ORAL ARGUMENT SCHEDULED FOR JUNE 2, 2016
No. 15-1363 (and consolidated cases)

**IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT**

STATE OF WEST VIRGINIA, *ET AL.*,

Petitioners,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, *ET AL.*,

Respondents.

On Petitions for Review of Final Action by the
United States Environmental Protection Agency

BRIEF OF *AMICI CURIAE* GRID EXPERTS BENJAMIN F. HOBBS, BRENDAN KIRBY, KENNETH J. LUTZ, JAMES D. MCCALLEY, AND BRIAN PARSONS IN SUPPORT OF RESPONDENTS

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April 1, 2016

CERTIFICATE AS TO PARTIES, RULINGS, AND RELATED CASES

A. Parties and *Amici*

All parties, intervenors, and *amici* appearing before this Court are listed or referenced in the Initial Brief of Respondent U.S. Environmental Protection Agency ("EPA") filed March 28, 2016, with the exception of *Amici Curiae* Grid Experts and the following movant *amici curiae* in support of respondents: Former State Environmental and Energy Officials Matt Baker, Janet Gail Besser, Ron Binz, Michael H. Dworkin, Jeanne Fox, Dian Grueneich, Roger Hamilton, Paul Hibbard, Karl Rábago, Barbara Roberts, Cheryl Roberto, Jim Roth, Kelly Speakes-Backman, Larry Soward, Sue Tierney, Jon Wellinghoff, and Kathy Watson; and Union of Concerned Scientists.

B. Rulings Under Review

References to the rulings at issue appear in Respondent EPA's Initial Brief filed March 28, 2016.

C. Related Cases

References to related cases appear in Respondent EPA's Initial Brief filed March 28, 2016.

RULE 29 STATEMENTS

The following parties have indicated their consent to the filing of this brief: Advanced Energy Economy; American Lung Association; American Wind Energy Association; Buckeye Institute for Public Policy Solutions; Calpine Corporation; Center for Biological Diversity; City of Austin d/b/a Austin Energy; City of Los Angeles, by and through its Department of Water and Power; City of Seattle, by and through its City Light Department; Clean Air Council; Clean Wisconsin; Competitive Enterprise Institute; Conservation Law Foundation; Klaus J. Cristoph; Samuel R. Damewood; Catherine C. Dellin; Denbury Onshore, LLC; Environmental Defense Fund; Independence Institute; Joseph W. Luquire; Lisa R. Markham; State of Missouri; National Grid Generation, LLC; Natural Resources Defense Council; New York Power Authority; Ohio Environmental Council; Pacific Gas and Electric Company; Patrick T. Peterson; Rio Grande Foundation; Kristi Rosenquist; Sacramento Municipal Utility District; Sierra Club; Solar Energy Industries Association; Southern California Edison Company; Sutherland Institute; and U.S. Environmental Protection Agency. All remaining parties do not oppose or take no position on the filing of this brief.

Pursuant to Fed. R. App. P. 29(c)(5), *Amici* state that no party or party's counsel authored this brief in whole or in part, and that no other person besides

Amici or their counsel contributed money that was intended to fund preparing or submitting the brief.

Pursuant to D.C. Cir. R. 29(d), *Amici* state that a separate brief is necessary due to their distinct expertise and interests. *Amici* are engineers with expertise in the operation, structure, economics, and reliability of the U.S. power system. They have a unique capacity to aid the Court in understanding the physical features of electricity and the electric grid, and the relevance of those features to the rule at issue in this case. No other *amici* of which we are aware share this perspective or address these specific issues. Accordingly, *Amici*, through counsel, certify that filing a joint brief would not be practicable.

/s/ Megan M. Herzog
MEGAN M. HERZOG

April 1, 2016

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GLOSSARY OF ABBREVIATIONS

The Rule	The final rule published in the Federal Register at 80 Fed. Reg. 64,662 (Oct. 23, 2015), JA___ and titled "Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units"
Best System	The "best system of emission reduction" pursuant to 42 U.S.C. § 7411(a)(1)
CO_2	Carbon Dioxide
EIA	U.S. Energy Information Agency
EPA	U.S. Environmental Protection Agency
ISO	Independent System Operator
JA	Joint Appendix
RIA	Regulatory Impact Analysis
RGGI	Regional Greenhouse Gas Initiative
RTO	Regional Transmission Organization
TSD	Technical Support Document

STATUTES AND REGULATIONS

Pertinent statutes and regulations are contained in Respondent EPA's Brief.

SUMMARY OF ARGUMENT AND *AMICI CURIAE*'S STATEMENT OF IDENTITY, INTEREST IN CASE, AND SOURCE OF AUTHORITY TO FILE

The Clean Power Plan, 80 Fed. Reg. 64,662 (Oct. 23, 2015), JA ___ ("the Rule"), respects and harnesses what *Amici* and other grid experts recognize as the defining feature of the U.S. electric grids: their operation as synchronous machines.

Engineers have declared the U.S. power system the largest, "most complex machine ever made." PHILLIP F. SCHEWE, THE GRID: A JOURNEY THROUGH THE HEART OF OUR ELECTRIFIED WORLD 1 (2007); *see also* MASS. INST. OF TECH., THE FUTURE OF THE ELECTRIC GRID 1 (2011).[1] Every electric generator in the continental United States is embedded within one of three regional grids and is linked to other generators and consumers through transmission and distribution lines. Each grid operates as a single machine. The fundamental purpose of each machine's interconnectedness is to allow grid operators to continuously balance

[1] *Available at* http://mitei.mit.edu/publications/reports-studies/future-electric-grid.

electricity supply and demand in real time, over vast regions, thus ensuring all consumers access to affordable and reliable power. This feat is accomplished through orchestrated second-by-second shifts among different generators, which the grids' physical structure is designed to facilitate. The usage of any individual generator is thus dependent on—and to a large extent, dictated by—the performance of other components of the machine.

The Rule harnesses the unique "interconnectedness" that "is a fundamental aspect of the nation's electricity system" (80 Fed. Reg. at 64,780) to drive significant, cost-effective reductions of carbon dioxide ("CO_2") emissions. The Rule's design is eminently sensible: it reflects the regional nature of the power system, facilitates familiar compliance approaches such as emissions trading, and gradually accelerates industry trends already underway, as aging coal-fired units are replaced with cheaper, cleaner natural gas and renewable energy generation.

Amici are engineers with a significant interest in the efficient functioning and regulation of the grid. They have expertise in grid structure, operations, economics, and modernization; integration of renewable energy generation; and power-system reliability and planning.[2] *Amici* believe that the Rule is consistent

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[2] *Amici*'s credentials are summarized in their Motion for Leave to Participate as *Amici Curiae* (Mar. 29, 2016).

with the grids' twin aims: power reliability and affordability for all consumers. Petitioners' claims that the Rule will result in grid "restructuring," "reliability problems," and other dire consequences are unfounded, and stem from fundamental misunderstandings, or misrepresentations, of how the grids respond to pollution controls. *See, e.g.*, Opening Br. of Pet'rs on Core Legal Issues 6 (Feb. 19, 2016) ("Pet. Legal Br."); Opening Br. of Pet'rs on Procedural and Record-Based Issues 43 (Feb. 19, 2016) ("Pet. Procedural Br."). To aid the Court's understanding of the technical matters at issue in this case, and to underscore the sensibleness of the U.S. Environmental Protection Agency's ("EPA") approach, this brief clarifies how and why the grids are designed and operated as they are; the implications of the grids' unique structure for pollution controls; and how the Rule relates to grid operations.

Amici emphasize two key points.

***First*, shifting generation among various sources is characteristic of routine grid operations, and is a long-used method to reduce harmful emissions.** All grid operators use the basic principles of "Constrained Least-Cost Dispatch"—utilizing the lowest-cost generators first, unless operational needs take precedence—to balance supply and demand. All power-sector environmental regulations affect the relative costs of different generators, just as changing fuel prices, generator efficiency, and other variables do; consequently, all power-sector environmental regulations result in relatively greater use of some generators than others. While the Rule may alter the relative costs of various generators, it *does not* change the framework that has long guided grid operations. The Rule will integrate seamlessly into existing Constrained Least-Cost Dispatch processes with no adverse reliability impacts.

***Second*, shifting from higher-emitting to lower-emitting generation is a well-demonstrated, cost-effective method to reduce CO_2 emissions.** EPA recognized this in determining that the "best system of emission reduction" ("Best System") for power-sector CO_2 includes reducing coal generation and increasing natural gas and renewable energy generation. *See* 42 U.S.C. § 7411(a)(1). Because all generators deliver undifferentiated power to a regional grid that operates as a single machine, it would make no sense for the Rule to consider only CO_2 emissions reductions that could be achieved through technologies installed within the ephemeral boundaries of individual facilities.

ARGUMENT

I. Effective Power-Sector Pollution Controls Acknowledge the Distinctive Characteristics of Electricity and the Interconnectedness of the Regional Grids.

The fungible nature of electricity and the need to instantaneously and continuously balance supply and demand in real time have driven the design of the world's most "complex machine"—the U.S. power system. SCHEWE at 1. Every generator in the continental United States is embedded within one of three regional, interconnected electric grids. To ensure that consumers receive reliable, affordable power that meets environmental standards, each grid is designed and operated specifically to facilitate, within its respective region, shifts among different generators. Shifting among generators is both unique to the power sector and an essential, routine feature of grid operations. Regulators have long harnessed these shifts as an efficient tool to reduce power-sector air pollution.

A. Electricity Is a Uniquely Fungible and "Real-Time" Good.

Electricity has two fundamental distinguishing features. First, electricity is fungible. In most of the United States, "any electricity that enters the grid immediately becomes a part of a vast pool of energy that is constantly moving in interstate commerce." *New York v. Fed. Energy Regulatory Comm'n*, 535 U.S. 1, 7 (2002). Energy must be pooled because it cannot be directed (like an e-mail or letter) to a particular recipient.

Second-by-second variation in demand is balanced by all generators in the grid, independent of the location of the generators, by responding to the frequency variation that those imbalances cause. The frequency is analogous to the water level in a swimming pool fed by many supply spigots located around the pool's edges; when the water level (frequency) increases, the water supply (generation) decreases, and vice versa. All spigots have the same effect on maintaining a constant water level, independent of their location around the pool (grid). In other words, "[i]f [someone] in Atlanta on the Georgia system turns on a light, every generator on Florida's system almost instantly is caused to produce some quantity of additional electric energy which serves to maintain the balance in the interconnected system . . . ." *Fed. Power Comm'n v. Florida Power & Light Co.*, 404 U.S. 453, 460 (1972) (citation omitted).

Electricity that is added to the grid energizes the entire grid. Generators do not "generate" electrons and consumers do not "consume" electrons, as is commonly believed—electric power is injected into and withdrawn from the grid. An electromagnetic wave, propagated by generators, moves at the speed of light along wires. Electrons in an alternating current network merely move back and forth at a frequency of 60 cycles per second. Because all electricity within a grid is pooled, the electric power added by any single generator becomes part of an undifferentiated stream. As with water added to a pool, consumers cannot distinguish coal-generated power from wind-turbine-generated power once it is injected into the grid.

The second elemental feature of electricity is that it cannot easily or economically be stored on a large scale with current technology. The inability to store large amounts of electricity means generation (supply) and load (demand) must continuously and precisely be balanced. This makes electricity the ultimate "real-time" product. *See* Paul L. Joskow, *Creating a Smarter U.S. Electricity Grid*, 26 J. ECON. PERSP. 29, 33 (2012).

B. Each of the Three Regional Grids Operates As a Single Machine.

The infrastructure necessary to balance supply and demand distinguishes the power system from any other industry or supply chain. Its defining feature is interconnection. Each of the three regional grids, or "interconnections"—Eastern, Western, and Texas—operates as a single, synchronized machine.[3]

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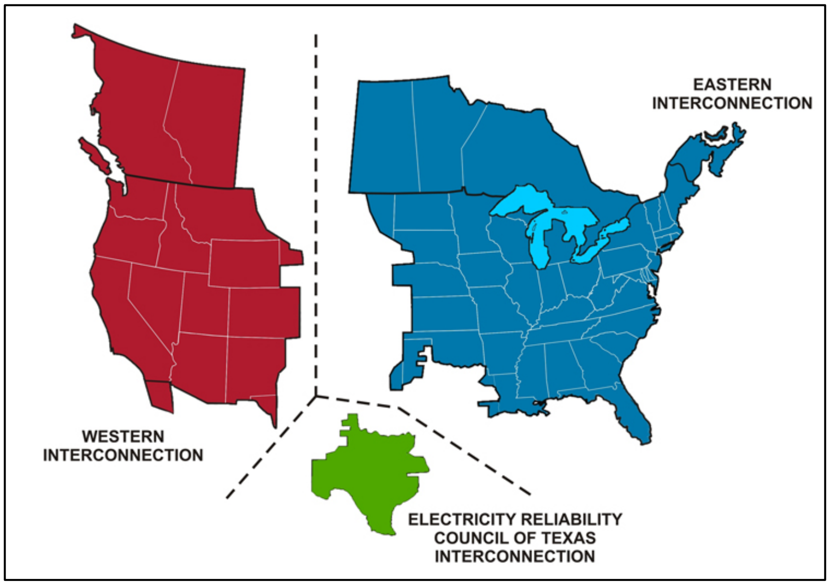
[3] Hawaii and Alaska have their own grids. They are not subject to the Rule. 80 Fed. Reg. at 64,708.

Figure 1. U.S. Power-System Interconnections[4]



Each of the grids consists of three components essential to delivering reliable and cost-effective power to consumers: generation, transmission, and distribution. *First*, a diverse set of generators converts primary energy (such as coal, sunlight, or wind) into electricity. *Second*, within each grid, a giant network of high-voltage transmission lines allows power to flow where it is needed, sometimes over hundreds or even thousands of miles. The transmission network is crucial because many generators are located far from population centers. The transmission network also facilitates system reliability: if one line goes down,

[4] U.S. DEP'T OF ENERGY, NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION INTERCONNECTIONS, *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/NERC_Interconnection_1A.pdf.

electricity can flow through alternate routes; when a generator fails, other generators can pick up the load smoothly without a power interruption. *Third*, local substations receive electricity from high-voltage transmission lines and lower the voltage for delivery to consumers via local distribution networks.

Grid interconnectedness is a product of history. The first power plants constructed in the late 1800s initially served only a small set of local customers. Backup generators maintained reliability. Local systems gradually consolidated to reduce costs and improve reliability. Consolidation required the development of transmission lines. Networks continued to grow, ultimately giving rise to the three interconnections. 80 Fed. Reg. at 64,690–92.

Today, each of the three interconnections is highly coordinated to maintain reliability. The balancing of generation and load must be virtually instantaneous across each interconnection, such that the amount of power dispatched to the grid is identical to the amount withdrawn for end uses in real time. Like orchestra conductors signaling entrances and cut-offs, grid operators use automated systems to signal particular generators to dispatch more or less power to the grid as needed over the course of the day, thus ensuring that power pooled on the grid rises and falls to meet changing demand.

As components of an integrated machine, interdependent generators must coordinate with one another, and with grid authorities, regarding their routine operations. Because the performance and usage of their units depends on the operation of other units outside their individual control, power companies regularly coordinate to plan new investments, plan unit retirements, and balance their respective systems—for example, through joint dispatch arrangements (which pool the generation sources of multiple utilities to reduce operating costs and increase reliability), joint power-plant ownership agreements, bilateral power purchase agreements, and short-term balancing transactions. As the Supreme Court has recognized, "generating facilities cannot be maintained on the basis of a constant demand." *Gainesville Util. Dep't v. Florida Power Corp.*, 402 U.S. 515, 518 (1971). Coordinated planning is critical to ensure there is always adequate generation to meet expected regional demand, plus additional capacity in case generators fail during times of peak demand. *Id.*

C. Dispatch Governance Frameworks Are Designed to Facilitate Shifts Among Generators and Ensure Affordable, Reliable Electricity.

Regional energy governance frameworks keep the "complex machine" operating reliably. Although governance differs within and across the three interconnections, the standard approach all grid operators use to dispatch generation is Security Constrained Unit Commitment and Economic Dispatch, or

"Constrained Least-Cost Dispatch." As its name implies, Constrained Least-Cost Dispatch deploys generators with the lowest variable costs first, as system operational limits allow, until all demand is satisfied. Constraints that grid operators routinely consider include transmission limits, generators' physical constraints, and environmental standards.

In competitive wholesale markets (which govern about two-thirds of the power sector), federally regulated entities called Independent System Operators ("ISOs") or Regional Transmission Organizations ("RTOs") utilize a series of auctions to match generation and load. Generators bid into a regional market with a price at which they are willing to sell electricity during specified periods, and the ISO/RTO ranks bids according to Constrained Least-Cost Dispatch principles. In traditional cost-of-service states outside of ISOs/RTOs, utilities use generators' marginal costs, rather than bid prices, to determine dispatch order. While the ISOs/RTOs' use of Constrained Least-Cost Dispatch principles is more transparent, Constrained Least-Cost Dispatch principles guide all dispatch planning across the country. Dispatch occurs on multiple scales—yearly, seasonally, monthly, weekly, daily, hourly, and five-minute intervals—as grid operators respond to variable supply, demand, and operational constraints by managing shifts among different generators. In both organized markets and traditional cost-of-service regimes, renewable energy generators typically receive dispatch priority because they have lower variable costs than fossil-fuel-fired generators, which must purchase fuel. 80 Fed. Reg. at 64,693.

Power companies recognize that their units are subject to Constrained Least-Cost Dispatch and have long planned their operations accordingly. They routinely execute contracts to purchase power from third-party generators; invest in demand-side energy efficiency programs; and, as existing units retire, invest in more efficient and cost-competitive generation facilities, such as natural gas and renewable sources, in order to compete for dispatch priority.

D. Power Companies and Grid Operators Have Historically Responded to Air Pollution Controls By Shifting to Lower-Emitting Generators.

All power-sector environmental regulations impact dispatch, either by increasing or decreasing the relative operating costs of affected sources or by constraining their operations. Because grid operators in both organized markets and traditional cost-of-service regimes employ Constrained Least-Cost Dispatch principles, a unit that experiences a cost increase or operational constraint will tend to operate less frequently, while units whose costs decrease will be dispatched more. Fossil-fuel-fired power plants are already subject to many pollution regulations, all of which have affected their dispatch competitiveness.

Congress, EPA, and state regulators have long recognized that a system-wide approach to reducing pollution works most efficiently within grid operations, and have harnessed shifts among generators as an economical tool to reduce harmful air emissions. *See* Resp't EPA's Initial Br. 32–34. One example is the Clean Air Act's Acid Rain Program, which set a nationwide cap on sulfur dioxide emissions from fossil-fuel-fired generators and required affected generators to hold a tradable allowance for each ton of sulfur dioxide emitted. 42 U.S.C. §§ 7651–7651o. The allowance requirement increased the costs of regulated units, which decreased the dispatch competitiveness of those units and led some to curtail their generation. That, in turn, led grid operators to dispatch cheaper, less-polluting generators to meet consumer demand. Industry quickly recognized that incorporating allowance costs into dispatch planning was cost-effective and did not disrupt power reliability or normal grid operations. *See, e.g.*, Thomas M. Jackson et al., *Evaluating Soft Strategies for Clean-Air Compliance*, 6 IEEE COMPUTER APPLICATIONS IN POWER 46 (1993).

The effect of pollution controls in wholesale power markets and in traditional cost-of-service regimes is similar. In traditional cost-of-service states, utility system operators and state regulators account for the additional costs of pollution control in dispatching generators, planning for and approving new investments, and setting electricity rates. In organized markets, the variable cost of pollution controls is reflected in generators' offers in ISO/RTO auctions.

The Regional Greenhouse Gas Initiative ("RGGI") provides an example of how carbon pollution controls blend seamlessly into organized markets' operations. RGGI is a cap-and-trade program for power-sector CO_2 pollution in nine northeast and mid-Atlantic states. The participating states span three ISOs/RTOs, all of which have been able to integrate carbon allowances into their dispatch methods with ease. Affected sources simply incorporate the cost of carbon allowances into their auction bids. This generally prompts grid operators to deploy lower-cost sources, such as renewable sources, first. In over six years, RGGI has not reduced reliability. PAUL HIBBARD ET AL., THE ECONOMIC IMPACTS OF THE REGIONAL GREENHOUSE GAS INITIATIVE ON NINE NORTHEAST AND MID-ATLANTIC STATES 13 (2015).[5]

[5] *Available at* http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/analysis_group_rggi_report_july_2015.pdf.

II. The Rule Respects and Utilizes the Physical Features of the Interconnected Electric Grids, Ensuring Efficient Compliance and Continued Reliability.

Like past successful pollution control programs, the Rule respects and harnesses the routine shifting of generation among sources to cost-effectively reduce CO_2 emissions from the machine as a whole. The Rule does not fundamentally change how each grid operates. Instead, like other pollution controls, compliance with the Rule will be one of multiple inputs to the Constrained Least-Cost Dispatch process, thereby allowing operators to employ normal tools and practices to ensure the lights do not go out. The gradual shifts that the Rule promotes are modest compared to broader changes already underway, as the power sector trends away from coal and toward cheaper, more efficient lower-carbon sources.

A. The Rule Will Not Destabilize the Grids.

Petitioners' claim that the Rule poses "reliability problems" is unfounded. Pet. Procedural Br. 43. EPA projects that the Rule will have four main effects on the power sector: gradually increasing utilization of the most efficient existing natural gas units; adding new renewable energy generation; gradually decreasing generation from higher-carbon sources; and modestly decreasing overall generation due to deployment of consumer-side energy efficiency measures. EPA, Regulatory Impact Analysis for the Clean Power Plan Final Rule ("RIA") 3-14, tbl.3-2, 3-27, tbl.3-11, EPA-HQ-OAR-2013-0602-37105 (Aug. 2015), JA ___, ___. Historical grid performance and technical assessments demonstrate that these gradual shifts fit easily within the capabilities and structure of the grids. *Accord* M. AHLSTROM, ET AL., RELEVANT STUDIES FOR NERC'S ANALYSIS OF EPA'S CLEAN POWER PLAN 111(D) COMPLIANCE iv (2015)[6] (reviewing an "extensive[]" suite of studies showing that "reliable and cost-effective compliance [with the Rule] is possible"). The power sector is able to support a very diverse and evolving portfolio of generation while maintaining reliability and affordability.

In terms of shifting generation from coal to natural gas, the Rule reasonably concludes that the utilization rate of existing natural gas combined-cycle units could increase to 75% net summer capacity, on average, within each interconnection. 80 Fed. Reg. at 64,728. Petitioners challenge this, claiming that EPA failed to consider "site- or region-specific factors." Pet. Procedural Br. 28–29. Some natural gas combined-cycle units do have a lower performance rate, but that is primarily because alternative generators are less expensive to run—not due to technical limitations. Other units regularly achieve performance rates that

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[6] *Available at* http://www.nrel.gov/docs/fy15osti/63979.pdf.

surpass 75% utilization. *See* 80 Fed. Reg. at 64,799 (stating that 15% of natural gas combined-cycle units operated at an annual utilization rate of 75% or more in 2012). In each region as a whole, on average, existing natural gas combined-cycle units are capable of operating at 75% capacity.[7] This performance rate provides ample margin for maintenance and is typical for base-load facilities.

There is also good evidence of the grids' ability to incorporate high levels of renewable energy generation. Under the Rule, renewable energy is projected to account for 20% of U.S. electricity generation by 2030—with the majority of this growth expected under business-as-usual trends, regardless of the Rule.[8] RIA at 3-27, tbl.3-11, JA ___. The grids can integrate renewable energy above this level without adverse reliability impacts. For example, in March 2016, wind met 48% of the Texas Interconnection's demand and 45% of the Southwest Power Pool's

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[7] Moreover, EPA's assumptions are based on consideration of the interconnection with the lowest potential to increase its utilization rate: the Eastern Interconnection. Therefore, there are even greater compliance opportunities in other interconnections. 80 Fed. Reg. at 64,730.

[8] Petitioners argue that the renewable energy growth assumptions EPA made in designing the Rule are "unrealistic." Pet. Procedural Br. 33. If anything, EPA's assumptions are conservative. In 2016 alone, the U.S. Energy Information Agency ("EIA") projects that renewable energy generation will increase 9%, to account for 14% of total U.S. generation. *See* EIA, *Electricity Generation from Renewable Sources Expected to Grow 9% This Year*, TODAY IN ENERGY (Feb. 2, 2016), *available at* http://www.eia.gov/todayinenergy/detail.cfm?id=24792.

demand. ELECTRIC RELIABILITY COUNCIL OF TEXAS, WIND INTEGRATION REPORT (Mar. 23, 2016);[9] Southwest Power Pool (@SPPorg), TWITTER (Mar. 21, 2016, 10:49 AM).[10] Wind met 25% of demand in the Midcontinent ISO on November 23, 2012. Michael Goggin, *The Records Keep Falling: More New Highs in Wind Energy Output*, INTO THE WIND (Feb. 23, 2016).[11] And the main grid operator in Colorado regularly meets demand with large percentages of wind, including 20 hours during which wind met over 60% of demand. Michael Goggin, *Output Records and NERC Report Show Increasing Reliability Contributions of Wind*, INTO THE WIND (Dec. 22, 2015).[12]

In fact, renewable sources can help *improve* reliability. For instance, wind generation was key in maintaining service in the northeast and mid-Atlantic during the 2014 Polar Vortex, when demand spiked to one of the highest winter peaks in regional history. ANALYSIS GROUP, ELECTRIC SYSTEM RELIABILITY AND EPA'S

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[9] *Available at* http://www.ercot.com/content/wcm/key_documents_lists/91400/ERCOT_Wind_Integration_Report_03_23_16.PDF.

[10] https://twitter.com/SPPorg/status/711973133255729153.

[11] http://www.aweablog.org/wp-content/uploads/2016/02/Regional-Wind-Records-2.22.2016.jpg.

[12] http://www.aweablog.org/output-records-and-nerc-report-show-increasing-reliability-contributions-of-wind/.

CLEAN POWER PLAN: THE CASE OF PJM 3, 12 (2015).[13] It is true that the availability of renewable energy is more variable than other types of generation, leading system operators to maintain generation reserves that provide back-up when renewable energy is unavailable. The U.S. power sector has successfully managed large amounts of renewable power in this manner, and technical studies have concluded the sector is capable of integrating even more without significant reliability impacts. *See, e.g.*, GE ENERGY, PJM RENEWABLE INTEGRATION STUDY (2014)[14] (finding that the RTO PJM could operate with up to 30% of generation from wind and solar with no significant reliability); ENERNEX CORP., EASTERN WIND INTEGRATION AND TRANSMISSION STUDY 27 (2011)[15] (finding that wind generation could feasibly supply 20% to 30% of electricity on the Eastern Interconnection); GE ENERGY, WESTERN WIND AND SOLAR INTEGRATION STUDY

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[13] *Available at* http://www.analysisgroup.com/uploadedfiles/content/insights/publishing/electric_system_reliability_and_epas_clean_power_plan_case_of_pjm.pdf.

[14] *Available at* http://www.pjm.com/committees-and-groups/subcommittees/irs/pris.aspx.

[15] *Available at* http://www.nrel.gov/docs/fy11osti/47078.pdf.

(2010)[16] (finding that the Western Interconnection could maintain reliability with 35% wind and solar generation).

Petitioners' protestations about the burden of transmission investments are also overstated. *See* Pet. Procedural Br. 38–41. Even considering the investments necessary to reach a high penetration of renewables, transmission costs will continue to be a modest percentage of the overall capital and operating costs of the grids. *See* Alexander E. MacDonald et al., *Future Cost-Competitive Electricity Systems and Their Impact on US CO_2 Emissions*, NATURE CLIMATE CHANGE 1 (2016)[17] (finding that the investments necessary to reduce power-sector CO_2 emissions up to 78% would have minimal impact on electricity costs). Furthermore, utilities are already planning significant infrastructure investments. *See, e.g.*, EPA, Greenhouse Gas Mitigation Measures Technical Support Document ("Mitigation TSD") 4-24, EPA-HQ-OAR-2013-0602-37114 (Aug. 3, 2015), JA ___ (stating that members of the Edison Electric Institute, which represents all investor-owned utilities, are planning to invest approximately $20 billion annually in transmission upgrades over the next five years).

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[16] *Available at* http://www.nrel.gov/docs/fy10osti/47434.pdf.

[17] http://www.nature.com/nclimate/journal/vaop/ncurrent/pdf/nclimate2921.pdf.

Importantly, the existing tools and procedures that industry and regulators use to ensure grid stability will continue to function effectively under the Rule. For example, the North American Electric Reliability Corporation develops and enforces reliability standards. The Federal Energy Regulatory Commission and state public utilities commissions are also closely involved in overseeing reliability. Additionally, balancing authorities, such as ISOs/RTOs, maintain reliability on particular areas of the grid, and can help contain any outages. All of these entities continuously incorporate changing economics and operational conditions into their planning processes. The Rule changes nothing about how they function. In fact, the Rule's regional approach reflects the regional perspective of reliability coordinators.

For all of these reasons, the Rule does not "subordinate[]" reliability policies. *See* Pet. Legal Br. 21. To the contrary, the Rule includes redundant reliability protections. For instance, compliance does not begin until 2022, with emissions reductions then phased in gradually over the next eight years. *See* 80 Fed. Reg. at 64,665, 64,743, 64,875. As EPA correctly noted, "[t]hese periods of time are consistent with current industry practice in changing generation or adding new generation." *Id.* at 64,744. Additionally, in an emergency situation, a unit can temporarily operate under less-stringent emissions standards. *Id.* at 64,878–79.

Amici also note that while reliability concerns have been raised in past EPA rulemakings, we know of no instance where an environmental regulation caused a reliability event.

These and other design elements, such as the option to adopt emissions trading programs, provide states and utilities substantial latitude to plan optimal emissions reductions and adjust compliance strategies if necessary. Reliability entities that initially raised concerns about the proposed rule have since praised EPA for its responsiveness on this issue. *See, e.g.*, Press Release, North Am. Elec. Reliability Corp., Statement on Clean Power Plan Finalization (Aug. 3, 2015).[18]

B. The Rule is Consistent with Broader Power-Sector Investment Trends.

In promoting lower-carbon generation, the Rule builds on ongoing market trends. With or without the Rule, the U.S. power sector is in the midst of a transition. Many coal-fired generators are headed toward retirement. By 2025, coal-fired units will be the dinosaurs of the power sector, with an average age of 49 years, and with 20% of units over 60 years old—well beyond their typical expected operating life of 40 years. *See* 80 Fed. Reg. at 64,694, 64,872. As aging

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[18] *Available at* http://www.nerc.com/news/Pages/Statement-on-Clean-Power-Plan-Finalization.aspx.

infrastructure is replaced, utilities are upgrading to renewable energy and other modern technologies that allow them to meet demand more cost-effectively and with fewer emissions.[19] Natural gas and renewable sources accounted for approximately 90% of new generation capacity built between 2000 and 2013. *Id.* at 64,694.

Renewable energy is already cost-effective, and costs are rapidly falling. In terms of the total unsubsidized cost of producing power over the life of a unit ("levelized cost"), wind is currently the cheapest generation source, followed by utility-scale solar and natural gas combined-cycle technologies. *See* LAZARD'S LEVELIZED COST OF ENERGY ANALYSIS, VERSION 9.0 2 (2015).[20] This is projected to remain the case over the course of Rule compliance. The levelized cost of onshore wind capacity that comes on line in 2020 is projected to be $74 per megawatt-hour, compared to $75 per megawatt-hour for natural gas combined-cycle and $95 per megawatt hour for conventional coal. *See* EIA, LEVELIZED COST AND LEVELIZED AVOIDED COST OF NEW GENERATION RESOURCES IN THE ANNUAL

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[19] Natural gas and renewable energy sources generate electricity with approximately 40 to 100% fewer CO_2 emissions than coal. Between 2005 and 2013, power-sector CO_2 emissions fell approximately 15%, mostly due to increased natural gas and renewable energy generation. *See* 80 Fed. Reg. 64,689.

[20] *Available at* https://www.lazard.com/media/2390/lazards-levelized-cost-of-energy-analysis-90.pdf.

ENERGY OUTLOOK 2015 7, tbl.2 (2015).[21] Given favorable economics and policies, EIA projects that renewable sources will account for one-third of all new generation over the coming decades.[22] EIA, ANNUAL ENERGY OUTLOOK 2015 ES-6, EPA-HQ-OAR-2013-0602-36563 (2015), JA ___.

Natural gas generation is growing, too. *See id.* at 16, JA ___ (projecting that demand for natural gas will increase nearly 15% by 2040). Natural gas combined-cycle technologies produce more electricity per unit of fuel energy than do coal-fired units, often more cheaply. Accordingly, decreasing coal generation has corresponded with increasing natural gas and renewable energy generation, as highlighted by Table 1 below. In 2004, coal represented nearly half of total U.S. generation; but, in less than a decade, the combination of natural gas and renewable energy surpassed coal. EIA projects that this year, annual generation from natural gas alone will surpass generation from coal. EIA, *Natural Gas*

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[21] *Available at* https://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf.

[22] Nonetheless, the transmission requirements and variable availability of renewable energy means that the most economical near-term generation portfolio is likely to remain a mix of renewable and fossil-fuel sources.

Expected to Surpass Coal in Mix of Fuel Used for U.S. Power Generation in 2016, TODAY IN ENERGY (Mar. 16, 2016).[23]

Table 1. U.S. Electricity Generation: Selected Sources[24]

Year	Coal	Natural Gas	Renewables
2004	49.7%	17.8%	8.8%
2005	49.5%	18.7%	8.8%
2006	48.9%	20.0%	9.5%
2007	48.4%	21.5%	8.5%
2008	48.1%	21.4%	9.3%
2009	44.4%	23.3%	10.6%
2010	44.7%	23.9%	10.4%
2011	42.2%	24.7%	12.6%
2012	37.3%	30.2%	12.4%
2013	38.7%	27.6%	13.1%
2014	38.5%	27.3%	13.5%

Meanwhile, growth in electricity demand has slowed to its lowest rate in decades, reflecting the success of federal and state policies in promoting energy efficiency in buildings, appliances, and electronic devices. *See* EIA, MONTHLY

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[23] https://www.eia.gov/todayinenergy/detail.cfm?id=25392.

[24] NAT'L RENEWABLE ENERGY LAB., 2014 RENEWABLE ENERGY DATA BOOK 12 (2015), *available at* http://www.nrel.gov/docs/fy16osti/64720.pdf.

ENERGY REVIEW: FEBRUARY 2016 106–23 (2016).[25] Over the coming decade, state policies will drive substantial growth in energy efficiency investments, with or without the Rule. *See* GALEN L. BARBOSE ET AL., THE FUTURE OF UTILITY CUSTOMER-FUNDED ENERGY EFFICIENCY PROGRAMS IN THE UNITED STATES: PROJECTED SPENDING AND SAVINGS TO 2025 30 (2013)[26] (projecting utility customer-funded spending of $9.5 billion annually by 2025). The Rule is likely to result in additional investments, as energy efficiency is frequently a cost-effective alternative to fossil-fuel-fired generation. *See* RIA at 3-12–3-16.

The Rule will not "end the use . . . of certain kinds of energy generation," as Petitioners assert. Pet. Legal Br. 33. Coal and natural gas will remain the country's two leading sources of electricity. Projections to 2030 show that coal will continue to provide more than one-quarter of all U.S. electricity generation—only 5.4% less than projected without the Rule—and natural gas will provide about one-third. *See* 80 Fed. Reg. at 64,665.

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[25] *Available at* https://www.eia.gov/totalenergy/data/monthly/archive/00351602.pdf.

[26] *Available at* https://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf.

C. States and Power Companies Have a Range of Familiar Compliance Options.

Petitioners' claims about the dire impacts of the Rule on grid operations are unfounded. The Rule does not "restructur[e] . . . nearly every State's electric grid" or otherwise change grid operations. Pet. Legal Br. 6, 33. Rather, the Rule respects the Constrained Least-Cost Dispatch principles that govern the grids.

Petitioners suggest that compliance options are limited to extreme measures such as "shutting down hundreds of coal-fired power plants." *Id.* at 4. This claim is exaggerated and unsupported. First, the Rule does not require any plant retirements. Retirements will occur, as they always have, only if unit owners decide that a plant is no longer economical. As stated above, many coal-fired units are already headed toward retirement. Second, at least twenty-one of the State Petitioners can fully comply with the Rule through the first compliance period—and at least eighteen can comply through 2030—by relying on existing and planned generation and implementation of existing state policies. Decl. of Diane Munns ¶ 9 (Dec. 7, 2015). In other words, affected units in many states can comply with the Rule without any change to business-as-usual operations.

In any case, compliance options are plentiful. They include:

- making technological or operational adjustments to improve the "heat rate" (generation efficiency) of coal-fired units;

- increasing generation from existing natural gas units;
- co-firing or fuel-switching at coal-fired units;
- investing in new renewable energy generation;
- investing in programs to lower demand by increasing consumer-side energy efficiency or by employing demand response;
- installing carbon capture and sequestration technologies;
- purchasing lower-emitting power via a power purchase agreement;
- establishing operational limitations on carbon-intensive sources through permits or run-time restrictions; and
- purchasing credits or allowances through a trading program.

All of these are actions that states and utilities regularly take to supply consumers with reliable and affordable power that meets regulatory standards.

The power sector can implement these familiar strategies without "changing dispatch methodology." *See* Pet. Legal Br. 20 (citation omitted). Constrained Least-Cost Dispatch principles will continue to guide grid operations under the Rule. Dispatch algorithms and ISO/RTO market software easily accommodate emissions constraints. It is normal for the competitive posture of generators to change over time, as fuel prices fluctuate, aging units retire, generation technologies evolve, and new pollution controls are implemented. The Rule may affect the operating costs of various units (*e.g.*, if an affected unit needs to purchase an emissions allowance), or lead to new permit restrictions that limit a unit's operating hours, but grid operators routinely account for such costs and operational limitations.

Most of the above-listed compliance actions do not involve procuring renewable energy generation; however, we note that owners and operators of affected units have ample opportunity to do so. Petitioners attempt to frame renewable sources as "competitors" to affected generators (Pet. Legal Br. 6, 24, 33), when, in fact, both are often part of a utility's integrated generation portfolio. Many affected generators are owned by utilities that largely control their generation mix and can acquire new renewable sources. Renewable energy plays a valuable role in a utility's resource portfolio because Constrained Least-Cost Dispatch typically favors it. Hence, virtually all major utilities are already planning investments in renewable energy. For example, EPA's study of utility planning documents shows that Xcel Energy Upper Midwest is planning for more than 3600 megawatts of utility-scale renewable energy by 2030, and Duke Energy Carolinas is planning for approximately 2144 megawatts. EPA, Review of Electric Utility Integrated Resource Plans 10, 23, EPA-HQ-OAR-2013-0602-36301 (May 7, 2015), JA ___; *see also* EPA, Supplement to the Review of Electric Utility

Integrated Resource Plans, EPA-HQ-OAR-2013-0602-36303 (Oct. 23, 2015) (describing numerous utilities' plans to convert coal units to natural gas generation). This year alone, EIA projects that power companies will install 9500 megawatts of utility-scale solar, making 2016 the first-ever year in which new solar exceeds additions of any other generation source. EIA, *Solar, Natural Gas, Wind Make Up Most 2016 Generation Additions*, TODAY IN ENERGY (Mar. 1, 2016).[27]

Additionally, all states can adopt compliance plans that allow affected units to invest indirectly in renewable energy through purchase of tradable credits or allowances. Market-based programs are well suited to the interconnected, transactional, and regionally coordinated operations of the power sector. Recognizing this, Congress and EPA have developed successful trading programs for power-sector pollutants such as sulfur dioxide, ozone, and particulate matter. *See* Resp't EPA's Initial Br. 32–34. Many states (including the vast majority of State Petitioners) are currently implementing these programs. Additionally, ten states already participate in trading programs for power-sector CO_2 emissions. In

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[27] http://www.eia.gov/todayinenergy/detail.cfm?id=25172.

all cases, grid operators have been able to smoothly integrate emissions trading into the routine operation of the "complex machine."

III. Petitioners Propose a Site-Constrained Approach to Developing Pollution Controls That Does Not Make Sense for Power-Sector CO_2.

Petitioners argue that EPA should have determined the "best system of emission reduction" for CO_2 considering only "technological controls" that could be implemented on-site at a power plant. Pet. Legal Br. 8, 48. But limiting EPA to a site-constrained approach in developing pollution controls does not make sense for grids that operate as integrated machines.[28] EPA correctly recognized that the power sector responds to pollution controls by shifting generation among sources.

A. EPA's Selected Best System Reflects the Grids' Machine-Like Operations and the Distinctive Characteristics of CO_2.

EPA appropriately concluded that shifting from higher-emitting to lower-emitting generators is part of the Best System for power-sector CO_2. This is not necessarily true for other pollutants or industries. *Cf.* 80 Fed. Reg. at 64,782 ("No

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[28] Petitioners' arguments are reminiscent of those raised against the Acid Rain Program. History has since shown that including the expense of allowances in dispatch, and substituting lower-emitting units for higher-emitting units, is an efficient way to control pollution without endangering reliability. *See Prepared Testimony on Acid Rain Special Topic Information Before the Pub. Util. Comm'n of Ohio* (Sept. 28, 1990) (testimony of Benjamin F. Hobbs on behalf of Ohio Consumers' Counsel), *available at* http://tinyurl.com/zs7q5g9.

other industry is both physically interconnected in this manner and manufactures such a highly substitutable product."). Carbon pollution is globalized, meaning the location of particular reductions is irrelevant to mitigating the associated harm. Additionally, CO_2 is chemically unreactive relative to other power-sector pollutants, and therefore less easily controlled through end-of-smokestack technologies. *Id.* at 64,725. Over the coming decades, the most cost-effective CO_2 emissions reductions are thus achieved primarily by displacing generation from carbon-intensive sources.

Recognizing this, the most successful CO_2-reduction policies to date have harnessed the interconnected nature of the power system to facilitate shifts away from high-emitting generators. In addition to the ten states that already participate in CO_2 trading programs, twenty-nine states plus the District of Columbia have enforceable Renewable Portfolio Standards requiring utilities to meet a certain percentage of electricity demand with renewable energy. *See, e.g.*, 2015 Cal. Legis. Serv. ch. 547 (West) (requiring 50% of utility retail sales in California to come from renewable energy by 2030). And at least half of the states have adopted a long-term target to reduce energy demand by increasing consumer-side energy efficiency. 80 Fed. Reg. at 64,695. Such policies have contributed to significant CO_2 emissions reductions by promoting shifts among generators. *See*

RYAN WISER ET AL., A RETROSPECTIVE ANALYSIS OF THE BENEFITS AND IMPACTS OF U.S. RENEWABLE PORTFOLIO STANDARDS 17 (2016)[29] (finding that new renewable energy generation used to meet Renewable Portfolio Standard obligations in 2013 reduced power-sector CO_2 emissions by about 3%); EPA, Demand-Side Energy Efficiency Technical Support Document 6, EPA-HQ-OAR-2013-0602-36842 (Aug. 2015), JA ___ (reporting that energy efficiency policies accounted for 35% to 70% of power-sector CO_2 emissions reductions in ten states). By including shifts to lower-carbon generation within its selected Best System, EPA recognized current industry best practices to reduce a distinctive pollutant, CO_2, from the uniquely interconnected power sector.

EPA sensibly used the Eastern, Western, and Texas Interconnections as the units for quantifying the level of CO_2 emissions reductions achievable through shifts to lower-carbon generation. Grid operators shift generation among sources to adjust the three regional pools of energy to meet demand in real time. It is also at the interconnection level that reliability standards are applied. Petitioners criticize the Rule's regional approach (*see* Pet. Procedural Br. 22, 48), but alternative approaches would not make sense. The "machines" pay no heed to

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[29] *Available at* https://emp.lbl.gov/sites/all/files/lbnl-1003961.pdf.

state or facility boundaries as they shift dispatch among generators according to Constrained Least-Cost Dispatch principles.

B. It Would Make No Sense to Disregard Shifts Among Generators in Developing Pollution Controls for Power-Sector CO_2.

Petitioners would limit EPA to considering only site-constrained measures that do not, by themselves, provide a sensible way to reduce power-sector CO_2 emissions over the coming decades. *See* Pet. Legal Br. 8, 48. The lowest-cost site-constrained system of CO_2 emissions reduction is heat-rate improvements at coal-fired units, which alone would influence the emissions intensity of individual units by only a few percentage points. Furthermore, due to the interconnected nature of the grid, heat-rate improvements actually have the potential to increase CO_2 emissions from the source category. Heat-rate improvements would reduce the variable costs of coal generation, thus enhancing coal's competitiveness in Constrained Least-Cost Dispatch. Combining heat-rate improvements with incentives to reduce coal generation, as EPA did, ensures meaningful emissions reductions. *See* 80 Fed. Reg. at 64,745, 64,748.

Had EPA identified other site-constrained measures, such as carbon capture and sequestration or co-firing, as the Best System, the resulting rule still would have caused the shifts among generation sources that Petitioners decry. *Id.* at 64,727–28, 64,756. Given the high costs of implementing these measures at existing units, it is expected that most units would comply with the resulting emissions standards by reducing or shifting generation. Lower-carbon generation would be more cost-competitive and therefore favored in dispatch and utility investments—just as it is under the Rule. *Id.* at 64,728, 64,784. Instead, EPA selected a Best System that is significantly less costly than co-firing or carbon capture, resulting in a rule with lesser impacts on the relative competitiveness of various generators. *Id.* at 64,727–28. Recognizing that the power sector responds to pollution controls with dispatch shifts, the Rule includes system-focused features—such as provisions facilitating emissions trading—that further increase compliance flexibility and lower costs.

As discussed above, companies that own fossil-fuel-fired units routinely invest in, and coordinate with, renewable energy generation—even to the point of co-locating natural gas or renewable energy generation with a coal-fired unit. *See* Mitigation TSD at 4-24–4-25 (discussing numerous examples of renewable generation sited within an affected generator's power control area). For instance, to reduce emissions, Iowa State University Utilities installed a wind turbine and solar panels next-door to its coal-fired power plant and partially converted the plant to natural gas. *See Environmental Performance*, IOWA STATE UNIV. UTIL.

SERV.[30] Louisville Gas and Electric and Kentucky Utilities are jointly installing Kentucky's largest array of solar panels at a coal facility owned by the utilities. EPA, Supplemental Memorandum to Mitigation TSD, EPA-HQ-OAR-2013-0602-37117 (Oct. 23, 2015). Co-located generation underscores the point that shifting among generation sources is routine in the integrated power sector.

A simple hypothetical best illustrates why Petitioners' calls for EPA to consider only "technological controls" that "are capable of being implemented at the source" make no sense. *See* Pet. Legal Br. 8. Consider coal-fired Power Plant A ("Plant-A"), which installs rooftop solar panels. By generating power with both its solar panels and coal-fired boiler, Plant-A can lower its CO_2 emissions rate (emissions per megawatt-hour). Plant-A can continue to produce the same amount of power by shifting some of its generation from coal to solar, thereby reducing the numerator of its emissions rate. Or, Plant-A can increase its annual output by adding solar to its coal generation, thereby increasing the emissions-rate denominator. In either case, Plant-A has installed what Petitioners advocate: "a system of emission reduction that can be achieved with technological or

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[30] https://www.fpm.iastate.edu/utilities/environmental_performance.asp.

operational measures that the regulated source itself can implement." Pet. Legal Br. 48.

Now, imagine that Plant-A instead installs solar panels on a field located next to its coal unit. The emissions rate result is the same. Likewise, the same emissions rate would result from solar panels instead installed several miles away. Regardless of where the solar panels are located, Plant-A would rely on the same regional network of transmission lines to pool power generated by the solar panels on the grid. From the perspective of regulators, consumers, grid operators, and EPA, it is irrelevant whether the solar panels that reduce Plant-A's emission rate are located on Plant-A's rooftop or in the next state over. From the perspective of Plant-A's owner, it is far more desirable to install solar panels in the most cost-effective location, whether or not that location is within the plant.

It would make little sense for EPA to consider only CO_2 emissions reductions within the ephemeral boundaries of individual facilities when all facilities deliver undifferentiated power to unitary grids. The Rule is a superior alternative because it works with the grid structure, rather than against it, to achieve significant low-cost emission reductions.

CONCLUSION

For reasons stated herein, the Court should deny the Petitions for Review.

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE

I hereby certify that the foregoing brief complies with the type-volume limitations set forth in D.C. Cir. R. 32(e)(3) and Fed. R. App. P. 29(d) because this brief contains **6987** words, excluding the parts of the brief exempted by Fed. R. App. P. 32(a)(7)(B)(iii) and D.C. Cir. R. 32(e)(1). The foregoing brief complies with the typeface requirements of Fed. R. App. P. 32(a)(5) and the type style requirements of Fed. R. App. P. 32(a)(6) because this brief has been prepared in a proportionally spaced typeface using Microsoft Office Word 2010 in 14-point Times New Roman font.

/s/ Megan M. Herzog
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April 1, 2016

CERTIFICATE OF SERVICE

I hereby certify that, on this 1st day of April, 2016, I electronically filed the foregoing with the Clerk of the Court for the United States Court of Appeals for the District of Columbia Circuit using the Court's CM/ECF system, which will send notice of such filing to all counsel who are CM/ECF registered users.

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