ORAL ARGUMENT NOT YET SCHEDULED
No. 19-1140 (and consolidated cases)

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

AMERICAN LUNG ASSOCIATION, *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, AND JAMES D. MCCALLEY IN SUPPORT OF PETITIONERS

CARA A. HOROWITZ
D.C. Circuit Bar No. 56629
WILLIAM BOYD
ANN E. CARLSON
CHARLES R. CORBETT
UCLA School of Law
405 Hilgard Avenue
Los Angeles, CA 90095
Tel: (310) 206-4033
horowitz@law.ucla.edu

April 23, 2020

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 State and Municipal Petitioners' Opening Brief filed April 17, 2020, with the exception of *Amici Curiae* Grid Experts and potentially other *amici curiae* in support of petitioners.

B. Rulings Under Review

References to the rulings at issue appear in State and Municipal Petitioners' Opening Brief filed April 17, 2020.

C. Related Cases

References to related cases appear in State and Municipal Petitioners' Opening Brief filed April 17, 2020.

RULE 29 STATEMENTS

Amici certify that all parties in these consolidated proceedings have consented to the filing of this amicus brief.

Pursuant to Fed. R. App. P. 29(a)(4), *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 rules 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/ Cara Horowitz
CARA HOROWITZ

April 23, 2020

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GLOSSARY OF ABBREVIATIONS

The Rule, The Repeal, The ACE Rule	The final rule published in the Federal Register at 84 Fed. Reg. 32,520 (Jul. 18, 2019), JA___ and titled "Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations," (codified at 40 C.F.R. pt. 60)
The CPP	The Clean Power Plan, published in the Federal Register at 80 Fed. Reg. 64,662 (Oct. 23, 2015), JA ___, *rescinded by* 84 Fed. Reg. 32,520
Best System or BSER	The "best system of emission reduction" pursuant to 42 U.S.C. § 7411(a)(1)
CO_2	Carbon Dioxide
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

STATUTES AND REGULATIONS

Pertinent statutes and regulations are contained in State and Municipal Petitioners' Opening Brief.

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

Effective air pollution controls for the U.S. power sector take account of the interconnected design and operation of the U.S. electric grids. The U.S. Environmental Protection Agency ("EPA") failed to give appropriate consideration to grid design and operation in its final rule, "Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations," 84 Fed. Reg. 32,520 (Jul. 8, 2019) ("Rule"), Joint Appendix ("JA") __. The Rule instead employs a fragmented, unit-by-unit approach to reducing power sector emissions of carbon dioxide ("CO_2"), one that does not account for the integrated management and deployment of grid resources. The repeal of the Clean Power Plan ("Repeal") therefore rests on an unreasonable and unsound basis, as does the inefficient and ineffective Affordable Clean Energy Rule ("ACE Rule") replacing it.

Engineers have declared the U.S. power system as 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). Every electric generator in the continental United States is embedded within one of three regional grids and linked to other generators and consumers through transmission and distribution lines. Each grid operates as a single integrated machine. The fundamental purpose of each machine's interconnectedness is to allow grid operators to continuously balance 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, facilitated by the grids' physical structure and design and by complex dispatch software and regional spot electricity markets. The use of any individual generator is thus dependent on the performance of other components of the machine.

The Rule's fragmented, unit-by-unit approach is at odds with the interconnected operation of the U.S. power system. Because it focuses too narrowly on a small subset of the measures that can be applied directly to coal-fired units, EPA fails to enable the emissions reductions possible by leveraging grid interconnectivity against CO_2 pollution. Instead, the Rule adopts a "best system of emission reductions" ("BSER") that does not reflect what industry experts understand to be the easiest, cheapest, and best way to reduce CO_2 emissions from coal-fired power plants: shifting generation away from those plants and toward cleaner sources of energy. *See* 42 U.S.C. § 7411(a)(1).

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.[1] To aid the Court's understanding of the technical matters at issue in this case, 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 interacts with grid operations.

Amici emphasize three key points:

***First*, effective power-sector emission controls reflect grid operations, which are defined by fundamental characteristics of electricity and of the infrastructure and markets that connect power generation to demand**. The power sector has distinctive operational features that create both opportunities and challenges for pollution control, and the determination of the BSER must account for this. For example, a defining feature of the three regional grids is that each

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[1] *Amici*'s credentials are summarized in the Addendum to this brief.

operates as a single, interconnected machine. Governance frameworks for the dispatch of electricity are designed to facilitate seamless shifts among generators to ensure affordable, reliable electricity. For these reasons, the most effective and least costly CO_2 pollution control measures for the power sector allow for shifting of generation to lower-emitting generators. The approach taken in the Clean Power Plan ("CPP") accomplishes this by including shifts from higher-emitting to lower-emitting generators as part of its definition of the Best System. *See* 80 Fed. Reg. 64,662, 64,717 (Oct. 23, 2015), *rescinded by* 84 Fed. Reg. at 32,521. In other words, the CPP works with grid interconnectivity to cut CO_2 emissions cost-effectively.

***Second*, and by contrast, the ACE Rule is inefficient and ineffective because it contradicts the design and operation of the three U.S. regional grids**. In defining the BSER, EPA failed to account sufficiently for the interconnected nature of the grid. The ACE Rule focuses too narrowly on a set of ineffective heat-rate approaches likely to deliver less than a percentage point in reductions in CO_2 emissions, if that. In doing so, the ACE Rule forgoes the significant emissions reductions possible through leveraging the grids' interconnectivity against CO_2 pollution. In defining the Best System, the ACE Rule unreasonably excludes many more effective measures that can reduce emissions from regulated sources, like natural gas co-firing, generation shifting, and reduced utilization of high-emitting units. A CPP-like framework can achieve emissions reductions an order of magnitude greater than the ACE Rule will, at reduced cost. For these reasons, EPA's determination of the Best System does not reflect a real-world understanding of the best way to reduce CO_2 emissions from these sources.

***Third*, given trends in electricity supply and pricing, sensible federal regulation can accelerate reductions in power sector CO_2 emissions without harming grid reliability.** Renewable sources of power are now cheaper than or cost-competitive with fossil fuel generation. Despite a decade of progress, however, the power sector remains a significant source of CO_2 emissions, endangering public health and welfare. Reducing power sector emissions is an urgent priority. A cleaner power grid is the linchpin for plans to reduce climate pollution economy-wide, and it can be achieved using familiar pollution-control tools that build on existing trends and practices. Emissions controls for this sector can be strengthened cost-effectively without risking grid reliability, and a sensible approach to the BSER would use these sectoral conditions to launch even deeper reductions in CO_2 pollution.

ARGUMENT

I. Effective Power Sector Pollution Controls Work with 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, and the ACE Rule unreasonably excludes this approach.

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). Electric energy moves across the grid according to the laws of physics, following the path of least resistance. It cannot be directed (like an e-mail or package) to a particular recipient.

Second-by-second variation in withdrawals of electricity (demand) is balanced by injections of electricity from generators connected to the grid (supply), 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 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, "If [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. Fla. Power & Light Co.*, 404 U.S. 453, 460 (1972) (citation omitted).

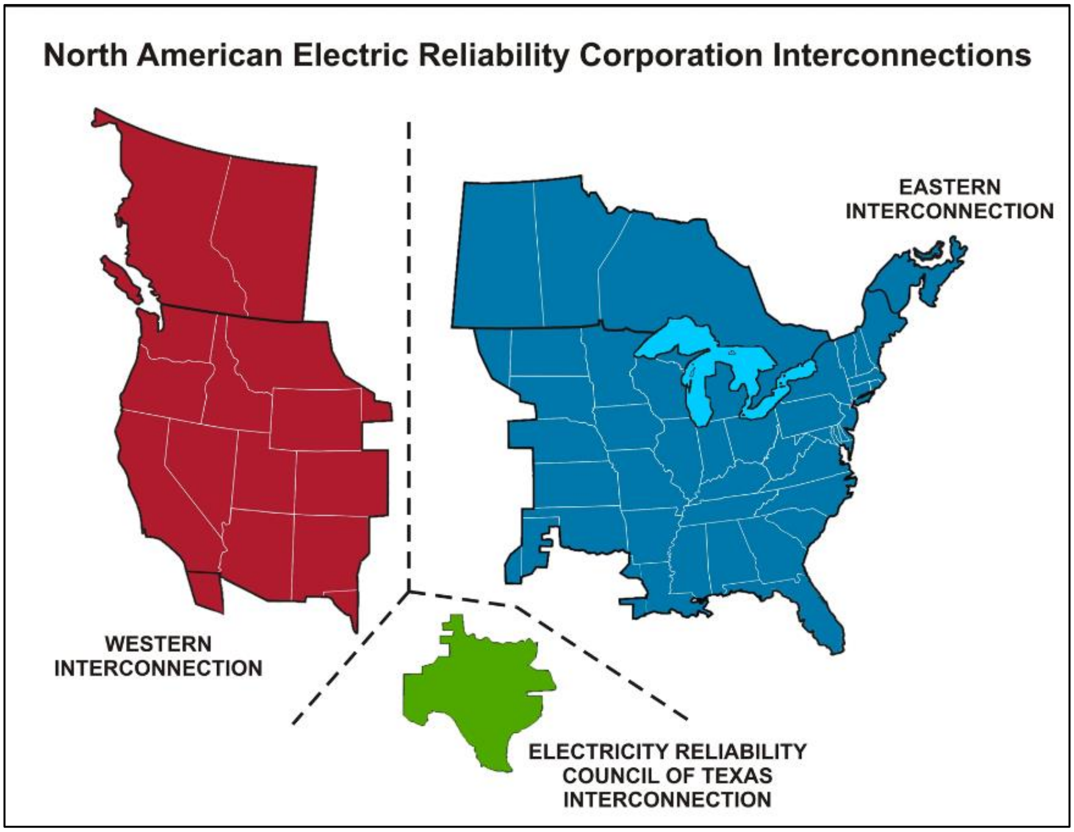
Electricity that is added to the grid energizes the entire grid. Generators do not "generate" electrons and consumers do not "consume" electrons, as is commonly believed—electric power is injected into and withdrawn from the grid. An electromagnetic wave, propagated by generators, moves at the speed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

The second distinctive feature of electricity is that it cannot yet be economically stored on a large scale. The present inability to store large amounts of electricity means generation (supply) and load (demand) must continuously and precisely be balanced. This makes electricity the ultimate "just-in-time" product. *See* Paul L. Joskow, *Creating a Smarter U.S. Electricity Grid*, 26 J. Econ. Persp. 29, 33 (2012); *but see* Energy Info. Admin., *U.S. Battery Storage Market Trends* 4 (2018) (noting rapid advances in energy storage technology that may someday overcome this hurdle).

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.[2]

Figure 1. U.S. Power-System Interconnections[3]



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

[2] Hawaii and Alaska have their own grids.

[3] U.S. Dep't of Energy, *North American Electric Reliability Corporation Interconnections*, https://www.energy.gov/oe/downloads/north-american-electric-reliability-corporation-interconnections.

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, 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, each generator is interdependent with every other generator, and routine operations are coordinated by grid operators. Because the performance and usage of their units depends on the operation of other units outside their 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. Fla. 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 "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") use 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. In these ways, Constrained Least-Cost Dispatch principles guide all dispatch planning across the country.

Dispatch and the necessary planning for it occur 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 and investments 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, 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 often, while units whose costs decrease will be dispatched more. Existing pollution regulations already affect the dispatch competitiveness of fossil-fuel-fired power plants. Under Constrained Least-Cost Dispatch, fuel costs and other costs are treated identically; the cheapest overall generation, once variable costs are accounted for, is used.

Congress, EPA, and state regulators have long recognized that a systemwide approach to reducing pollution works most efficiently within grid operations. They have accordingly harnessed shifts among generators as an economical tool to reduce harmful air emissions. 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; *see also* Emanuele Massetti et al., Oak Ridge Nat'l Lab., *Environmental Quality and the U.S. Power Sector: Air Quality, Water Quality, Land Use and Environmental Justice* 20 (2017). The allowance requirement increased the costs of regulated units, which decreased the dispatch competitiveness of those units and led some to reduce 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* 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 ten 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. *See, e.g.*, Paul Hibbard et al., *The Economic Impacts of the Regional Greenhouse Gas Initiative on Nine Northeast and Mid-Atlantic States* 6 (2018).

E. The CPP's Approach Respected and Harnessed These Fundamental Grid Characteristics.

Like past successful pollution control programs, the CPP harnessed the routine shifting of generation to cost-effectively reduce CO_2 emissions from regulated sources. It identified the emissions reductions that could be achieved by regulated sources in each state based, in part, on gains from generation shifting. This was possible because it defined the Best System to include reductions in coal generation and increasing natural gas and renewable energy generation, relying on the interconnected workings of the grids. Compliance options to meet state emission-reduction targets were plentiful and were well-matched to grid operations. Regulated sources could reduce emissions through a mix of generation shifting, reduced utilization, emissions trading, heat rate improvements, and other measures. *See* 80 Fed. Reg. at 64,666–67. The CPP thereby leveraged the grids' interconnected, synchronous operation to realize meaningful—and very cost-effective—cuts in emissions from the sources it regulated.

II. The ACE Rule's Fragmented Approach to Pollution Control Fails to Account for the Grids' Interdependent Operation and Therefore Does Not Make Sense for Regulating Power-Sector CO_2.

By contrast with the approach adopted under the CPP, the ACE Rule excludes emission-reduction measures that take advantage of grid operations and interconnectedness, such as generation shifting. It adopts a Best System definition that does not reflect real-world understandings of how best to reduce power-sector CO_2. As discussed below, the consequence is that costs of achieving the targeted emissions reductions are much higher than necessary, and inexpensive opportunities to lessen emissions further are missed. This translates into more pollution, worsened health outcomes, and billions of dollars in net benefits forgone, as compared with a rule that reflected, rather than dismissed, grid operations and successful pollution-reduction strategies.

A. Because the ACE Rule Treats Individual Sources As If They Operate In Isolation From the Grid, It Achieves Almost No Emission Reductions, If Any.

The grid is a synchronous machine, and the most meaningful and cost-effective CO_2 emissions reductions are achieved by encouraging the displacement of generation from carbon-intensive sources. Successful CO_2-reduction policies to date have harnessed the interconnected nature of the power system to drive shifts away from high-emitting generators like coal- and oil-fired plants. These policies have contributed to significant, cost-effective emissions reductions and could continue to do so. *See, e.g.*, *supra* pp. 14-17; Ryan Wiser et al., *A Retrospective Analysis of the Benefits and Impacts of U.S. Renewable Portfolio Standards* 17 (2016) (finding that new renewable energy generation used to meet state-level targets in 2013 reduced power-sector CO_2 emissions by about 3%); ICF Int'l, Inc., *Assessing Effects on the Power Sector of Greenhouse Gas Emission Standards* 3, 5 (Oct. 31, 2018), JA___ (concluding that generation shifting measures, together with others, could result in reductions of CO_2 emissions of 18-27% by 2030).

The ACE Rule fails to reflect these lessons. In defining the Best System, EPA looks only to measures that can be "applied at and to certain" individual coal-fired units and settles on a definition that includes only certain changes to the physical equipment and processes of generators, specifically, heat-rate improvements at coal-fired power plants. Rule at 32,532, 32,536, JA___. It asserts that this approach necessarily excludes many of the pollution-control measures that experts know to be the most effective at reducing emissions from coal unit operations, rejecting, for example, natural-gas co-firing, decreased utilization of the highest-emitting units, and generation shifting. *Id.* at 32,532, 32,543, JA___. By rejecting such measures, EPA unreasonably excludes a broad set of pollution controls that have been shown to most cost-effectively reduce emissions from the Rule's target sources, coal power plants.

Moreover, the Rule adopts only those measures that reduce an individual facility's *rate* of emissions—that is, its emission of CO_2 per unit of electricity produced—and fails to credit measures that would reduce a facility's total emissions without necessarily affecting rate, such as reduced utilization. Rule at

32555, JA___. Notably, a facility that improves its rate of emissions can still increase its total emissions in aggregate, simply by operating more. *Id.* at 32,542–43, JA___.

Little in the way of pollution control can be achieved through the limited measures EPA includes in the BSER. The selected heat-rate improvement measures provide only a small increase in efficiency, between 0.1% to 2.9%, depending on technology and characteristics of the energy-generating unit. Rule at 32,537 tbl. 1, JA___. Slight efficiency improvements, in turn, can allow for only small reductions in CO_2 emitted per a unit of energy generated. *See* Amelia T. Keyes et al., *The Affordable Clean Energy Rule and the Impact of Emissions Rebound on Carbon Dioxide and Criteria Air Pollutant Emissions*, 14 Envtl. Res. Letters No. 044018 2 (2019).

Not surprisingly, then, the ACE Rule will result in few, if any, emissions reductions. EPA projects that the ACE Rule will cause U.S. power sector CO_2 emissions to fall by only 0.7% against its projected baseline in 2030. EPA, *Regulatory Impact Analysis* ES-6 tbl. ES-4, 3-11 (2019) ("Final RIA"), JA___. By 2035, EPA's projected percent-reduction against the baseline is even less substantial, at 0.5%. *Id*.

Even these modest projected gains are far from certain, depending both on state implementation and on the interaction of regulated facilities with others on the grid. EPA leaves to states the all-important decision of whether, and to what degree, to require that heat-rate improvements be made at individual facilities at all. Rule at 32,551, JA___; *see also* Pub. Health and Envtl. Pet. Br. at 19-26. Moreover, even if heat-rate improvements are implemented, the ACE Rule may result in a "rebound effect," further limiting its effectiveness by making coal-fired electricity more competitive in interconnected power markets. Keyes, *Impact of Emissions Rebound* at 3. As a result, these plants can operate more frequently and for longer periods of time, driving up their overall CO_2 emissions. The rebound effect can undermine, and sometimes overwhelm, the emissions reductions realized by clean air regulations. Driscoll et al., *US Power Plant Carbon Standards and Clean Air and Health Co-Benefits*, 5 Nat. Climate Change 535, 537 (2015); Kathy Fallon Lambert et al., *Carbon Standards Reexamined* 4 (Harv. T.H. Chan Sch. Pub. Health et al., Working Paper 2019) (describing the likely significant rebound effect of the ACE Rule).

EPA claims overall regulated-source emissions will still fall despite the rebound effect. Rule at 32,543, JA___. But this does little to assure that the ACE Rule is sensible as a whole. Even if EPA is correct, which we do not concede, the

ACE Rule still unreasonably favors minimally effective pollution controls over well-established regulatory designs that are far cheaper and more effective in reducing CO_2.

B. By Omitting Established Best Methods For Reducing Emissions, The ACE Rule Harms Public Health, Forgoes Billions of Dollars in Benefits, and Provides Few Savings for Industry.

Because it fails to incorporate common, successful methods for reducing emissions from coal-fired plants, the ACE Rule significantly underperforms as compared with a better-designed rule. Using the latest data on power-sector trends, updated analysis shows that applying the CPP's more flexible regulatory approach to current conditions would drive deep cuts in power-sector emissions—far greater than those under the ACE Rule and at equivalent or cheaper cost per ton abated. ICF Int'l, Inc. at 3, 5, JA___. Under five different policy scenarios, the analysis found that a regulatory design relying on generation shifting, emissions trading, and reduced utilization would cause an additional 18–27% reduction in CO_2 emissions by 2030, relative to a business-as-usual baseline, depending on the mix of regulatory tools used. *Id.* at 5, JA___.

These results tower over EPA's projections for the ACE Rule, which show less than a percentage point in additional CO_2 emissions reductions by 2030. Final RIA at ES-6, JA___. The ACE Rule achieves an order of magnitude fewer emissions reductions than the reductions possible under a CPP-style approach: 11 million short tons versus 300 million short tons. *Compare* Final RIA at ES-6 tbl. ES-4 *with* ICF at 6 fig. 6, JA___. If the BSER were defined to include reduced unit utilization—a method that certainly could be "applied to" individual coal-fired generators—the power sector would realize hundreds of millions of short tons in additional CO_2 reductions by 2030. ICF at 6 fig. 6, 7 fig. 7 (scenario "PC3"), JA___.[4]

EPA's approach in the ACE Rule is not only less effective than it could be, but also imposes greater abatement costs on industry than other approaches would to achieve the same effect. Abatement costs under an updated CPP would range between $18–$29 per ton of CO_2. *See id.* at 7, JA___. These costs are less than or on par with EPA's estimates for the ACE Rule. *See* Final RIA at ES-5 tbl. ES-3, ES-6 tbl. ES-4, JA___ (projecting costs of $25 per ton abated in 2030).

The ACE Rule's deficits will harm public health and lead to many preventable deaths, as compared with a rule that better reflects grid operations and drives more emission reductions. Some of these harms will come from unrealized climate benefits. *See* Final RIA at 4-4, JA___ (quantifying climate benefits).

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[4] *See* Pub. Health and Envtl. Pet. Br. 38-40 (addressing reduced unit utilization from a legal perspective).

Others will result from increased emissions of co-pollutants like sulfur dioxide, ground-level ozone, and particulate matter harmful to human health. *See id.* at 4-1, JA___. Together, the climate and health co-benefits lost from abandoning the CPP are valued in the billions of dollars. *See* Kathy Fallon Lambert et al. at 4 (estimating an updated CPP, compared to a no-policy baseline, would reduce national levels of sulfur dioxide emissions by 47% and nitrogen oxide emissions by 40%); NRDC Comments on Proposed ACE Rule at 24–25 (Oct. 31, 2018), JA___ (monetizing health benefits of additional co-pollutant reductions). The EPA conceded as much in its original analysis in support of the Rule, finding that repealing the CPP would significantly increase co-pollutants and inflict several billion dollars in health damages. *See* 83 Fed. Reg. 44,746 , 44,790 tbl. 14 (Aug. 31, 2018), JA___.

C. When Reducing Power Sector CO_2, It Is Not Sensible For EPA To Consider Only Limited, Site-Specific Control Measures.

Using a site-constrained approach in developing pollution controls does not make sense for grids that operate as integrated machines.[5] All generators deliver

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[5] EPA's decision to consider only site-constrained approaches in choosing the Best System is reminiscent of a previously rejected approach to controlling sulfur dioxide from power plants. In the debates over the 1990 Clean Air Act amendments, some had suggested that only site-specific "scrubbers" be used to control SO_2, in lieu of the Acid Rain Program's more flexible approach that allows

undifferentiated power to a regional grid that operates synchronously. The power sector responds to pollution controls with dispatch shifts regardless of rule design, whenever those controls alter the relative costs of sources (as they almost always do). Excluding generation shifting in rule development does not mean that shifting will not occur; it simply won't be captured and used by regulators to craft a cheaper, more effective rule. For these reasons, a "best" system of emission reduction cannot be one that defines measures such as generation shifting and reduced unit utilization as out-of-bounds.

A hypothetical illustrates why EPA's site-constrained approach does not result in a sensible definition of the Best System. Consider a coal-fired power plant ("Plant-A") that is subject to the ACE Rule and that installs solar panels as part of its facility. 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.

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for substituting lower-emitting units for higher-emitting units. History has since shown that the more flexible approach is a superior way to control pollution without endangering reliability. *See* Paul L. Joskow et al., *The Market for Sulfur Dioxide Emissions*, 4 Am. Econ. Rev. 669, 683 (1998). The rejected site-specific approach would have been significantly less effective and more expensive. *See id.* at 669–70.

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 a compliance mechanism that "can be applied at and to a stationary source (i.e., as opposed to off-site measures)" and "lead[s] to continuous emission reductions." Rule at 32,534, JA___.

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.

EPA takes account of none of these possible approaches in designing its Best System, the consequence of which is to leave low-hanging emission reduction fruit unharvested. Furthermore, none of these is allowable as a compliance method (save perhaps the on-site panels, about which the Rule is ambiguous). Rule at

32,555, JA___. The effect of this is to reduce industry's flexibility in choosing low-cost emission reduction strategies.

No coal-fired unit operates by itself. Each is a piece of a power plant that, in turn, is part of the grid. It is unreasonable for EPA to consider CO_2 emissions from the perspective of isolated coal units when these units, like all generators, are part of one big machine that delivers undifferentiated power to a unitary grid.

III. Trends in Electricity Supply and Pricing Allow for Significant Further Reductions in CO_2 From Regulated Sources, Without Harming Grid Reliability.

The U.S. power sector is shifting from coal-fired plants to lower- and zero-carbon sources like natural gas, wind, and solar. To avoid climate-based harms to human health and the environment, EPA can and should regulate CO_2 using regulatory tools consistent with these trends, such as emission limits, generation shifting, and emissions trading. This would reinforce existing industry practices and would not harm grid reliability.

A. U.S. Power Sector Emissions Have Decreased Because of Shifts Toward Cleaner Energy Sources.

Successful regulation and market forces have driven large reductions in power sector CO_2 emissions. In 2017 and 2018, the U.S. power sector emitted 30% less CO_2 compared to 2005 levels. Final RIA at 2-14, JA___. State energy standards requiring deployment of renewables have played a large role in this trend. Ryan Wiser et al., Lawrence Berkeley Nat'l Lab. & Nat'l Renewable Energy Lab., *A Retrospective Analysis of Benefits and Impacts of U.S. Renewable Portfolio Standards* ix fig. ES-1 (2016). So too have federal clean air regulations for electricity generation. *See, e.g.,* Rule at 32,546, JA___ (reporting thirty-nine instances of power plants replacing coal-fired units with natural gas–fired units to comply with the Mercury and Air Toxics Standards, 77 Fed. Reg. 9304 (Feb. 16, 2012)). In other words, pollution control strategies that rely on shifts in generation away from high-emitting sources are widely employed, workable, and successful.

In particular, the power sector has shifted generation away from coal and will continue to do so. By 2025, the average age of coal-fired units is projected be 49 years old, with 20% of units older than 60—well beyond their expected operating life of 40 years. *See* 80 Fed. Reg. at 64,694, 64,872, JA___; *see also* Rule at 32,548 n.215, JA___. As coal plants age, they become more expensive compared to newer units. Final RIA at 2-7, JA___. Natural gas prices, meanwhile, are low because of abundant supply, while renewable energy costs have plunged because of improving technology and government policy incentives. *Id.* at 2–11, JA___. The falling price of renewable energy has been particularly dramatic: The cost of building and operating new solar and wind projects is now cheaper than the cost of continuing to operate many coal-fired units. *Id.* These market forces are pushing coal-fired plants offline, replacing them with cleaner energy resources. *See id.* at 2-7, JA___.

B. A True "Best System" Would Build on These Trends, Not Undermine Them.

Notwithstanding progress made to date, the U.S. power sector remains a significant source of CO_2 emissions endangering public health and welfare. In 2018, it emitted more than a quarter of total annual U.S. greenhouse gas emissions. *See* EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2018* ES-5 fig. ES-1, 2-3 tbl. 2-1 (2020). And progress limiting U.S. power sector emissions may be slowing or halting: Annual emissions in 2018 increased by 1.2%. EPA, *Inventory of U.S. Greenhouse Gas Emissions* at ES-7, tbl. ES-2.

A Best System would reduce CO_2 pollutants from regulated sources by building on the last decade's power-sector shifts rather than undercutting them. It could do this by recognizing that the easiest, cheapest, and most established method for reducing emissions from coal-fired power plants is to continue the shift in generation away from those plants toward cleaner sources. Instead, the ACE Rule explicitly rejects crediting sectoral shifts toward cleaner energy sources. Worse, its approach will tend to make coal-fired plants more competitive by mandating heat-rate improvements, which will have the perverse effect of entrenching the use of these facilities beyond their current useful life.

Further reductions in power sector emissions, achieved in ways consistent with the generation shifts already underway, would help the U.S. to reach carbon reduction goals elsewhere in the U.S. economy. Electrification is at the heart of decarbonization strategies for harder-to-decarbonize sectors like transportation, buildings, and industrial heat. Daniel Steinberg et al., Nat'l Renewable Energy Lab., *Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization* vi (2017). Electrifying those sectors could greatly reduce their carbon pollution—but only if the power sector continues to shrink its own emissions.

C. Propping Up Coal Is Unnecessary for Grid Reliability.

One reason EPA gives for its approach is that placing additional burdens on coal generation would harm grid reliability. *See* Rule at 32,551, JA___ ("burden[ing] . . . coal-fired EGUs [] could compromise the stability of the power sector and thus energy reliability to consumers"). EPA provides no support for this position, and it is wrong. Despite a large number of coal retirements in recent years, grid-wide indicators for reliability have been "adequate for all interconnections and are generally trending in a positive direction." N. Am. Elec. Reliability Corp., *2019 Long-Term Reliability Assessment* 27 (2019). The changing energy mix requires new and flexible grid operation strategies, not artificial lifelines for coal-fired resources. *See id.* at 8.

The Department of Energy has found that, despite coal retirements, "markets have achieved reliable wholesale electricity delivery." Dept. of Energy, *Staff Report to the Secretary on Electricity Markets and Reliability* 10 (2017) ("Staff Report"). Independent market analysis has also found that "the diverse US power supply portfolio has proven resilient to significant deviations from normal operating conditions." IHS Markit, *Ensuring Resilient and Efficient Electricity Generation* 4 (2017). Coal-fired power, furthermore, is no cure-all for reliability concerns. For example, the 2014 Polar Vortex froze coal piles solid, leaving many coal plants inoperable during a surge in energy demand. *Staff Report* at 98.

In fact, renewable sources can help *improve* reliability in some circumstances. 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 Clean Power Plan: The Case of PJM* 3, 12 (2015). 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.*, Nat'l Renewable Energy Lab., *Eastern Renewable Generation Integration Study* xvii (2016) (concluding that the U.S. Eastern Interconnection can accommodate upwards of 30% wind and solar photovoltaic generation); Elec. Reliability Council of Tex., *2018 State of the Grid* 2, 4 (2018) (reporting Texas's electricity grid was "operating effectively and efficiently" with about 19% energy provided by wind sources); GE Energy Consulting, *PJM Renewable Integration Study: Executive Summary Report* 6–7 (2014) (finding that the RTO PJM could operate with up to 30% of generation from wind and solar with no significant harm to reliability). By contrast, we know of no good evidence, and EPA cites none, to support the idea that propping up coal generation is necessary for grid reliability.

CONCLUSION

The Best System must recognize energy generating units for what they are: interwoven parts of a greater whole. The Rule eschews pollution reduction measures that reflect grid operations and that experts recognize as the most effective methods for reducing power-sector CO_2. It should be set aside.

Respectfully submitted,

/s/ Cara Horowitz

CARA HOROWITZ
D.C. Circuit Bar No. 56629
WILLIAM BOYD
ANN E. CARLSON
CHARLES R. CORBETT
UCLA School of Law
405 Hilgard Avenue
Los Angeles, CA 90095
Tel: (310) 794-5132
horowitz@law.ucla.edu

Counsel for Amici Curiae

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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. Ap. P. 29(a)(5) because this brief contains 6,470 words, excluding the parts of the brief exempted by Fed. R. App. P. 32(f) 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 2016 in 14-point Times New Roman font.

/s/ Cara Horowitz
CARA HOROWITZ

April 23, 2020

CERTIFICATE OF SERVICE

I hereby certify that, on this 23rd day of April, 2020, 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.

/s/ Cara Horowitz
CARA HOROWITZ

April 23, 2020

ADDENDUM – CREDENTIALS OF GRID EXPERTS

Amici are engineers with expertise in the operation, structure, economics, and reliability of the U.S. power system. They have expertise in grid structure, operations, economics, and modernization; integration of renewable energy generation; and power-system reliability and planning.

Benjamin Hobbs is the Theodore M. and Kay W. Schad Professor in Environmental Management in the Department of Geography and Environmental Engineering at Johns Hopkins University. He has a joint appointment in the Department of Applied Mathematics and Statistics, and directs the Johns Hopkins University Environment, Energy, Sustainability and Health Institute. His research focuses on electric power and energy market planning, risk analysis, and environmental and energy systems analysis and economics. He is Chair of the California Independent System Operator Market Surveillance Committee and a Fellow at the Institute of Electrical and Electronics Engineers ("IEEE") and the Institute of Operations Research and Management Science. He was also a consultant to the PJM Independent System Operator and developed the methodology it uses to evaluate the capacity market demand curve. From 1995 to 2002, he was consultant to the Federal Energy Regulatory Commission's Office of the Economic Advisor. He holds a Ph.D. in Civil and Environmental Engineering from Cornell University.

Brendan Kirby is a private consultant with clients including the Hawaii Public Utilities Commission, Grid Lab, National Renewable Energy Laboratory, Energy Systems Integration Group, Electric Power Research Institute, American Wind Energy Association, Oak Ridge National Laboratory, and others. He has forty-five years of electric grid experience, and has published over 180 papers, articles, book chapters, and reports on power system reliability and integrating renewable energy generation into the power grid. He was a member of the North American Electric Reliability Corporation's Essential Reliability Services Task Force, and previously served on its Standards Committee. He retired from the Oak Ridge National Laboratory's Power Systems Research Program. He is a Licensed Professional Engineer with an M.S. degree in Electrical Engineering (Power Option) from Carnegie-Mellon University and a B.S. in Electrical Engineering from Lehigh University.

Kenneth J. Lutz is an Affiliated Professor in the Department of Electrical and Computer Engineering at University of Delaware, where he does research and teaches a specially designed course on the smart grid. He has decades of experience in the regulation of utilities. He founded AMR Strategies, LLC, to help utilities modernize their grids. Previously, he served as an IEEE/American Association for the Advancement of Science Congressional Fellow for United States Senator Ron Wyden, where he played a key role in drafting federal legislation for renewable energy and energy efficiency. He has a Ph.D. in electrical engineering from the Johns Hopkins University and a B.E.E. from the University of Delaware.

James D. McCalley is the London Professor of Power System Engineering in the Electrical and Computer Engineering Department at Iowa State University. He has graduated twenty-eight Ph.D. students under his supervision and is the author of over 230 publications in electric power systems engineering. His areas of research include: transmission planning, power-system security, power-system dynamics, wind energy, long-term investment planning for energy and transportation systems at the national level, and power-system decision problems under uncertainty, including those encountered in operations and planning. Dr. McCalley has been an IEEE Fellow since 2004. He chaired the IEEE Power and Energy Society's Subcommittee on Risk, Reliability, and Probability Applications from 2004 to 2006. He has been involved in the International Conference on Probabilistic Methods Applied to Power Systems (PMAPS) since PMAPS-4 in 1994 and served as General Chair of PMAPS-8. Prior to joining the Iowa State

University faculty, from 1985 to 1990, he was a Transmission Planning Engineer with Pacific Gas and Electric Company in San Francisco, California, and a licensed professional engineer. He holds Ph.D., M.S., and B.S. degrees in electrical engineering from the Georgia Institute of Technology.