dry ice formation in cryogenic air (i.e., $N_2/O_2/Ar$) separation plants."); Gary T. Rochelle, *Amine Scrubbing for CO_2 Capture*, 325 SCIENCE 1652, 1652 (2009) ("Amine scrubbing has been used to separate carbon dioxide (CO_2) from natural gas and hydrogen since 1930.").

Run in Maryland, Shady Point in Oklahoma, Searles Valley Minerals in California, Boundary Dam in Canada, as well as the proposed Petra Nova in Texas. The Proposal, however, makes no mention at all of the first three of these plants, raises questions about early operational difficulties at Boundary Dam that EPA already concluded were not attributable to the CO_2 capture equipment, and raises concerns about Petra Nova's design choices that do not relate to its ability to achieve the standard set by the 2015 Rule. In short, the Proposal's expressed concerns about the technical feasibility of capturing CO_2 are baseless.

The world's largest post-combustion CO_2 capture project, Petra Nova, is in Texas and has been successfully capturing and using the captured CO_2 since January 2017.[11] By September 2018, Petra Nova had captured two million metric tons of carbon dioxide.[12] The captured CO_2 is transported for use in enhanced oil recovery ("EOR") operations at the West Ranch Oil Field, which has, as a result, seen its oil production increase by twelve hundred percent.[13] Petra Nova has been successful in other ways, too. Notably, the project (retrofitting an existing unit with CCS) was completed on budget and on schedule.[14] At a ribbon-cutting ceremony in April 2017, Secretary of Energy Rick Parry said, "I commend all those who contributed to this major achievement. . . . While the Petra Nova project will certainly benefit Texas, it also demonstrates that clean coal technologies can have a meaningful and positive impact on the Nation's energy security and economic growth."[15]

Petra Nova was named 2017 Plant of the Year by POWER Magazine.[16] At the 2017 Pennel's Power-Gen International Conference, Petra Nova received the Best Coal-Fired Project and Best Overall Power Project of the Year awards from Power Engineering.[17] Petra Nova unequivocally demonstrates the feasibility of carbon capture for coal-fired power plants.

The Proposal asserts that Petra Nova "has not demonstrated the integration of the thermal load of the capture technology into the EGU steam generating unit (i.e., boiler) steam cycle," because "parasitic electrical and steam load are supplied by a new 75 MW co-located natural gas-fired

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[11] *Petra Nova, World's Largest Post-Combustion Carbon-Capture Project, Begins Commercial Operation*, DEP'T OF ENERGY (Jan. 11, 2017), https://www.energy.gov/fe/articles/petra-nova-world-s-largest-post-combustion-carbon-capture-project-begins-commercial.

[12] GLOBAL CCS INSTITUTE, THE GLOBAL STATUS OF CCS: 2018, at 17 (2018) [hereinafter "GLOBAL STATUS OF CCS 2018"], *available at* https://www.globalccsinstitute.com/resources/global-status-report/.

[13] *DOE-Supported Petra Nova Captures More Than 1 Million Tons of CO2*, DEP'T OF ENERGY (Oct. 23, 2017), https://www.energy.gov/fe/articles/doe-supported-petra-nova-captures-more-1-million-tons-co2 (increase from 300 barrels per day when it began operations to about 4,000 barrels per day).

[14] *Secretary Perry Celebrates Successful Completion of Petra Nova Carbon Capture Project*, DEP'T OF ENERGY (Apr. 13, 2017), https://www.energy.gov/articles/secretary-perry-celebrates-successful-completion-petra-nova-carbon-capture-project.

[15] *Id.*

[16] Sonal Patel, *Capturing Carbon and Seizing Innovation: Petra Nova Is POWER's Plant of the Year*, POWER MAGAZINE (Aug. 1, 2017), https://www.powermag.com/capturing-carbon-and-seizing-innovation-petra-nova-is-powers-plant-of-the-year/.

[17] *Two DOE-Supported Projects Receive Awards for Carbon Capture Technologies*, DEP'T OF ENERGY (Dec. 7, 2017), https://www.energy.gov/fe/articles/two-doe-supported-projects-receive-awards-carbon-capture-technologies.

[combined heat and power] facility."[18] This assertion is flawed. First, the use of a natural gas combined heat and power facility was a conscious design choice for Petra Nova, not a technical shortcoming or a workaround in response to a problem. The developers of Petra Nova decided to include a natural-gas power supply due to the low price of natural gas.[19]

Second, there are numerous examples of coal-fired plants using post-combustion capture of CO_2 that demonstrably integrate the thermal load of the capture equipment. These include Canada's Boundary Dam project (discussed further below),[20] the successful amine-based solvent pilot program at the Łaziska Power Plant in Poland,[21] and several pilot projects in the United States using the chilled ammonia process.[22] Given the demonstrated feasibility of integrating the thermal load, it is appropriate to view Petra Nova's choice as just that, a choice, rather than a short-coming.

Finally, and importantly, the process of capturing CO_2 has also been successfully employed for many decades on numerous coal- and natural gas-fired EGUs used in industrial processes other than for production of electricity. Examples include the In Salah facility in Algeria, as well as the Sleipner West and Snøhvit facilities in Norway.[23] In 2015, EPA properly took these applications into account in its analyses; now it is ignoring this relevant and dispositive evidence of the feasibility of capturing CO_2. As the D.C. Circuit has explained, a system of emissions reduction may be adequately demonstrated based on "the reasonable extrapolation of a technology's performance in other industries."[24]

[18] 83 Fed. Reg. at 65,444.

[19] PETRA NOVA PARISH HOLDINGS LLC, W.A. PARISH POST-COMBUSTION CO2 CAPTURE AND SEQUESTRATION PROJECT, at 11-12 (Feb, 17, 2017), https://www.osti.gov/scitech/biblio/1344080-parish-post-combustion-co2-capture-sequestration-project-final-publicdesign-report; *see also* Patel, *supra* note 16 (To address parasitic load "NRG determined that the project would benefit from a purpose-built 70-MW gas-fired cogeneration system . . . that is 'converting fossil fuels at an efficiency of 55%, instead of the host coal unit, which is converting fossil fuels at an efficiency of 33.34%.'") (quoting David Greeson, Vice President of Development at NRG Energy).

[20] *See Boundary Dam Power Station*, SASKPOWER, https://www.saskpower.com/our-power-future/our-electricity/electrical-system/system-map/boundary-dam-power-station (last visited Mar. 18, 2019); *SaskPower Boundary Dam and Integrated CCS*, POWER TECHNOLOGY, https://www.power-technology.com/projects/sask-power-boundary/ (last visited Mar. 18, 2019).

[21] Marcin Stec et al., *Demonstration of a Post-Combustion Carbon Capture Pilot Plant Using Amine-Based Solvents at the Łaziska Power Plant in Poland*, 18 CLEAN TECH. ENVTL. POL'Y 151 (2016), https://link.springer.com/content/pdf/10.1007%2Fs10098-015-1001-2.pdf.

[22] Ola Augustsson et al., *Chilled Ammonia Process Scale-up and Lessons Learned*, 114 ENERGY PROCEDIA 5593, 5600 (Table 1) (2017), https://doi.org/10.1016/j.egypro.2017.03.1699. These successful, small-scale pilot projects include the AEP Mountaineer Project in West Virginia (2009-2011) and WE Energies Pilot Plant in Wisconsin (2008-2009). *See id.*

[23] *See* P.S. Ringrose et al., *The In Salah CO_2 Storage Project: Lessons Learned and Knowledge Transfer*, 37 ENERGY PROCEDIA 6226, 6226 (2013), https://doi.org/10.1016/j.egypro.2013.06.551; *Carbon Storage*, EQUINOR, https://www.equinor.com/en/how-and-why/climate-change/carbon-storage.html (last visited Mar. 18, 2019).

[24] *Lignite Energy Council v. EPA*, 198 F.3d 930, 934 (D.C. Cir. 1999).

2. *Transport of Captured CO_2*

The second component of a CCS system is the transport of the captured CO_2 to a location where it will be utilized or sequestered. At the time EPA prepared the 2015 Rule, there were already approximately 5,000 miles of pipeline in the U.S. transporting CO_2 (captured and mined) for use in EOR, other types of utilization, and sequestration.[25] Since then, more such pipelines have been built.[26] In addition, CO_2 can be shipped by truck or train to its ultimate destination.[27] The feasibility of transporting CO_2 is well demonstrated and, indeed, the Proposal does not question it.

3. *Utilization and Sequestration of Captured CO_2*

The third element of a CCS system is the use or storage of the captured CO_2. Whether mined or captured, CO_2 has been used for a variety of purposes for nearly a century. It has long been used in the food and beverage industry, for EOR, in cement production, and for other industrial purposes.[28] It has monetary value and is sold for approximately $30/ton.[29] The CO_2 captured by Petra Nova, for example, is used for EOR. The Boundary Dam plant in Canada uses some of its captured CO_2 for EOR and some is geologically sequestered. An innovative new plant in Texas, NET Power, captures the CO_2 it generates and uses its own captured CO_2 to operate the plant and produce power.[30]

If the captured CO_2 is sequestered rather than utilized, then that process is the same regardless of whether the CO_2 is captured from a power plant or another type of industrial facility. Around the

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[25] *Annual Report Mileage for Hazardous Liquid or Carbon Dioxide Systems*, U.S. DEP'T OF TRANSP., PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMIN. (Mar. 1, 2019), https://cms.phmsa.dot.gov/data-and-statistics/pipeline/annual-report-mileage-hazardous-liquid-or-carbon-dioxide-systems (reporting 5,190 miles of high-pressure pipelines carrying CO_2 in 2013); *see also* 80 Fed. Reg. at 64,572.

[26] *Annual Report Mileage for Hazardous Liquid or Carbon Dioxide Systems*, U.S. DEP'T OF TRANSP., PIPELINE AND HAZARDOUS MATERIALS SAFETY ADMIN., *supra* note 25 (reporting 5,237 miles of high-pressure pipelines carrying CO_2 in 2017).

[27] *See C2 Land transport of CO2*, GLOBAL CCS INSTITUTE, https://hub.globalccsinstitute.com/publications/strategic-analysis-global-status-carbon-capture-storage-report-1/c2-land-transport-co2 (last visited Mar. 18, 2019).

[28] *See, e.g.*, 80 Fed. Reg. at 64,550 (AES Warrior Run became operational in 2000 and the facility's captured CO_2 is used for the food and beverage industry); *Terrell Natural Gas Processing Plant (formerly Val Verde Natural Gas Plants), Facilities Database, the Global Carbon Capture and Storage Intelligence Database (CO_2RE)*, GLOBAL CCS INSTITUTE, https://co2re.co/StorageData (last visited Mar. 18, 2019) (EOR operation began in 1972).

[29] Sam A. Rushing, *Carbon Dioxide from Flue Gas v. Concentrated By-Product Chemical Sources; and the Impact of Distribution Costs on Economic Feasibility*, BIOFUELS DIGEST (May 31, 2017), https://www.biofuelsdigest.com/bdigest/2017/05/31/carbon-dioxide-from-flue-gas-v-concentrated-by-product-chemical-sources-and-the-impact-of-distribution-costs-on-economic-feasibility/.

[30] The Net Power facility in LaPorte, Texas uses Allam Cycle technology to produce zero emissions. Akshat Rathi, *A Radical US Startup has Successfully Fired up its Zero-Emissions Fossil-Fuel Power Plant*, QUARTZ (May 31, 2018), https://qz.com/1292891/net-powers-has-successfully-fired-up-its-zero-emissions-fossil-fuel-power-plant/. The Allam Cycle "uses a high-pressure, highly recuperative, oxyfuel, supercritical CO_2 cycle that makes emission capture a part of the core power generation process, rather than an afterthought. The result is high-efficiency power generation that inherently produces a pipeline-quality CO_2 byproduct at no additional cost to the system's performance." *Net Power Has Reinvented the Power Plant*, *Technology*, NETPOWER, https://www.netpower.com/technology/ (last visited Mar. 18, 2019).

world, many millions of tons of CO_2 have been captured from a variety of industrial operations and successfully sequestered in a variety of geological settings on-shore and off-shore. Examples include the Sleipner gas field in Norway, the Snøhvit field in the Barents Sea, and the Krechba gas field in Algeria.[31] Here in the United States, from 2011-2014, Archer Daniels Midland successfully captured and sequestered one million tons of CO_2 in a saline formation in Illinois.[32] In April 2017, Archer Daniels Midland began Phase II of its capture and sequestration project, the Illinois Industrial Carbon Capture and Storage ("ICCS") project, which is expected to store approximately 1.1 million tons of carbon annually.[33]

4. CCS Systems Have Been Operating Successfully Around the World

Eighteen large-scale industrial or power generating facilities using CCS are currently in operation, another five are under construction, and twenty are in various stages of development around the world.[34] Boundary Dam, located in the province of Saskatchewan in Canada, is a coal-fired power plant originally built in 1959. One of its EGUs was retrofitted with CCS and has been operating since 2014.[35] As of February 2019, Boundary Dam had captured and sequestered more than 2.5 million metric tons of carbon dioxide.[36] Boundary Dam has successfully integrated the thermal load of the capture technology into the EGU steam cycle. This evidence plainly answers the question raised in the Proposal about whether such integration is possible.[37]

During its first year of operation after the CCS retrofit, Boundary Dam experienced technical difficulties. The Proposal seeks comment on whether these "problems cast doubt on the

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[31] *See In Salah*, ZEROCO$_2$.NO, http://www.zeroco2.no/projects/in-salah (last visited Mar. 18, 2019); *Sleipner Area*, EQUINOR, https://www.equinor.com/en/what-we-do/norwegian-continental-shelf-platforms/sleipner.html (last visited Mar. 18, 2019); *Snøhvit*, EQUINOR, https://www.equinor.com/en/what-we-do/norwegian-continental-shelf-platforms/snohvit.html (last visited Mar. 18, 2019).

[32] *Decatur Fact Sheet: Carbon Dioxide Capture and Storage Project*, CARBON CAPTURE AND SEQUESTRATION TECHNOLOGIES PROGRAM @ MIT, https://sequestration.mit.edu/tools/projects/decatur.html (last updated Sept. 30, 2016).

[33] *ADM Begins Operations for Second Carbon Capture and Storage Project*, ARCHER DANIELS MIDLAND (Apr. 4, 2017), https://www.adm.com/news/news-releases/adm-begins-operations-for-second-carbon-capture-and-storage-project-1.

[34] *See* GLOBAL STATUS OF CCS 2018, *supra* note 12, at 22. The five facilities expected to come online by 2020 are the Gorgon Carbon Dioxide Injection Project in Australia, two projects in Alberta, Canada, associated with the Alberta Carbon Trunk Line, and two in China (Sinopec Qilu Petrochemical and Yanchang Integrated Carbon Capture and Storage and Demonstration Facility). *See Gorgon Carbon Dioxide Injection*, *Projects Database*, GLOBAL CCS INSTITUTE, https://perma.cc/Y7DG-H6KX; *Alberta Carbon Trunk Line ("ACTL") With North West Redwater Partnership's Sturgeon Refinery CO_2 Stream*, *Projects Database*, GLOBAL CCS INSTITUTE, https://perma.cc/3UP4-CWPM; *Carbon Trunk Line ("ACTL") With Agrium CO_2 Stream*, *Projects Database*, GLOBAL CCS INSTITUTE, https://perma.cc/89TU-44DT.

[35] *Boundary Dam Power Station*, SASKPOWER, https://www.saskpower.com/our-power-future/our-electricity/electrical-system/system-map/boundary-dam-power-station (last visited Mar. 18, 2019).

[36] *BD3 Status Update: February 2019*, SASKPOWER (Mar. 12, 2019), https://www.saskpower.com/about-us/our-company/blog/bd3-status-update-february-2019.

[37] *See supra* text accompanying note 20.

technical feasibility of fully integrated CCS."[38] (**Comment C–10**). Notably, EPA already analyzed and answered this question in its response to the petitions for reconsideration of the 2015 Rule. It concluded that:

> the early operating difficulties at Boundary Dam related chiefly to ancillary operating systems rather than directly to the carbon capture system, and stemmed in part from the complexity of retrofitting CCS onto an existing plant, which is not a concern for *new* steam units.[39]

The current request for comment on this question is a red-herring for several reasons. First, EPA already analyzed the question and confirmed that the technical difficulties did *not* relate to the capture equipment. Second, it is more difficult to retrofit a plant to add capture equipment—as was the case at Boundary Dam—than to build a new plant, which is the focus of the Proposal. Third, and most important, Boundary Dam has been successfully operating at a commercial scale for several years. From February 2018 to February 2019, the 12-month average time online was 67.2%.[40] During February 2019, the carbon capture equipment was operating 96.5% of the time.[41] Notably, Boundary Dam operates full—not partial—CCS at commercial scale, more than adequately demonstrating the feasibility of CCS. As EPA has previously explained, even during Boundary Dam's initial year of operations, from October 2014 through September 2015, it had a capture rate of more than 40 percent, "which is significantly more efficient than the 12-month annual capture rate (reflecting partial carbon capture at an annual rate of approximately 16 to 23) on which the [2015 Rule] is predicated."[42]

Successful implementation of CCS has been accomplished in other countries too, including Algeria, Norway, China, and Japan. In Algeria, the In Salah facility stored 3.8 million metric tons of CO_2 between 2004 and 2011.[43] Norwegian firm Equinor has captured over 20 million tons of carbon dioxide from its CCS facilities in Sleipner and Snøhvit.[44] Norway is also home to the world's largest CCS research facility, the Technology Centre at Mongstad.[45] Meanwhile,

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[38] 83 Fed. Reg. at 65,444.

[39] EPA Brief, *supra* note 8, at 24 (emphasis in the original) (citing Basis for Denial of Petitions to Reconsider the CAA Section 111(b) Standards of Performance for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Utility Generating Units 7-8, 10 (Apr. 2016), EPA-HQ-OAR-2013-0495-11918) [hereinafter, "Reconsideration Memo"].

[40] *BD3 Status Update: February 2019*, *supra* note 36.

[41] *Id.* Start-up problems are not unusual for first-of-a-kind facilities and Boundary Dam was the first plant in the world to retrofit a large-scale EGU with CCS. In addition, it involved retrofitting carbon capture into an existing plant and retrofit projects are generally much harder and more expensive to accomplish than building a new coal plant designed to include CCS. Edward S. Rubin & Haibo Zhai, *The Cost of Carbon Capture and Storage for Natural Gas Combined Cycle Power Plants*, 46 ENVTL. SCI. & TECH. 3076, 3083 (2012).

[42] Reconsideration Memo, *supra* note 39, at 9.

[43] Joshua A. White et al., *Geomechanical Behavior of the Reservoir and Caprock System at the In Salah CO_2 Storage Project*, 111 PNAS 8747, 8747 (2014).

[44] *Carbon Storage*, EQUINOR, https://www.equinor.com/en/how-and-why/climate-change/carbon-storage.html (last visited Mar. 18, 2019).

[45] *About TCM*, TECHNOLOGY CENTRE MONGSTAD, http://www.tcmda.com/en/ (last visited Mar. 18, 2019).

China's CCS industry is growing quickly. China has developed two CCS and six EOR facilities with twelve more projects in various stage of development.[46] A recent study projects that coal-fired CCS units in China will have a cheaper levelized cost of electricity ("LCOE") than natural gas plants, even in the absence of a price on carbon.[47]

Notably, the BSER requirement of "adequately demonstrated" and "available" can be satisfied even when *no* plant has met it at pilot or commercial scale.[48]

B. The Administration Has Repeatedly Lauded the Feasibility and Importance of CCS

The technical feasibility of CCS has been not only recognized, but applauded, by other agencies in the federal government. For example, on December 12, 2018, just eight days before the publication of the Proposal, the State Department praised the feasibility and effectiveness of CCS at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change ("COP24"). In an official statement, Judith G. Garber, Principal Deputy Assistant Secretary of the Bureau of Oceans and International Environmental and Scientific Affairs at the State Department, declared on behalf of the Trump Administration that the United States supports a "balanced approach [to energy development] that promotes economic growth, improves energy security, and protects the environment."[49] In particular, she stressed that the continued use of fossil fuel energy such as coal is justified because of advances in emissions reduction technologies such as CCS:

> R&D and operational experience are bringing down the cost of Carbon Capture, Utilization, and Storage or CCUS. One hybrid coal and gas power plant in Texas [Petra Nova] captures more than 90 percent of the emissions from its flue gas

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[46] H.J. Liu et al., *Worldwide Status of CCUS Technologies and Their Development and Challenges in China*, GEOFLUIDS, Aug. 2017, Article ID 6126505, at 13.

[47] Jing-Li Fan et al., *The LCOE of Chinese Coal-Fired Power Plants with CCS Technology: a Comparison with Natural Gas Plants*, 154 ENERGY PROCEDIA 29, 29 (2018) ("The LCOE is lower for coal-fired power plants with CCS than for natural gas power plants if the coal-fired plants have the same level of emission reduction as the natural gas power plants.").

[48] *Sierra Club v. Costle*, 657 F.2d 298, 362-64 (D.C. Cir. 1981).

[49] Judith G. Garber, Principal Deputy Assistant Secretary, Bureau of Oceans and International Environmental and Scientific Affairs, *U.S. National Statement at COP24*, DEP'T OF STATE (Dec. 12, 2018), https://www.state.gov/e/oes/rls/remarks/2018/288054.htm.

Ms. Garber echoed earlier comments of Energy Secretary Rick Perry who told the International Energy Agency that:

> I don't believe you can have a real conversation about clean energy without including CCUS. The United States understands the importance of this clean technology and its vital role in the future of energy production . . . . *We have already seen the success of projects like Petra Nova in Texas*, which is the world's largest post-combustion carbon-capture system . . . . Our experience with CCUS proves that you can do the right thing for the environment and the economy too.

IEA and China host high-level gathering of energy ministers and industry leaders to affirm the importance of carbon capture, INT'L ENERGY AGENCY (June 6, 2017), https://www.iea.org/newsroom/news/2017/june/iea-and-china-host-high-level-gathering-of-energy-ministers-and-industry-leaders.html (emphasis added).

> stream. CCUS enhances our energy security and economic development and preserves the environment.[50]

DOE has been researching and helping to develop and demonstrate CCS since 1997.[51] To expand that work, in 2003, DOE introduced its Regional Carbon Sequestration Partnership Initiative, which includes forty-two states, four provinces in Canada, and two Native American nations.[52] Between 2010 and the present, Congress has appropriated more than $5 billion to fund DOE's work to advance CCS.[53] In 2017, DOE issued a "Report of the Mission Innovation Carbon Capture, Utilization, and Storage Experts' Workshop," which declared:

> [t]he technologies needed to make CCUS work on an industrial scale *are commercially available today*, as is demonstrated by CCUS processes that have been deployed at various sites for a number of years.[54]

In May 2018, Deputy Secretary of the U.S. Department of Energy Dan Brouillette told the 9th Clean Energy Ministerial:

> As a critical technology used to reduce carbon dioxide emissions from fossil-fueled power plants and other industrial activities, CCUS also helps to provide energy security by securing energy diversity and furthering investments made in existing infrastructure. CCUS is an important priority for the United States and the Trump Administration because it is a key ingredient in meeting our goals of lowering emissions while also stimulating our economy, ensuring our energy security, and protecting our health.[55]

DOE has remained steadfast in its position. On February 28, 2019, U.S. Department of Energy Secretary Rick Perry said that "[w]ithout carbon capture, any climate target is virtually

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[50] Garber, *supra* note 49.

[51] PETER FOLGER, CONGRESSIONAL RESEARCH SERV., R44902, CARBON CAPTURE AND SEQUESTRATION (CCS) IN THE UNITED STATES 14 (2018) ("DOE has funded R&D of aspects of the three main steps leading to an integrated CCS system since 1997. Since FY2010, Congress has provided more than $5 billion total in annual appropriations for CCS activities at DOE."), *available at* https://fas.org/sgp/crs/misc/R44902.pdf.

[52] *Regional Carbon Sequestration Partnership (RCSP) Initiative*, NAT'L ENERGY TECH. LABORATORY, https://www.netl.doe.gov/research/coal/carbon-storage/carbon-storage-infrastructure/rcsp (last visited Mar. 18, 2019).

[53] FOLGER, *supra* note 51, at 14.

[54] ACCELERATING BREAKTHROUGH INNOVATION IN CARBON CAPTURE, UTILIZATION, AND STORAGE: REPORT OF THE MISSION INNOVATION CARBON CAPTURE, UTILIZATION, AND STORAGE EXPERTS' WORKSHOP, at xii (Sept. 2017) (emphasis added), *available at* https://www.energy.gov/sites/prod/files/2018/05/f51/Accelerating%20Breakthrough%20Innovation%20in%20Carbon%20Capture%2C%20Utilization%2C%20and%20Storage%20_0.pdf.

[55] *The Role of Carbon Capture, Utilization, and Storage in Forming a Low-Carbon Economy*, DEP'T OF ENERGY (May 21, 2018), https://www.energy.gov/articles/role-carbon-capture-utilization-and-storage-forming-low-carbon-economy.

impossible to meet. . . . We believe that you can't have a serious conversation about reducing emissions without including nuclear energy and carbon capture technology."[56]

The Proposal ignores DOE's extensive experience and findings, ignores the official position of the United States about CCS in the context of international negotiations, and ignores the successful, demonstrated implementation of CCS in the United States and throughout the world.

C. Petra Nova and Boundary Dam's Receipt of Government Support is Irrelevant to their Demonstration of the Technical Feasibility of CCS

The Proposal questions whether the fact that Boundary Dam and Petra Nova both received government funding "raises concerns as to the extent to which developers are willing to accept the risks associated with the operation and long-term reliability of CCS technology."[57] (**Comment C-11**) The suggestion is irrelevant and a non-sequitur. Whether a facility has received government subsidies is not relevant to the question of technical feasibility; such subsidies do not undermine the technological success that Boundary Dam and Petra Nova represent. EPA has already recognized this point: in 2015, EPA explained that "the availability of—or the lack of—external financial assistance does not affect the technical feasibility of the technology."[58] Moreover, by focusing only on Boundary Dam and Petra Nova, the Proposal ignores that "[n]ot one of the CO_2 capture systems at Warrior Run, Shady Point, or Searles Valley was installed for regulatory purposes or as government-funded demonstration projects. They were installed to capture CO_2 for commercial use"[59]—a point EPA made when promulgating the 2015 Rule. To the extent they are relevant at all, government subsidies should be considered only as part of the economic feasibility analysis.

II. CCS IS GEOGRAPHICALLY FEASIBLE

During its development of the 2015 Rule, EPA carefully evaluated the feasibility of carbon storage/sequestration. It concluded then that there is *ample* demonstrated storage capacity in the United States for new coal-fired power plants. Nothing in the Proposal undermines or contradicts that finding. The two reasons offered by the Proposal for reversing the 2015 conclusion—that unmineable coal seams are not sufficiently demonstrated as reservoirs for large-scale CO_2 storage and that the water needs of CCS will limit its availability in arid regions—are both inconsistent with the factual record.

A. Carbon Storage Sites are Widely Available in the United States

DOE and the U.S. Geological Survey have each independently estimated there are several *trillion* metric tons of subsurface storage capacity in the United States.[60] "This estimated storage

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[56] Kelsey Brugger, *Perry Announces $24M for CCS, Talks Emissions*, GREENWIRE (Feb, 28, 2019), https://www.eenews.net/greenwire/stories/1060122691.

[57] *Id.*

[58] 80 Fed. Reg. at 64,550.

[59] *Id*. at 64,551.

[60] 80 Fed. Reg. at 64,578–64,579.

capacity exceeds the *total* annual CO_2 emissions from the domestic energy sector by a factor of at least 500."[61] Reviewing these analyses, EPA concluded in 2015 that thirty-nine states had deep saline storage capacity, twelve states had EOR operations (totaling one hundred twenty-five projects in ninety-eight oils fields), ten states had carbon dioxide pipelines (with more in development), eighteen states were within one-hundred km of an EOR location, twenty-one states had unmineable coal seams, and the few remaining states without confirmed geologic storage capacity either lacked coal or had enacted laws prohibiting new coal-fired plants.[62] The 2015 Rule thus properly focused on "plausible new sources [of coal-fired power plants] or compliance scenarios," not on hypotheticals.[63]

B. The Proposal's Rejection of Unmineable Coal Seams as Proven Sequestration Sites Does not Justify a Conclusion that CCS is not Geographically Available

For the most part, the Proposal does not question the conclusions reached by EPA in 2015. In fact, the Proposal acknowledges that updated information on the geographic extent of suitable deep saline formations and oil and gas reservoirs, as well existing EOR operations and carbon dioxide pipelines, "do not significantly change the EPA's understanding of which areas are amenable to GS."[64] Together, deep saline formations, oil and gas reservoirs, and EOR operations account for 96% of the areas the Proposal identified as suitable for geological sequestration.

The only area in which the Proposal suggests that the geographic availability of sequestration sites is less than it concluded was the case in 2015 is with respect to unmineable coal seams—which accounted for only 4% of the sites considered in the 2015 Rule. In particular, the Proposal concludes that unmineable coal seams are unproven as viable sites for large-scale sequestration.[65] Yet the Proposal cites no new information on unmineable coal seams' potential for storing carbon that has emerged since 2015. Instead, it relies on the fact that "there have been no large-scale demonstrations of [geological sequestration] associated with unmineable coal seams," and the pilot projects' "durations and injected amounts were limited."[66] That such projects have until now been tested only on a small scale does not support an affirmative conclusion that unmineable coal seams do not have sufficient storage potential to be considered

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[61] EPA Brief, *supra* note 8, at 31. There is thus adequate storage capacity for full capture on new coal *and* new gas-fired power plants.

[62] 80 Fed. Reg. at 64,576–64,582.

[63] EPA Brief, *supra* note 8, at 35; *see also Portland Cement Ass'n v. EPA.*, 665 F.3d 177, 190 (D.C. Cir. 2011) (upholding Section 111 standards for cement kilns despite arguments that EPA "failed to consider the effects of its standards on older kilns" and deferring to EPA's record-based finding that it was "entirely conjectural" and unlikely that any new sources would use the older kiln design) [hereinafter, "*Portland Cement III*"]; *Kennecott Greens Creek Min. Co. v. Mine Safety & Health Admin.*, 476 F.3d 946, 954-56 (D.C. Cir. 2007) (holding that it was reasonable to regulate known risks while continuing to research potential risks; a standard is "feasible" if there is a "reasonable possibility that the typical firm . . . can meet the [limit]"; the fact that a few operators will not be able to comply does not undermine a showing that the standard is generally feasible).

[64] 83 Fed. Reg. at 65,441.

[65] *Id.* at 65,442.

[66] *Id.*

at all.[67] Even if unmineable coal seams were shown to have limited storage potential, the correct response would be to adjust the 2015 figures, not eliminate this category of sequestration site altogether.

Moreover, even if the Proposal were correct that unmineable coal seams are not viable geological sequestration sites, those sites represent only 4% of the sites identified as feasible in the 2015 Rule. The Proposal does not explain how such a minor change in the geographic availability of geological sequestration sites justifies its conclusion that CCS is not adequately demonstrated.

C. The Proposal's Conclusion That CO_2 Capture Is Not Feasible in Arid States Is Unsupported by Any Evidence

The Proposal also suggests that CCS is not geographically available because CCS's need for water will limit the technology's feasibility in arid regions.[68] This assertion does not justify a reversal of the 2015 finding because it is not based on any quantitative analysis of the geographic area implicated, because it is contradicted by the International CCS Knowledge Centre's recent analysis of a proposed successor to the Boundary Dam facility, and because it ignores the scientific literature on the water needs of CCS.

The most fundamental flaw in this part of the Proposal is that it never quantifies the extent to which water needs will reduce the geographic area available for sequestration. Instead, it only alludes vaguely to how water needs might reduce the viability of CCS in arid regions. Thus at times the Proposal states that "[c]ertain regions of the country" have an arid climate,[69] or that "the Western U.S. . . . has lower amounts of water available for EGUs,"[70] without specifying how much less water is available and how much of a difference this will make. Yet the Proposal never quantifies the extent of the areas that will lack in water to a sufficient extent that CCS should not be considered "available" in those regions. Instead, it concludes only that "many sequestration sites might not have sufficient water resources to operate CO_2 capture equipment."[71] The Proposal never explains how many sequestration sites would not have sufficient water resources, what amount of water is sufficient, or how the allegedly unavailable areas compare to areas where coal plants have historically been constructed or would plausibly be expected to be constructed in the future. Vague generalities and hand-waving do not amount to reasoned decision-making and cannot overcome the clear evidence that CCS is technically feasible.

The Proposal also fails to acknowledge the significance of the Boundary Dam project, which—as the Proposal acknowledges—"captures water from the flue gas and recycles the water, resulting

[67] *See* Part IV below; *see also Essex Chem. Corp. v. Ruckelshaus*, 486 F.2d 427, 440 (D.C. Cir. 1973) (upholding the achievability of a NSPS for coal-fired EGUs that had not been achieved at full scale, based in part on "prototype testing data," which, along with vendor guarantees, indicated that the promulgated standard was achievable).

[68] 83 Fed. Reg. at 65,442–65,444.

[69] *Id.* at 65,443.

[70] *Id.* at 65,444.

[71] *Id.*

in decreased withdrawal of fresh water."[72] This kind of recycling can significantly reduce the water needs of a CCS-equipped power plant. Based on the technology successfully implemented at Boundary Dam, the International CCS Knowledge Centre, in its recently-completed feasibility study for a successor to Boundary Dam that could be located at Canada's Shand Power Plant, concluded that a CCS retrofit could be completed without increasing the plant's water demand at all.[73] Because the Shand plant operates in an area of limited water supply and strict water use restrictions,[74] it provides a fair comparison to operation of a CCS plant in the United States' arid west.

The Proposal ignores this contrary evidence. It does not discuss the Shand report at all. Its only response to Boundary Dam's success is to state that, in the 2015 Rule, "specific data on how much water was captured/saved [at Boundary Dam] was not cited."[75] This response is grossly inadequate. When presented with evidence that a facility is demonstrating a technology in 2019, the agency cannot simply indicate that it lacked the necessary data several years earlier, without making any new and independent attempt to obtain and analyze the relevant data.

In addition to evidence of the Boundary Dam plant and Shand analysis, a recent independent review of the scientific literature on the impact CCS has on water usage at power plants concludes that:

> For coal fired power plants using once-through cooling, the results indicate that increased water consumption is only associated with process makeup water requirements of the capture system. However, since the addition of a postcombustion capture system allows for some recovery of water from the flue gas, the additional makeup requirements are balanced, or off-set, by the water production. For this reason, the percentage variation for coal fired power plants with once-though cooling is negative. Normalised consumption varies from -20 to -96 per cent. These results highlight that, depending on the case considered, *CO_2 capture can actually contribute to reducing water consumption*.[76]

The Proposal does not discuss this review at all or attempt to rebut its conclusions. In short, the Proposal does not address the most up-to-date scientific information on the impact of CCS on a power plant's water consumption and, even assuming that CCS would increase water consumption, does not quantify the degree to which this increase would limit the geographic availability of partial CCS.

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[72] *Id.* at 65,443.

[73] INT'L CCS KNOWLEDGE CENTRE, THE SHAND FEASIBILITY STUDY: PUBLIC REPORT, at x (Nov. 2018), *available at* https://ccsknowledge.com/pub/documents/publications/Shand%20CCS%20Feasibility%20Study%20Public%20_Full%20Report_NOV2018.pdf [hereinafter THE SHAND CCS FEASIBILITY STUDY PUBLIC REPORT].

[74] *Id.*

[75] 83 Fed. Reg. at 65,444 n.86.

[76] Guido Magneschi et al., *The Impact of CO_2 Capture on Water Requirements of Power Plants*, 114 ENERGY PROCEDIA 6337, 6346 (2017) (emphasis added).

D. The Assumption that a Technology Must be Feasible for Every Potential New Source to be Justified as BSER is Factually and Legally Mistaken

Each aspect of the Proposal's geographic feasibility analysis is premised on an assumption that CO_2 storage capacity needs to be available for every potential new source in order for CCS to be deemed feasible and adequately demonstrated. This very issue was raised in challenges to the 2015 Rule. EPA concluded then—and has no basis for concluding differently now—that the idea "lacks merit."[77]

As a factual matter—as EPA explained in 2015—developers of new coal plants can choose where to locate and select sites near to EOR sites and/or other geologic storage options. They can utilize the extensive CO_2 pipeline network that already exists and continues to expand. Moreover, EPA pointed out that its estimate of the geographic availability of storage sites was conservative because it included only areas with confirmed storage capacity; this did not mean that all excluded areas lacked such capacity, because many had not yet been evaluated.[78]

The Proposal improperly rests on the implausible hypothetical that new coal-fired power plants might be located in every state.[79] Starting with that faulty premise, the Proposal unreasonably concludes that inadequate storage capacity exists.[80] The Proposal fails to identify any plausible scenario in which new coal-fired power plants would be located in areas of the United States that lack access to deep saline aquifers, oil and gas reservoirs, EOR operations, salt mines, or CO_2 pipelines. To the contrary, the Proposal acknowledges that there are not likely to be many—if any—new coal-fired plants built at all regardless whether the 2015 Rule remains in effect or not.[81]

Moreover, the Proposal improperly ignores the key fact that some states have enacted laws that directly or indirectly preclude new coal-fired power plants or require capture and storage of a larger share of CO_2 emissions than required by the 2015 Rule.[82] It is unreasonable for the

[77] EPA Brief, *supra* note 8, at 29.

[78] EPA Brief, *supra* note 8, at 31-32. In addition, EPA explained that "[t]he availability of . . . non-CCS compliance alternatives . . . also support[s] EPA's reasonable conclusion that the final standard of performance imposes no geographical constraints on the siting of potential new sources. . . . Indeed, there is no obligation that each new source actually install the type of technology on which the standard is predicated."). *Id.* at 36.

[79] 83 Fed. Reg. at 65,441-65,442.

[80] *Id.* at 65,441.

[81] 83 Fed. Reg. at 65,427.

[82] For example, Oregon has effectively banned new coal-fired power plants by prohibiting electric utilities in the state from obtaining electricity from coal-fired power plants after January 1, 2030. Or. Rev. Stat. Ann. § 757.518(2). Montana requires that any new coal-fired power plant sequester at least 50% of its carbon emissions. Mont. Code Ann. § 69-8-421(8). California, New York, and Washington have emissions performance standard for all new baseload EGUs that effectively require the use of CCS on coal plants. Cal. Pub. Util. Code § 8341(d)(1); N.Y. Comp. Codes R. & Regs. tit. 6, § 251.3; Wash. Rev. Code Ann. § 80.80.040. California, in addition, requires that 100% of the state's electricity generation come from renewable energy and zero-carbon resources by 2045; coal plants could comply with this standard only if they capture 100% of their CO_2 emissions. Cal. Pub. Util. Code § 454.53(a).

Proposal to assume that new coal-fired plants would be located in these states regardless of whether storage capacity exists.

As a legal matter, in the 2015 rulemaking EPA already correctly concluded that "[u]nder CAA section 111, an emissions standard may meet the requirements of a 'standard of performance' even if it cannot be met by every new source in the source category that would have constructed in the absence of that standard."[83] EPA premised this conclusion on the legislative history of section 111, on case law under analogous provisions of the CAA, and on the agency's prior practice in section 111 rulemakings.[84] The Proposal improperly fails to acknowledge that it is changing the agency's position on this issue and thus fails to comply with the legal requirement that it must at a minimum offer a justification for such a change. Here, the Proposal does nothing to rebut the 2015 Rule's reasoning or conclusions.[85]

EPA's conclusion in 2015 was correct. Courts have ruled in a variety of regulatory contexts that a technology can be economically feasible even if not all plants in all locations can satisfy it. For example, the D.C. Circuit in *Indus. Union Dep't, AFL-CIO v. Hodgson*—a case involving asbestos dust exposure standard under OSHA—held that:

> [t]he concept of economic feasibility [does not] necessarily guarantee the continued existence of individual employers. It would appear to be consistent with the purposes of the Act to envisage the economic demise of an employer who has lagged behind the rest of the industry in protecting the health and safety of employees and is consequently financially unable to comply with new standards as quickly as other employers.[86]

The same conclusion applies to other aspects of feasibility. Just as it is acceptable under the concept of economic feasibility to establish a standard under which facilities in some locations may shut down, so is it acceptable to establish a standard under which facilities in some locations may not be built.

III. CCS IS ECONOMICALLY FEASIBLE

As a result of decades of government investment and support, the cost of CCS has declined dramatically. As established in the record for the 2015 Rule, the capital costs of partial CCS are in line with those of previous NSPSs. Moreover, because the plants examined for the 2015 Rule were first-of-their-kind facilities, the costs of the next generation of plants are projected to be significantly lower. Accordingly, the Shand Feasibility Study concludes that the cost of CCS for

[83] 79 Fed. Reg. at 1466.

[84] *Id.*; *see also* 80 Fed. Reg. at 64,540–41.

[85] *See Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2126, (2016) ("[A]n unexplained inconsistency in agency policy is a reason for holding an interpretation to be an arbitrary and capricious change from agency practice. An arbitrary and capricious regulation of this sort is itself unlawful and receives no *Chevron* deference.") (alterations, internal quotation marks, and citations omitted).

[86] *Indus. Union Dep't, AFL-CIO v. Hodgson*, 499 F.2d 467, 478 (D.C. Cir. 1974).

that plant would be 67% lower than the cost of the Boundary Dam facility.[87] The Proposal's alternative economic feasibility analysis, based on the LCOE, is seriously flawed because it adopts a set of implausible assumptions that render it inapplicable in most states. Accordingly, the Proposal does nothing to overturn the 2015 Rule's conclusion that CCS is economically feasible.

A. The Cost of Partial CCS is not Exorbitant

Section 111(a)(1) mandates that EPA, when determining BSER, must "tak[e] into account the cost of achieving such" emissions reductions. 42 U.S.C. § 7411(a)(1). Although cost is a factor in establishing a NSPS, the D.C. Circuit has repeatedly made it clear that section 111 is intended to be a technology-forcing statute and therefore the standards promulgated under it may impose significant costs on the regulated industry and may even prevent some facilities from being built. The court has explained that section 111 prohibits only "exorbitant" costs, meaning those that are "greater than the industry [as a whole can] bear and survive."[88] Here, the drag on coal-fired power plants is the persistently low cost of natural gas. It is the cost of natural gas, not the cost of CCS, that is preventing the construction of new coal plants.

In 2015, EPA determined that the 2015 Rule would increase the capital costs of new coal-fired power plants by 21-22%.[89] As the 2015 Rule explained—and as the Proposal acknowledges—this increase is broadly similar to that in several other section 111 rules dating back to 1971 that were subsequently upheld by the D.C. Circuit. Thus the 1971 PM, SO_2, and NO_X NSPS for coal-fired EGUs increased capital costs by 15.8 percent and was upheld in *Essex Chemical Corp. v. Ruckelshaus*.[90] The 1978 EGU NSPS, which a Congressional Budget Office study determined to have increased capital costs by 10 to 20 percent, was upheld in *Sierra Club v. Costle*.[91] In *Portland Cement Association v. Ruckelshaus*, the court upheld a NSPS for Portland cement plants that was projected to increase capital costs by 12 percent and operating costs by 5 to 7 percent.[92]

The Proposal disputes the comparability of these precedents for two reasons. First, it asserts that even if the percentage increase in cost is similar, the absolute increase in cost is greater, because coal-fired EGUs must already comply with a variety of other environmental regulations.[93] The Proposal cites no precedent for adopting this measure of costs; nor does it quantify how the absolute costs imposed by this rulemaking compares to those of prior rulemakings, much less make this comparison after taking inflation into account. Second, it asserts that "the fact that the

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[87] THE SHAND CCS FEASIBILITY STUDY PUBLIC REPORT, *supra* note 73, at 77.

[88] *Portland Cement Ass'n* v. *EPA*, 513 F.2d 506, 508 (D.C. Cir. 1975).

[89] 80 Fed. Reg. at 64,560.

[90] 486 F.2d at 440; *see also* 80 Fed. Reg. at 64,559–60.

[91] 657 F.2d at 410; *see also* 80 Fed. Reg. at 64,560.

[92] 486 F.2d 375 (D.C. Cir. 1973).

[93] 83 Fed. Reg. at 65,440 ("All of these additional environmental control requirements increase the baseline costs of constructing a new coal-fired EGU. Therefore, at the same percentage increase in capital costs, absolute costs are much higher.").

utility industry was able to absorb 20 percent increases in cost due to pollution control in the past does not necessarily mean the industry could do so today," pointing to the difficulty of passing on capital costs to consumers, "at least in deregulated markets."[94] As explained below, *see* Section III.B.4, *infra*, this argument is flawed because the set of assumptions underlying it is applicable in at most three states.

B. The Proposal's LCOE Analysis is Based on an Implausible Set of Assumptions

In addition to analyzing the capital costs, the Proposal also looks at the LCOE to assess the economic feasibility of partial CCS. This LCOE analysis, however, contains several flaws. First, it overestimates transportation costs. Second, it improperly excludes the significant federal tax credits for which new coal-fired power plants satisfying the 2015 Rule are eligible. Third, it improperly ignores potential revenue from sales of CO_2 for use in EOR. Finally, because the analysis applies only to states with deregulated electricity markets, it applies (after incorporating state regulatory requirements and revenue opportunities) to at most a few states.

1. The LCOE Analysis Overestimates Transportation Costs

The LCOE analysis is based on an overestimation of transportation costs. As the Proposal explains, the estimated CO_2 transportation costs represent the "annual transportation through a 100-kilometer (km) (62 mile) CO_2 pipeline."[95] As explained elsewhere in the Proposal, EPA considers a site to be geographically available only if it is within 100 km of a location with sequestration potential.[96] As a result, the *maximum* distance that CO_2 would need to be transported for any plant under the Proposal's geographic analysis is 100 km. However, for purposes of the LCOE analysis, the Proposal assumes that 100 km is the *average* distance that CO_2 would be transported. Given the improbability that every plant built subject to the 2015 Rule's standards would be located at precisely the maximum distance assumed in the geographic analysis, the result is that the Proposal overestimates transportation costs.

Moreover, even if it was appropriate to assume transportation costs through a 100 km pipeline in the context of the 2015 Rule,[97] that fact does not make it appropriate now. In the context of the 2015 Rule this was a conservative assumption; as explained below, maintaining such an assumption while reversing the underlying conclusion is not rational.[98]

2. The CO_2 Utilization Market Provides a Revenue Stream for Captured CO_2

Captured CO_2 is regularly sold for EOR, for use in the food and beverage industry, and for industrial feedstock.[99] EOR demand has been growing and has reached 19 million tons per

[94] *Id.* at 65,440–41.

[95] 83 Fed. Reg. at 65,438.

[96] *Id.* at 65,441.

[97] 80 Fed. Reg. at 64,572

[98] *See* text accompanying notes 110–111, *infra*.

[99] 83 Fed. Reg. at 65,440; *see also* GLOBAL CCS INSTITUTE, ACCELERATING THE UPTAKE OF CCS: INDUSTRIAL USE OF CAPTURED CARBON DIOXIDE 41-44 (2011), *available at* https://hub.globalccsinstitute.com/sites/default/files/publ

year.[100] This demand could reach 49 million tons by 2030.[101] The Petra Nova plant sells its captured CO_2 to EOR operations in Texas' West Ranch Oil Field.[102] EOR in the West Ranch Oil field has grown production from 300 barrels per day to an estimated 15,000 barrels per day.[103] Additionally, captured CO_2 can be sold as feedstock in various industrial processes, such as curing concrete and producing renewable methanol.[104]

The infrastructure necessary to meet the demand for CO_2 exists.[105] CO_2 pipelines to EOR sites already exist, namely: the Gulf Coast pipeline network, the Permian Basin pipeline network, the Rocky Mountain pipeline network, and the Mid-Continent pipeline network.[106] At present, there are more than 5,200 miles of CO_2 pipelines in the U.S. Captured CO_2 is also delivered by trucks and trains to some users.

Nevertheless, the Proposal "assum[es] no revenues from the sale of captured CO_2" for purposes of the LCOE analysis.[107] It justifies ignoring these benefits because EPA also assumed no revenues from the sale of captured CO_2 in the 2015 Rule.[108] However, in the context of the 2015 Rule this was a conservative assumption; EPA concluded that the costs of partial CCS were reasonable *even without taking these offsetting benefits into account*.[109] Now that the agency is proposing to reverse its conclusion, it is no longer logically supportable to retain this assumption. Instead of ignoring information that would only strengthen its conclusion, it is ignoring information that undermines it. As the Supreme Court has stated, "[s]o long as they are supported by a body of reputable scientific thought, the Agency is free to use conservative assumptions . . . *risking error on the side of overprotection rather than underprotection*."[110] Here, the Proposal's disregard for the benefits of sales to EOR operations is the opposite of this

ications/14026/accelerating-uptake-ccs-industrial-use-captured-carbon-dioxide.pdf [hereinafter, "GLOBAL CCS INSTITUTE, ACCELERATING THE UPTAKE OF CCS: INDUSTRIAL USE OF CAPTURED CARBON DIOXIDE"].

[100] DEEPIKA NAGABHUSHAN & JOHN THOMPSON, CLEAN AIR TASK FORCE, CARBON CAPTURE & STORAGE IN THE UNITED STATES POWER SECTOR: THE IMPACT OF 45Q FEDERAL TAX CREDITS, at 15 (Feb. 2019), *available at* https://www.catf.us/wp-content/uploads/2019/02/CATF_CCS_United_States_Power_Sector.pdf.

[101] *Id.*

[102] Edward Klump & Nathanial Gronewold, *After Petra Nova, What's Next for NRG and Carbon Capture?*, E&E NEWS (Apr. 14, 2017), https://www.eenews.net/stories/1060053094.

[103] FOLGER, *supra* note 51, at 13.

[104] GLOBAL CCS INSTITUTE, ACCELERATING THE UPTAKE OF CCS: INDUSTRIAL USE OF CAPTURED CARBON DIOXIDE, *supra* note 99, at 41-44, 92.

[105] GLOBAL CCS INSTITUTE, TRANSPORTING CO_2, at 2 (2015), *available at* http://decarboni.se/sites/default/files/publications/191083/fact-sheet-transporting-co2.pdf.

[106] MATTHEW WALLACE ET AL., NAT'L ENERGY TECH. LABORATORY, A REVIEW OF THE CO_2 PIPELINE INFRASTRUCTURE IN THE U.S. 3 (2015).

[107] 83 Fed. Reg. at 65,440.

[108] *Id.*

[109] Moreover, in the 2015 rulemaking process, EPA acknowledged that in general, "[i]n determining the costs of pollution control technology, it is reasonable to into account any revenues generated by the sale of any by-products of the control process." 79 Fed. Reg. at 1464.

[110] *Indus. Union Dep't AFL-CIO v. API*, 448 U.S.607, 656 (1980) (emphasis added).

approach and improperly amounts to "entirely fail[ing] to consider an important aspect of the problem."[111]

3. *The LCOE Analysis Ignores Federal Tax Incentives*

To advance CCS and "clean coal" technologies, Congress has appropriated significant funds since the early 1990s. Congress has, for example, authorized federal loan guarantees for "clean coal" technologies,[112] appropriated funds to create public-private partnerships to support the testing and commercialization of CCS,[113] and created investment tax credits ("ITCs") for "clean" coal power generation facilities.[114]

Of these federal incentives and investments, the one most directly relevant to the LCOE analysis is an ITC in section 45Q of the Internal Revenue Code, which was originally created in the Energy Improvement and Extension Act ("EIEA") of 2008.[115] This ITC, as amended and expanded by the FUTURE Act of 2018,[116] significantly lowers the cost for new CCS projects built in compliance with the 2015 BSER. Section 45Q originally had a 75 million metric ton cap but the FUTURE Act eliminated this cap and now provides ITCs that ramp up over time. These ITCs increase from $20 per metric ton of carbon dioxide captured and sequestered in saline formations 2017 to $50 per ton in 2026 and from $10 per metric ton used for EOR operations in 2017 to $35 per ton in 2026.[117] These benefits are significant; by 2020, the ITC will match the Proposal's estimated transportation and storage ("T&S") costs for a low-rank coal plant with 26% CCS, while by 2024, they will match the T&S costs for a bituminous coal plant with 16% CCS.[118]

The Proposal erroneously excluded the ITC from its LCOE analysis, reasoning that Section 45Q credits are only available for facilities commencing construction before 2024,[119] which is "before

[111] *Motor Vehicle Manufacturers Association v. State Farm Auto Mutual Insurance Co.*, 463 U.S. 29, 43 (1983).

[112] Section 1703 of Title VXII of EPACT05, 42 U.S.C. §16513(b)(5). For further discussion, *see* JOHN P. BANKS & TIM BOERSMA, BROOKINGS INSTITUTION, FOSTERING LOW CARBON ENERGY 24 (2015), https://perma.cc/A8ZB-VJLD, and PETER FOLGER & MOLLY F. SHERLOCK, CONG. RESEARCH SERV., R43690, CLEAN COAL LOAN GUARANTEES AND TAX INCENTIVES: ISSUES IN BRIEF 4-6 (2014), *available at* https://nationalaglawcenter.org/wp-content/uploads//assets/crs/R43690.pdf.

[113] 42 U.S.C. §§ 15961-15965. The Clean Coal Power Initiative ("CCPI") authorized DOE to allocate funds for new technologies to cut emissions from coal-based plants. *Id.* § 15962. DOE selected six CCS projects for the initiative's third, most recent round of funding. *See Clean Coal Power Initiative Round III*, DEP'T OF ENERGY, https://perma.cc/HPQ5-PZSC. It only selected one project with a CCS component in the second round. *CCPI Round 2 Selections*, DEP'T OF ENERGY, https://perma.cc/4QKA-S5ZE.

[114] 26 U.S.C. § 48A (creating a 30% tax credit for qualifying advanced coal projects that capture and sequester 65% of more of their CO_2 emissions); *id.* § 48B (creating a 30% tax credit for qualifying gasification projects for electricity generation or industrial applications that capture and sequester at least 75% of the CO_2 emissions);

[115] Pub. L. No. 110-343, § 115(a), Oct. 3, 2008, 122 Stat. 3829.

[116] Pub. L. No. 115-123, § 41119(a), Feb. 9, 2018, 132 Stat. 162.

[117] 26 U.S.C. § 45Q; *see also* NAGABHUSHAN & THOMPSON, *supra* note 100, at 9.

[118] 83 Fed. Reg. at 65,439 & tbl. 6.

[119] 26 U.S.C. §45Q(a)(3)-(4), (d).

the end of the eight-year period in which the EPA is required to review."[120] However, the ITC is available and is utilized by industry actors including Petra Nova and NET Power. On a twelve year time-horizon, Petra Nova could generate approximately $588 million in tax credits.[121] The ITC is part of the economic calculus for regulated entities at the time the NSPS will go into force; it is irrational to exclude this aspect of current economic reality. There is no reason to conclude at this time that Congress will allow the credits to expire. In any case, as discussed below, *see* Section III.C, the costs of CCS technologies can be expected to decline between now and 2024; those declines may more than offset the potential loss of the ITC.

4. The LCOE Analysis is Applicable in at Most Two States

The LCOE also analysis relies on a set of irrational assumptions—particularly its limitation to states with deregulated electricity markets—that do not apply in most states. The full set of assumptions adopted by the Proposal apply to, at most, Ohio and Pennsylvania. An analysis that applies to at most two states cannot rationally serve as the basis for the economic feasibility determination for a nationwide NSPS.

First, the LCOE analysis is premised on the assumption that the costs of implementing CCS will decrease the frequency with which a coal plant will be dispatched—a consideration that, as the Proposal recognizes, applies only in deregulated markets.[122] In states with regulated markets, vertically-integrated utilities will be able to sell the power from a new coal-fired power plant with CCS as long as the state's public utility commission approves the cost of constructing and operating the plant as being prudently incurred.

At present, there are only sixteen states plus the District of Columbia with either partially or completely deregulated electricity markets (California, Connecticut, Delaware, Illinois, Massachusetts, Maryland, Maine, Michigan, Montana, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, and Texas).[123] The LCOE analysis is therefore inapplicable to the other 34 states, which have regulated electricity markets. The Proposal fails to provide a comparable analysis for these states or explain how it would determine whether the costs of partial CCS are reasonable in them.

Second, the Proposal excludes the "potential benefits of reduced criteria and GHG emissions due to the use of partial CCS" from its LCOE analysis.[124] (**Comment C-8**) Among these potential benefits are reduced costs of compliance with a state or interstate CO_2 cap-and-trade program. Of the sixteen states with deregulated markets, eight are currently part of the Regional

[120] 83 Fed. Reg. at 65,440.

[121] *Renewed Momentum for Carbon Capture in the US*, PEABODY, https://www.peabodyenergy.com/Sustainability/Industry-Insights/Renewed-Momentum-for-Carbon-Capture-in-the-US (last visited Mar. 18, 2019).

[122] 83 Fed. Reg. at 65,438 ("[A] new coal-fired EGU must compete directly against all other forms of generation" only "[i]n deregulated markets.").

[123] AMERICAN PUBLIC POWER ASS'N, RETAIL ELECTRIC RATES IN DEREGULATED AND REGULATED STATES: 2017 UPDATE (2018), *available at* https://www.publicpower.org/system/files/documents/Retail-Electric-Rates-in-Deregulated-States-2017-Update%20%28003%29.pdf.

[124] 83 Fed. Reg. at 65,438.

Greenhouse Gas Initiative (RGGI) (Connecticut, Delaware, Massachusetts, Maryland, Maine, New Hampshire, New York, and Rhode Island), one is in the process of rejoining RGGI (New Jersey), and one has its own statewide greenhouse gas cap-and-trade program (California). In each of these ten states, a newly-constructed coal-fired power plant would receive economic benefits from using partial CCS in the form of reduced costs for purchasing allowances in the carbon market. The Proposal's LCOE analysis does not account for those benefits. Likewise, many states have created tax incentives for CCS.[125] These include three states with deregulated electricity markets: Illinois, Montana, and Texas.[126] Again, the Proposal's LCOE analysis does not account for those benefits.

Third, the Proposal does not account for revenues from the potential "sale of the captured CO_2."[127] Three states with deregulated electricity markets had active EOR operations as of 2014 (Michigan, Montana, and Texas).[128] In these states a newly-constructed coal-fired power plant would receive economic benefits from using partial CCS in the form of revenues from selling the captured CO_2 (as well as from reduced transportation and storage costs). As described above, the Proposal's analysis does not account for those benefits.[129]

Fourth, the Proposal also arbitrarily ignores that in some of these states, CCS is mandated for new coal-fired power plants. Of the deregulated states, California, Montana, and New York all require that new coal-fired power plants sequester more than the 15% of emissions covered by the 2015 Rule.[130] Because these states have regulatory requirements that exceed those in the 2015 Rule, retaining that Rule would impose no additional costs on sources in those states.

The result is that the Proposal's rejection of partial CCS relies on an LCOE that is applicable in at most two states—Ohio and Pennsylvania. EPA needs to conduct a state-by-state analysis of the impact of state carbon regulations, opportunities for revenue from the sale of CO_2 to EOR operations, and whether the state has a regulated or deregulated carbon market. That analysis is pivotal to any decision about whether to revise the 2015 Rule.

5. *The Same Flaw Infects the Capital Cost Analysis*

The same flaw invalidates the Proposal's conclusion that "the increase in capital costs due to partial CCS are not reasonable."[131] This conclusion is based, in part, on the assumption that the

[125] *See, e.g.*, Ill. Comp. Stat. 655/5.5; Ind. Code Ann. § 6-3.1-29-14; Kan. Stat. Ann. § 79-32,256; Miss. Code Ann. § 27-65-19; Mont. Code Ann. § 15-24-3111; N.M. Stat. Ann. § 7-2-18.25; N.D. Cent. Code Ann. § 57-60-02.1; Tex. Tax Code. Ann. §§ 171.602, 171.108 Wyo. Stat. Ann. § 39-15-105(a)(viii)(F).

[126] See sources cited in footnote 125.

[127] 83 Fed. Reg. at 65,438.

[128] CLEAN WATER ACTION, THE ENVIRONMENTAL RISKS AND OVERSIGHT OF ENHANCED OIL RECOVERY IN THE UNITED STATES 22 (2017), *available at* http://www.cleanwater.org/sites/default/files/docs/publications/The%20Environmental%20Risks%20and%20Oversight%20of%20Enhanced%20Oil%20Recovery%20in%20the%20United%20States.pdf.

[129] *See* Section III.B.2.

[130] *See* sources cited in footnote 82, *supra*.

[131] 83 Fed. Reg. at 65,441.

increased capital costs "cannot be passed on to end users as easily" as those in other industries because the higher operating costs associated with using CCS would, "*at least in deregulated markets*," result in a "loss of sales."[132]

Like the LCOE analysis, this analysis of capital costs does not apply to any of the 34 states that do not have deregulated electricity markets. In addition, as above, the relative competitiveness of new coal-fired power plants using partial CCS will be affected by their competitors' need to purchase carbon allowances in ten of those states and by the revenue opportunities available from carbon dioxide sales to EOR operations in at least three of those states. As a result, the Proposal's capital costs analysis applies in at most three states (Illinois, Ohio, and Pennsylvania) and therefore—like its LCOE analysis—is fundamentally flawed.

C. The Cost of CCS is Declining and is Expected to Continue to Decline As Technology Further Improves

Declining costs are typical as a technology advances.[133] EPA recognized as much in the 2015 rulemaking.[134] "First-of-a-kind" projects cost more than "next-of-a-kind" and then "Nth-of-a-kind" projects.[135] This is because the costs of a new pollution control technology typically follow a learning curve in which costs peak at the demonstration project stage and then decline significantly thereafter.[136]

Important lessons have been learned from the first set of large scale coal-fired CCS power plants retrofitted with CCS[137]—Petra Nova and Boundary Dam. Because these "first-of-a-kind" plants are already in operation, the next generation of plants should, experts in the field of technology innovation and diffusion have concluded "that CCS technology is advanced enough that costs of

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[132] *Id.*

[133] *See, e.g.*, Linda Argote & Dennis Epple, *Learning Curves in Manufacturing*, 247 SCIENCE 920, 920 (1990).

[134] 80 Fed. Reg. at 64,565 ("It is reasonable to expect costs to decline over time.").

[135] *See* Edward S. Rubin et al., *The Cost of CO_2 Capture and Storage*, 40 INT'L J. GREENHOUSE GAS CONTROL 378, 379 (2015). This is as true of the nuclear energy sector as it is of CCS. The Proposal cites recent difficulties at the Summer and Vogtle nuclear plants as justification for arguing the LCOE for nuclear energy is higher than previously assumed. 83 Fed. Reg. at 65,437. However, the Summer and Vogtle plants incur "first-of-a-kind" costs due to being the first American nuclear plants built in decades and using new, state-of-the-art technologies. Moreover, even if nuclear energy is not currently economical in the United States, such a development should be viewed as a positive one for coal-fired power plants. Neither nuclear nor coal is cost-competitive with natural gas at this time; fuel diversity is the primary reason that utilities might choose coal or nuclear. *Id.* at 65,436. Therefore, the relative decline in competitiveness of nuclear energy may increase the attractiveness of coal-fired plants using partial CCS, making developers willing to accept greater costs, all else being equal, to such plants. (**Comment C-7**)

[136] *See* Edward S. Rubin et al., *The Outlook for Improved Carbon Capture Technology*, 38 PROGRESS IN ENERGY & COMBUSTION SCI. 630 (2012).

[137] THE SHAND CCS FEASIBILITY STUDY PUBLIC REPORT, *supra* note 73, at x ("Reductions in capital costs have been evaluated and are projected at 67% less expensive than they were for BD3 on a cost per tonne of CO_2 basis.").

implementation in power plant contexts are declining with each successive deployment."[138] For example, the Global CCS Institute has stated:

> Cost comparisons make no account for CCS on power generation still being at its earliest, highest cost stage. Because these facilities are large and complex, first attempts involved considerable contingencies and hence dramatic cost reductions are expected for second and subsequent attempts. Like all technologies, ongoing research and deployment will deliver further cost reductions from next generation capture technologies.[139]

In November 2018, the International CCS Knowledge Centre issued the "The Shand CCS Feasibility Study" which discusses SaskPower's Boundary Dam facility and a proposed follow-up CCS project at the Shand power plant and concludes that capital costs are projected to be 67% less for the Shand unit than were incurred just four/five years ago by Boundary Dam.[140] The Shand Study observes:

> As with any world-first project, many lessons were learned through the design, construction and operations of the facility. These lessons have resulted in novel optimizations, operating methods and overall learnings for the facility and its role as a power generator in the power utility. While ongoing improvements are anticipated, second-generation CCS will undoubtedly realize many improvements over the first generation.[141]

The Shand Feasibility Study provides a concrete example of this expected trend. It projects that a retrofitted 300 MW coal-fired EGU will enjoy a 67% reduction in capital cost per ton of captured carbon dioxide, up to 97% higher capture rates, and lower operating costs than the Boundary Dam project.[142] The Feasibility Study credits these cost reductions to experience

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[138] Brief of *Amici Curiae* Technological Innovation Experts Nicholas Ashford, M. Granger Morgan, Edward Rubin, and Margaret Taylor in Support of Respondents at 18, *State of North Dakota v. EPA*, No. 15-01381 (D.C. Cir.) (filed Dec. 21, 2016).

[139] LAWRENCE IRLAM, GLOBAL CCS INSTITUTE, GLOBAL COSTS OF CARBON CAPTURE AND STORAGE: 2017 UPDATE 2 (2017), *available at* https://hub.globalccsinstitute.com/sites/default/files/publications/201688/global-ccs-cost-updatev4.pdf.

[140] THE SHAND CCS FEASIBILITY STUDY PUBLIC REPORT, *supra* note 73, at iii, 77.

[141] *Id.* at ii.

[142] *Id.* at iii. The cost of capture is estimated at \$45/t CO_2 compared to current cost estimates of \$69-\$103/t CO_2. *The Cost of Carbon Capture: Is it Worth Incorporating into the Energy Mix?*, POWER TECH. (Oct. 4, 2018), https://www.power-technology.com/features/carbon-capture-cost/. Technology outside of the kind employed by Boundary Dam suggests alternative methods to reach cheaper carbon capture. *See* Jeffrey Heimgartner, *Carbon Capture Cost Savings on the Horizon*, ENGINEERING.COM (Jan. 15, 2019), https://www.engineering.com/DesignerEdge/DesignerEdgeArticles/ArticleID/18218/Carbon-Capture-Cost-Savings-on-the-Horizon.aspx ("[T]echno-economic analyses yielded 1,153 mixed matrix membranes with a carbon capture cost of less than \$50 per ton removed. Thus, the potential exists for creating an economically affordable and efficient means of CO_2 capture at coal power plants throughout the world[.]").

derived from retrofitting Boundary Dam's Unit 3, as well as larger scale and more effective CCS integration.[143]

Capture technologies developed by NET Power and FuelCell Energy in the United States also provide examples of opportunities for reducing costs. In 2018, NET Power began operating an EGU that uses its own high-purity carbon dioxide rather than steam, reducing CO_2 capture costs to "effectively zero."[144] FuelCell Energy uses flue gas from a conventional power plant to generate electricity. By creating a purified CO_2 stream, this method achieves lower carbon capture costs than using low-carbon flue gas.[145] Additionally, studies have shown that injecting captured carbon in basalt formations may significantly increase the efficacy of sequestration and reduce long-term costs, as the injected carbon dioxide mineralizes in a matter of years as opposed to centuries.[146]

For all of these reasons, the actual cost of implementing partial CCS on coal-fired power plants would likely be lower in the coming years than projected in the 2015 Rule and in the Proposal. As the Proposal acknowledges, coal is generally not cost-competitive now because of the persistently low price of natural gas, not because of the costs imposed by EPA regulations. Leaving the 2015 Rule in place (and expanding it to require a greater percentage of CO_2 to be captured at coal plants and to cover natural gas plants) would help push CCS technology farther along the learning curve and reduce costs. Repealing it will do nothing to help the coal industry.[147]

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[143] THE SHAND CCS FEASIBILITY STUDY PUBLIC REPORT, *supra* note 73, at iii, 77.

[144] Specifically, NET Power uses the Allam cycle instead of the traditional steam cycle to generate electricity. The Allam cycle uses mostly pure, high-pressure carbon dioxide (achieved via oxy-combustion) to turn a turbine and generate electricity. This high-purity carbon dioxide stream can then be easily sequestered. NET Power has built a 50-MW demonstration plant in Texas and expects to generate electricity with minimal emissions during 2018. *Technology*, NETPOWER, https://perma.cc/Q3TF-NVJQ; *see also* Rathi, *supra* note 30 ("[NET Power's] new facility is the first fossil-fuel power plant that promises to capture all its emissions effectively at zero extra cost.").

[145] Note that this fuel cell differs from others in that it uses flue gas from conventional power plants instead of ambient air, hence its advantages for capturing and sequestering carbon dioxide. *See Carbon Capture*, FUELCELL ENERGY, https://perma.cc/5EYE-M7Z3.

[146] Juerg M. Matter et al., *Rapid Carbon Mineralization for Permanent Disposal of Anthropogenic Carbon Dioxide Emissions*, 352 SCIENCE 1312, 1312 (2016); B. Peter McGrail et al., *Field Validation of Supercritical CO_2 Reactivity With Basalts*, 4 ENVTL. SCI. & TECH. LETTERS 6, 6-10 (2016).

[147] Lower prices for natural gas and renewable energy will continue to force coal retirement regardless of the 2015 rule, perhaps even faster than expected. *See* U.S. ENERGY INFORMATION ADMIN., SHORT-TERM ENERGY OUTLOOK (STEO), at 9 (Mar. 2019) ("EIA now expects coal-fired generation this year to fall by 12%, compared with a forecast 2019 decline of 8% in last month's STEO. These changes in the forecast are driven primarily by new natural-gas fired generating capacity coming online sooner than expected."); Umair Irfan, *The EPA is Lifting Greenhouse Gas Limits on Coal Power Plants: The Latest Proposal Won't Stop the Steady Decline of the Coal Industry*, VOX (Dec. 7, 2018), https://www.vox.com/energy-and-environment/2018/12/6/18127399/trump-coal-epa-carbon-capture ("[I]t's not regulations that are hurting the US coal industry; it's competition. Natural gas and renewables are increasingly cheaper than coal. With energy demand projected to stay level, that means it's coal that's going to yield.").

D. The BACT Analyses Cited by the Proposal do not Provide Appropriate Comparisons

After the LCOE and capital costs analyses, the Proposal suggests a third measure of so-called reasonable costs: the technologies identified as "reasonable cost control technolog[ies]" in "a dozen GHG permits for EGUs and other industrial facilities that were permitted between 2011 and 2017."[148] The analyzed permits involve determinations of the Best Available Control Technology (BACT) under the Prevention of Significant Deterioration program of the CAA.

A review of the underlying documentation (https://www.regulations.gov/document?D=EPA-HQ-OAR-2013-0495-11951) demonstrates that these facilities do not provide an appropriate comparison for a new coal-fired power plant as of 2019. First, of the thirteen facilities for which permitting documentation is included in the docket, only five are coal-fired power plants. The others include natural gas plants, a biomass and natural gas boiler, and a hybrid solar-natural gas plant. Second, all five of the coal-fired power plant permits date to 2011 or 2012. As a result, they do not take into account the use of CCS at Boundary Dam or Petra Nova or any of the technological advancements that have occurred in the intervening seven or eight years. Therefore, the permits identified in the Proposal do not provide an appropriate comparison for the economic feasibility of partial CCS in 2019 and do not demonstrate that partial CCS is not economically feasible.

IV. THE PROPOSAL APPLIES AN ERRONEOUS LEGAL STANDARD, VIOLATES THE SUPREME COURT'S REQUIREMENTS FOR EXPLAINING A REVERSAL OF A PRIOR RULE, AND IMPROPERLY ATTEMPTS TO BOLSTER ONE SUBSET AN INDUSTRY IN VIOLATION OF THE CAA

A. The Proposal is Plainly Inconsistent with the Requirements of Section 111

Section 111 of the CAA instructs the EPA to adopt:

> [a] standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.[149]

The D.C. Circuit has explained that a system is "adequately demonstrated" if it is "shown to be reasonably reliable, reasonably efficient, and [one] which can reasonably be expected to serve the interests of pollution control without becoming exorbitantly costly."[150] As described above, CCS is technically, geographically, and economically feasible and has been adequately demonstrated. Coal-fired power plants are suffering economically because of the low price of natural gas, not because the cost of partial CCS is exorbitant and not because the technology has

[148] 83 Fed. Reg. at 65,441.

[149] 42 U.S.C. § 7411(a)(1).

[150] *Essex Chem. Corp. v. Ruckelshaus*, 486 F.2d 427, 433 (D.C. Cir. 1973).

not been adequately demonstrated.[151] The Proposal is based on no facts or rationale that justify replacing the 2015 Rule.

The court has emphasized that the best system of emission reduction must "look[] toward what may fairly be projected for the regulated future, rather than the state of the art at present."[152] EPA has "authority to hold the industry to a standard of improved design and operational advances, so long as there is substantial evidence that such improvements are feasible and will produce the improved performance necessary to meet the standard."[153] The system does not need to "be in actual routine use somewhere;" instead, the "essential question" is "whether the technology would be available for installation in new plants."[154] Here, there is no doubt about the availability of CCS: its use has been demonstrated in a variety of places and contexts over many decades.

The 2015 Rule honored the legislative history of Section 111, although it could properly have gone farther and could properly have required more capture of CO_2 by coal-fired EGUs and, in addition, at least partial capture by NGCC units. The Proposal conflicts with the plain language of the Section 111 and the legislative history. The Senate Report for the 1970 Clean Air Act Amendments stated that "[s]tandards of performance [under section 111] should provide an incentive for industries to work toward constant improvement in techniques for preventing and controlling emissions from stationary sources."[155] The Senate Committee Report for the 1977 amendments to the CAA noted that in section 111, Congress intended "to assure the use of available technology and to stimulate the development of new technology."[156] Similarly, the House Report explained that section 111 "require[d] achievement of the maximum degree of emission reduction from new sources, while encouraging the development of innovative technological means of achieving equal or better degrees of control."[157] Even the Proposal acknowledges that "[t]he D.C. Circuit has made clear that Congress intended for CAA section 111 to create incentives for new technology."[158]

As explained above, *see* section II.D, the Proposal incorrectly assumes that a technology must be achievable at every potential new source to count as BSER. This approach ignores the technology-forcing nature of section 111. "The fact that a few isolated operations within an industry will not be able to comply with the standard does not undermine a showing that the standard is generally feasible."[159] "When a statute is technology-forcing, the agency can impose

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[151] *See* sources cited in footnote 6, *supra*.

[152] *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 391 (D.C. Cir. 1973).

[153] *Sierra Club v. Costle*, 657 F.2d 298, 364 (D.C. Cir. 1981).

[154] *Portland Cement Ass'n*, 486 F.2d at 391.

[155] S. Rep. No. 91–1196, at 16 (1970).

[156] S. Rep. No. 95–127, at 171 (1977).

[157] H.R. Rep. No. 95–294, at 189 (1977).

[158] 83 Fed. Reg. at 65,434 (citing *Sierra Club*, 657 F.2d at 346–47).

[159] *Kennecott Greens Creek Min. Co. v. Mine Safety & Health Admin.*, 476 F.3d 946, 957 (D.C. Cir. 2007) (citation and internal quotation marks omitted).

a standard which only the most technologically advanced plants in an industry have been able to achieve—even if only in some of their operations some of the time."[160]

B. The Proposal Does not Adequately Justify its Reversal of EPA's Conclusions in the 2015 Rule

The Proposal repeatedly ignores facts underlying the 2015 Rule and/or fails to acknowledge that it is reversing the agency's position or a variety of legal, policy, and factual matters. This is contrary to Supreme Court precedent. As the Court has explained, an:

> agency must at least "display awareness that it is changing position" and "show that there are good reasons for the new policy." In explaining its changed position, an agency must also be cognizant that longstanding policies may have "engendered serious reliance interests that must be taken into account." "In such cases it is not that further justification is demanded by the mere fact of policy change; but that a reasoned explanation is needed for disregarding facts and circumstances that underlay or were engendered by the prior policy." It follows that an "[u]nexplained inconsistency" in agency policy is "a reason for holding an interpretation to be an arbitrary and capricious change from agency practice."[161]

The Proposal repeatedly fails this standard.

C. Protecting a Particular Subset of an Industrial Sector is not Permissible under Section 111 of the CAA

The Proposal represents an unlawful effort to preserve one subset of the electric generating industry at the expense of the plain requirements of Section 111 of the CAA and decades of investment by Congress in CCS. As the Proposal explains, it was prompted by Executive Order 13,783, which directed EPA to "immediately review existing regulations that potentially burden the development or use of domestically produced energy resources." The existence of such a burden is not a legally-permissible basis for taking action under section 111. Whether a rule "burden[s] the development or use of domestically produced energy resources" is not a relevant consideration under section 111 and cannot serve as the basis for a regulation under that provision. As the Supreme Court has explained, "an agency rule would be arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider."[162]

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[160] *Id.* (citation and internal quotation marks omitted); *see also API v. EPA*, 706 F.3d 474, 480 (D.C. Cir. 2013) ("Our prior decisions relating to technology-forcing standards are no bar to this conclusion. We recognize here, as we have recognized in the past, that an agency may base a standard or mandate on future technology when there exists a rational connection between the regulatory target and the presumed innovation.") (citing *Sierra Club v. Costle*, 657 F. 2d at 364).

[161] *Encino Motorcars, LLC v. Navarro*, 136 S. Ct. 2117, 2126 (2016) (citations omitted).

[162] *Motor Vehicle Mfrs. Ass'n of U.S., Inc. v. State Farm Mut. Auto. Ins. Co.*, 463 U.S. 29, 43 (1983).

In summary, EPA has not demonstrated either a legitimate need or a rational basis for its Proposal. There has been no significant, new information since 2015 that warrants a substantial revision of the EPA's 2015 analysis or the 2015 Rule. New information that has emerged confirms the feasibility of CCS. The established feasibility and declining costs of CCS technologies demonstrate that the Rule could be expanded to require more CO_2 to be captured from new coal-fired units and to require CCS for new natural gas combined cycle units. We therefore urge EPA to withdraw the Proposal.

Thank you for your attention to these comments.

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