AMERICAN COALITION FOR CLEAN COAL ELECTRICITY

IMPACTS OF EPA'S CARBON REGULATIONS ON ELECTRIC RELIABILITY

In June 2014, EPA proposed the Clean Power Plan (CPP) for regulating CO_2 emissions from existing fossil-fuel power plants under section 111(d) of the Clean Air Act. The CPP requires states to reduce their net CO_2 emission rate from power generation beginning in 2020, with target rates growing more stringent through 2030. Compliance will require a significant reduction in the use of coal and oil for power generation, and an increased reliance on natural gas, renewables, and end-use energy efficiency programs.

The major changes to the generating mix that will result from the CPP have the potential to cause significant electric reliability issues. EPA has done little analysis to assess the impact on electric reliability of the CPP, but other organizations are performing detailed transmission studies to assess reliability. Preliminary results from these studies confirm that the CPP will significantly impact the reliability of the power system.

ELECTRIC RELIABILITY HAS MANY COMPONENTS

The North American Electric Reliability Corporation (NERC) has the responsibility to develop and enforce standards for electric reliability of the bulk power system in the United States and Canada. There are more than one hundred reliability standards enforced by NERC on the electricity system,[i] which can be grouped into three essential categories:[ii]

- **ADEQUACY**. Adequacy means having sufficient resources to provide customers with a continuous supply of electricity at the proper voltage and frequency, virtually all of the time. Resources refer to a combination of electricity generating and transmission facilities that produce and deliver electricity, and demand-response programs that reduce customer demand for electricity.

- **OPERATING RELIABILITY**. The ability of the Bulk-Power System to withstand sudden disturbances, such as electrical short circuits or unanticipated loss of system elements from credible contingencies, while avoiding uncontrolled cascading blackouts or damage to equipment.

- **FUEL SECURITY**. Associated with both adequacy and operational reliability, access to reliable fuel supplies for generation must be maintained in the presence of ongoing changes to market structures, supply routes, and deliverability challenges.

HOW THE CPP IMPACTS ELECTRIC RELIABILITY

As proposed, the CPP will require major changes to the way electricity is produced and consumed. Generation from coal and oil will be reduced, while generation from natural gas and renewables will increase, as the table below shows. Each of these changes can have significant impacts on electric reliability.

Generating Capacity in 2020 under the CPP[iii]

Generating Resource	*2012 Capacity (GW)*	*2020 Capacity (GW)*	*Change (%)*
Coal	310	195	-37%
Natural Gas	369	395	7%
Renewables	77	105	36%

Retirement of more coal plants

- Retiring capacity can lead to resource adequacy shortfalls, particularly for generators located in load pockets behind transmission constraints. NERC has identified the Electric Reliability Council of Texas (ERCOT) and the Midcontinent Independent System Operator (MISO) as two regions at risk of not having adequate generating capacity over the next decade,[iv] yet EPA forecasts substantial amounts of coal retirements in each of these regions under the CPP (over 9,800MW in ERCOT and over 16,700MW in MISO).[v]

- The electric transmission system is designed for the generators that use it, and removing a large power plant at one location will impact how power flows through the rest of the system, potentially causing transmission constraints, voltage and stability issues in other parts of the grid unless necessary transmission upgrades are made.[vi]

- Coal units are particularly valuable for their ability to provide essential reliability services, such as reactive power, voltage support, and frequency stabilization.[vii] The value of many of these services is tied to the location of the power plant, making them difficult to replace by another power plant at another point on the system.[viii]

Increased generation from natural gas plants

- Fuel supply risk is a major concern associated with natural gas power plants, and can affect power system reliability when plants are needed to operate but cannot secure fuel because of pipeline-related outages or supply shortages.[ix]

- An example of the impact natural gas fuel supply risk can have on power system reliability can be seen in the Polar Vortex cold weather events in early 2014. Due to extreme cold and record power demand, natural gas demand also peaked, and many natural gas plants were unable to arrange for fuel.[x]

Increased generation from renewable energy facilities

- Wind accounts for 82 GW of the 105 GW of renewable energy projected by EPA in 2020, but provides intermittent generation that cannot be scheduled and dispatched. For this reason, wind capacity adds little to the adequacy of generating resources, with on-peak capacity contributions from wind averaging only 17% of nameplate capacity nationwide.[xi]

- Wind resources are generally unable to provide essential reliability services such as voltage support and frequency stabilization. In fact, the volatility of wind generation consumes essential reliability services from more predictable generators.[xii]

EPA'S RELIABILITY ASSESSMENT IS INADEQUATE

EPA has not performed a full assessment of the impacts its CPP proposal could have on electric reliability. The Resource Adequacy and Reliability Analysis technical support document (TSD) provided by EPA explores only one element of reliability: reserve margins. Reserve margins are a basic resource adequacy measure of how much extra electric generating capacity exists in a region, above what is needed to meet peak load forecasts. For example, if a region had 115,000 MW of electricity supply resources and a peak summer load forecast of 100,000 MW, then the region would have 15,000 MW of "reserve capacity," and a 15% reserve margin. Reserve capacity acts as insurance against either power demand that exceeds forecasts or unplanned outages occurring at power plants during peak demand periods.

EPA found that reserve margins would be lower under the CPP (by 1.9 percentage points nationally) but that each region would still meet its target reserve margin.[xiii] According to EPA, this amounts to a "demonstration that the implementation of this rule can be achieved without undermining resource adequacy or reliability."[xiv]

However, EPA *assumed* that transmission adequacy and essential reliability services would not be problems under the CPP, and that any local grid reliability concern that might arise from a power plant retirement "can be managed within the normal reliability planning and management time frames."[xv] Yet, EPA performed no analysis to determine whether this would indeed be the case. And EPA made no mention of fuel security concerns, much less dismiss them.

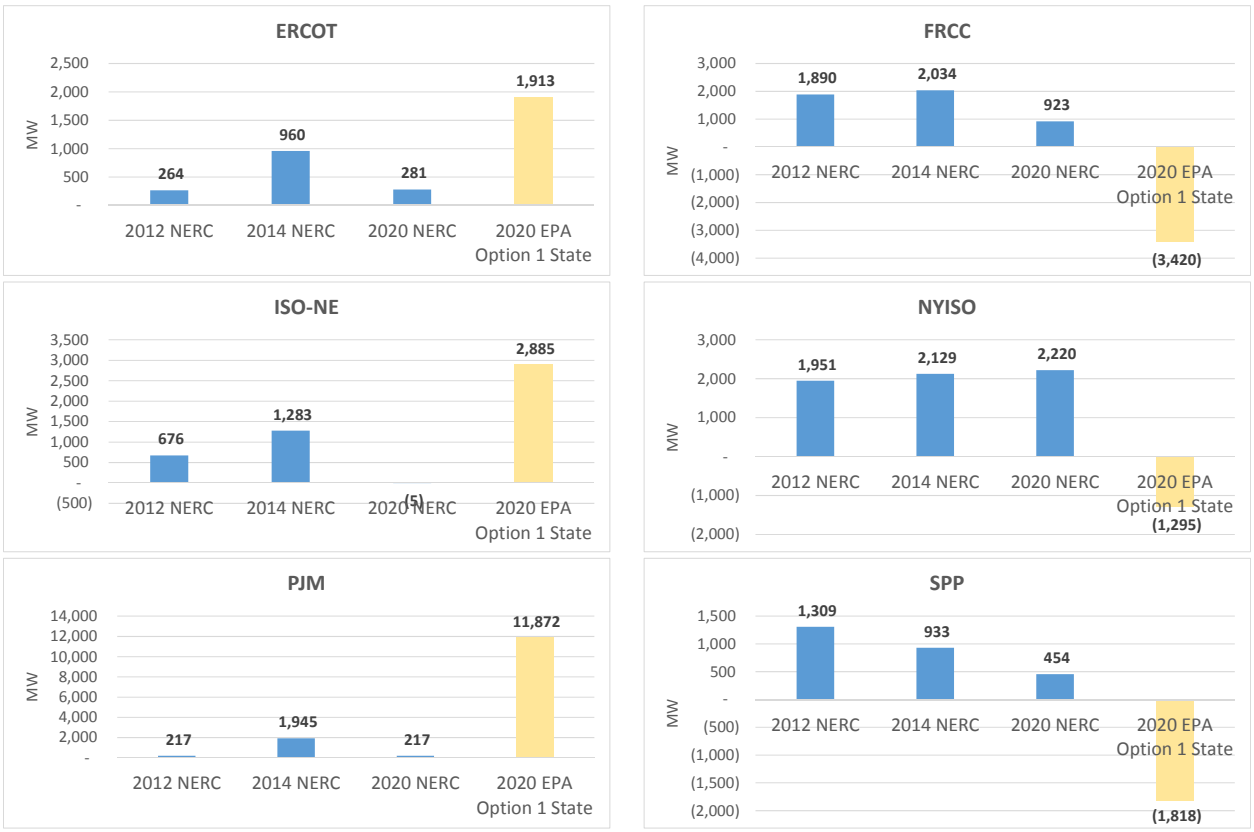
Had EPA wanted to address all aspects of reliability, it would not have been able to do so with the tool it used to assess reserve margins. Assessing whether power can be reliably delivered to customers requires a model that includes a full representation of the transmission system and the location of generators and loads on that system. Instead, EPA relied on the Integrated Planning Model (IPM), the same model it uses to calculate the costs of proposed regulations.

IPM represents the transmission system as a simplified network of interconnected regions that represent balancing authorities such as regional transmission organizations or utility control areas. Each IPM region is represented as a single point on the network, with no information about its internal transmission network or the location of generators and loads on that network. If IPM included these details, EPA could have conducted a reliability analysis that addressed the deliverability of power. Instead, "IPM assumes that adequate transmission capacity exists to deliver any resources located in, or transferred to, the region."[xvi]

With respect to the aspect of reliability EPA did address, reserve margins, EPA's conclusion that there are no concerns appears questionable. In order for each region to meet its target reserve margin, EPA's model assumes that transmission areas with a shortfall of generating capacity will arrange with generators in neighboring transmission areas to purchase excess capacity they may have available. Although such contractual arrangements have long been used by utilities and transmission authorities to ensure adequate capacity, in many cases they have never occurred at the level, or flowed in the direction, that EPA assumes will happen.

This is illustrated in the figure below, which shows historical firm capacity imports (blue) for the summer peak period in six regional transmission areas in 2012 and 2014, along with firm imports already in place for 2020 (exports to other regions are shown as negative values). Also shown are the levels of firm imports (yellow) assumed by EPA in calculating regional reserve margins for its CPP reliability assessment.

Firm Net Capacity Imports by Transmission Area [xvii]



EPA's assumptions for 2020 are large departures from the historic patterns of capacity transfers between transmission areas, and would seem implausible in a business-as-usual world. They are even more implausible under the CPP, where states are individually accountable for carbon emissions within their borders, and might find ways to discourage CO_2-emitting power plants from selling output to a different transmission area in another state.

If these capacity sales do not take place, some regions could be at risk of insufficient electricity supply. Using the PJM Interconnection region (PJM) as an example, the 11,872 MW of firm imports calculated by EPA account for nearly 7% of the 173,839 MW of capacity EPA expects in the region in 2020 under the CPP, and nearly half of the region's 15.4% reserve margin. Without these imports, not only would PJM fall below its target reserve margin (also 15.4%), it would not be able to survive events like the Polar Vortex of winter 2014, when PJM experienced record winter demand combined with a 22% forced outage rate (due in part to natural gas delivery problems).[xviii] For comparison, PJM had a 29% reserve margin heading into the Polar Vortex.[xix]

COMMENTS CONFIRM RELIABILITY CONCERNS

Numerous organizations with a responsibility to maintain reliable delivery of electricity (regional transmission organizations, grid operators, and utilities) are undertaking detailed transmission and reliability studies of the effects CPP implementation will have in their territories. Although many of these studies are still in process, some findings are already being reported.

NERC

NERC released an initial assessment of EPA's CPP proposal, and has plans for more detailed studies.[xx] NERC identified a number of electric reliability concerns raised by the CPP, including:

- The large number of fossil-fuel power plant retirements resulting from the CPP will reduce regional reserve margins.
- Significant transmission upgrades will be required, but will take 5-10 years to complete *after* they are identified in state SIPs.
- An increased reliance on natural gas generation will leave the power system more vulnerable to gas supply and transportation risks.
- Changes in the mix of supply resources (e.g., less coal and more renewables) will strain the system's ability to maintain essential reliability services.
- Higher electricity prices may lead to an increased reliance on distributed energy resources by consumers, which are not visible to or controlled by the system operators but must be backed up by system resources.

NERC recommended a delay in implementation of the CPP so that regional groups could coordinate and conduct detailed reliability assessments. They provided a list of the studies that are needed (see table below), and noted the importance of beginning such studies immediately, as "the industry does not operate the grid without a thorough and complete analysis."[xxi]

Studies and Assessments Needed for a Complete Reliability Evaluation [xxii]

Local Reliability Assessments	Area/Regional Reliability Assessments
Specific generator retirement studies	Resource adequacy
Specific generator interconnection studies	Power flow (regional)
Specific generator operating parameters	Stability and voltage security (regional)
Power flow (thermal, voltage)	Gas interdependencies; pipeline constraints
Stability and voltage security	Operating reserves and ramping
Offsite power for nuclear facilities	System restoration/blackstart

Federal Energy Regulatory Commission (FERC)

FERC is tasked with the regulation of wholesale power markets and the electric transmission system, but was not involved by EPA in the development of the CPP. In comments to EPA on the proposed rule, FERC Commissioner Philip Moeller noted his concerns about its impact on electric reliability:

> "I am concerned that the costs of the CPP could total hundreds of billions of dollars. But my primary concern relates to implications of the CPP on the reliability of the nation's electricity system. I continue to call for a more formal and transparent process involving FERC (and not just its staff) to examine these reliability implications."[xxiii]

Following testimony before the House Subcommittee on Energy and Power by EPA's Janet McCabe, Members of Congress asked FERC commissioners to respond to her assertion that FERC was included in the development of the CPP proposal.[xxiv] Each commissioner denied that FERC was meaningfully involved in EPA's proposal, and noted that EPA had not yet engaged them in its development of the final rule.[xxv]

Despite its exclusion from the development of the rule, FERC has nonetheless announced a series of technical conferences beginning in February 2015 that will address CPP reliability and cost concerns with state regulators and industry participants.[xxvi]

Southwest Power Pool (SPP)

The Southwest Power Pool (SPP) conducted a transmission system impact analysis (TSIA) to determine how system reliability would be affected by the 9,000 MW of power plant retirements EPA projects for the region under the CPP. SPP found that unless new generating capacity is built to replace retiring units, the system would be so stressed that its transmission modeling software could not find a feasible solution, "which is generally indicative of voltage collapse and blackout conditions."[xxvii]

After adding new natural gas and wind generation to their TSIA, SPP found numerous reliability issues, with overloaded transmission elements (e.g., transmission lines, transformers) across the SPP region. Even though SPP's current transmission expansion projects were included in the model, those projects were planned without knowledge of new CPP-related generator retirements. These additional retirements will change the way power flows on SPP's transmission system, and create a need for further system upgrades.

In light of these reliability concerns, SPP has asked EPA to delay the CPP by at least five years to allow new transmission and generation to be built, and to focus more attention on the reliability implications of the proposal in workshops and further analysis.[xxviii]

ERCOT

ERCOT conducted a study of the impacts the CPP would have on its system, using the analytical framework it uses for Long Term System Assessments (LTSA).[xxix] Results showed the CPP would cause the retirement of 3,300-8,700 MW of existing coal capacity in ERCOT and impact reliability in two critical ways:

1. Coal-fueled generators have particular value for reliability, and that value would be lost. According to ERCOT, "Coal resources provide essential reliability services, including reactive power and voltage support, inertial support, frequency response, and ramping capability. The retirement of coal resources will require reliability studies to determine if there are any voltage/reactive power control issues that can only be mitigated by those resources..."[xxx]

2. The CPP would increase ERCOT's reliance on intermittent renewable generators from 10% of demand in 2013 to 22% in 2029. Integrating these resources into the system "will increase the challenges of reliably operating all generating resources."[xxxi]

ERCOT also noted that consumer costs would increase by 20% in 2020 under the CPP due to higher electricity generating costs, and that increases will be even higher when the costs of new infrastructure and generating capacity are included.

American Electric Power (AEP)

AEP has also conducted preliminary reliability studies of the impact of the CPP on the utility's transmission system in the PJM region, and found "severe, widespread reliability concerns across the PJM footprint" consisting of thermal overloads on transmission elements and voltage drops that could lead to cascading outages.[xxxii] The company also noted that once the region identified the set of generating resources that will need to be retired and others that will need to be built to comply with the CPP, it will take another 5-10 years to plan and built the transmission upgrades that will be needed to ensure reliability.[xxxiii]

[i] North American Electric Reliability Corporation (NERC), *Reliability Standards for the Bulk Electric Systems of North America*, Updated October 1, 2014.

[ii] Adapted from NERC, *2013 Long-Term Reliability Assessment*, December 2013.

[iii] 2012 data are from EPA, *Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants*, June 2014, Table 2-1. 2020 data are from "Proposed Clean Power Plan_Option 1 State_ssr.xlsx" downloaded from http://www.epa.gov/airmarkets/powersectormodeling/cleanpowerplan.html.

[iv] NERC, 2013 *Long-Term Reliability Assessment*, December 2013.

[v] Data are compiled from IPM results in the file "Option 1 State - April 2014 Draft CapacityRetrofits.xlsx", from http://www.epa.gov/airmarkets/powersectormodeling/cleanpowerplan.html.

[vi] *Ibid.*

[vii] NERC Essential Reliability Task Force, *A Concept Paper on Essential Reliability Services that Characterizes Bulk Power System Reliability*, October 2014.

[viii] NERC, *2014 Summer Reliability Assessment*, May 2014.

[ix] NERC, *2013 Special Reliability Assessment: Accommodating an Increased Dependence on Natural Gas for Electric Power, Phase II*, May 2013.

[x] NERC, *Polar Vortex Review*, September 2014.

[xi] NERC, 2013 *Long-Term Reliability Assessment*, December 2013.

[xii] *Ibid.*

[xiii] EPA, *Technical Support Document (TSD) for the CAA Section 111(d) Emission Guidelines for Existing Power Plants: Resource Adequacy and Reliability Analysis*, June 2014. These results are for EPA's Option 1 proposal with state compliance. For Option 1 regional compliance, EPA found reserve margins to decrease by 1.8 percentage points nationally. Target reserve margins range from 12.6% to 19.25%.

[xiv] *Ibid.*

[xv] EPA, *Technical Support Document (TSD) for the CAA Section 111(d) Emission Guidelines for Existing Power Plants: Resource Adequacy and Reliability Analysis*, June 2014, p.5.

[xvi] EPA, *Technical Support Document (TSD) for the CAA Section 111(d) Emission Guidelines for Existing Power Plants: Resource Adequacy and Reliability Analysis*, June 2014, p.2.

[xvii] 2012 and 2014 values are from NERC, *2012 Summer Reliability Assessment*, May 2012, and NERC, *2014 Summer Reliability Assessment*, May 2014, respectively. 2020 values are from NERC, *2012 Long-Term Reliability Assessment*, November 2012, the most recent report in which NERC published capacity transactions for future time periods. 2020 EPA projections are from EPA, *Technical Support Document (TSD) for the CAA Section 111(d) Emission Guidelines for Existing Power Plants: Resource Adequacy and Reliability Analysis*, June 2014, Table A6.

[xviii] PJM, *Problem Statement on PJM Capacity Performance Definition*, August 1, 2014.

[xix] NERC, *2013 Summer Reliability Assessment*, May 2013.

[xx] NERC, *Potential Reliability Impacts of EPA's Proposed Clean Power Plan Initial Reliability Review*, November 2014.

[xxi] *Ibid.*

[xxii] *Ibid.* From Table 4.

[xxiii] Comments of FERC Commissioner Philip D. Moeller, EPA Docket ID No. EPA-HQ-OAR-2013-0602, Dec. 1, 2014.

[xxiv] Letter to Commissioners Moeller, Clark, Bay, and Honorable from Reps. Upton and Whitfield and Sen. Murkowski, December 22, 2014, http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/letters/20141222FERC.pdf.

xxv Letters to Rep. Upton, Rep. Whitfield, and Sen. Murkowski from Commissioners Clark, Bay, Honorable, and Moeller, January 12, 2015. Commissioner Honorable was not yet at FERC during development of the CPP proposal, and her responses do not address FERC's engagement by EPA before her arrival. http://energycommerce.house.gov/sites/republicans.energycommerce.house.gov/files/114/Letters/20150112FERCresponses.pdf.

[xxvi] http://www.ferc.gov/media/news-releases/2014/2014-4/12-09-14.asp#.VIiA9o05CUn.

[xxvii] Southwest Power Pool, *SPP's Reliability Impact Assessment of the EPA's Proposed Clean Power Plan*, October 8, 2014.

[xxviii] Southwest Power Pool, "SPP assesses Clean Power Plan, says more time is needed to implement," press release October 9, 2014.
[xxix] Electric Reliability Council of Texas, *ERCOT Analysis of the Impacts of the Clean Power Plan*, November 17, 2014.
[xxx] *Ibid.*
[xxxi] *Ibid.*
[xxxii] American Electric Power, *Transmission Challenges with the Clean Power Plan*, September 2014.
[xxxiii] *Ibid.*