

The Electric Grid: 2030

How EPA's Power Plant Rule Will Affect
the U.S. Transmission Grid

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Abstract

Power plants emit about thirty-seven percent of all carbon dioxide (CO₂ or carbon) emissions in the United States. In August 2015, the Environmental Protection Agency (EPA) issued a rule called the Clean Power Plan that aims to reduce national CO₂ emissions 32% below 2005 levels by the year 2030. Each state has an individualized target and EPA gives states flexibility in how to achieve those reductions. Three general categories of responses are expected: more efficient use of energy, increased use of lower- or zero-carbon energy, and market-based trading between companies and states. This paper investigates each option.

Critics claim that the rule threatens the reliability of the electric grid. Not true: EPA regulations have never caused a blackout on our nation's transmission grid and the Clean Power Plan will be no different. Weather and human error have caused blackouts, but not the EPA.

This paper closely inspects critics' true concern: that utilities will not be able to build enough low- or no-carbon power plants in time to comply with the rule. However, utilities have been able to adjust to market forces and policy changes in the past, creating precedent that they can do so again.

Those market and policy forces are already prompting new electricity infrastructure and the EPA's rule will carry that trend into the future. Contrary to critics' claims that the new rule threatens grid reliability, the rule actually gives utilities a perfect opportunity to improve the Grid and address the weaknesses that cause blackouts.

The EPA's rule is one of the most ambitious policy changes in a generation. But it does not threaten the U.S. transmission grid. And utilities, despite their apprehension, have the ability and track record to meet the new requirements.

Contents

Author’s Note: This paper is divided into two parts. Part one is a simplified primer on the U.S. electricity system and the current state of the grid. Part two provides an analysis of the EPA’s power plant rule and addresses critics’ concerns about the rule’s effect on grid reliability.

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Part One: How the Grid Works

It is hard to imagine everyday life without electricity. From cooking food; to powering all our gadgets and pumping gas at the corner station; to running the New York Stock Exchange, air traffic control, and our missile defense system: electricity is the mortar between the bricks of our society. Nothing should threaten that mortar, least of all the federal government.

The United States Environmental Protection Agency's (EPA's) Clean Power Plan (CPP), which limits carbon dioxide (CO₂ or carbon) from existing power plants,¹ is no exception. As the head of the EPA recently stated:

There is absolutely no scenario, no standard, no compliance strategy that I will accept where [electric] reliability comes into question. Period. End of statement.

Gina McCarthy, Administrator EPA.²

To understand why the CPP will not undermine the reliability of our electric system, one must first understand how electricity is manufactured and transmitted. While some see it as “magic”, electricity is just like any other commodity: it is manufactured somewhere and then transported to the location where it will be used.

Manufacturing of Electricity

When the power of electricity was first harnessed in the late 1800's, electricity was manufactured at power plants nearby its users. With time, power plants grew larger and moved away from population centers.³

In the first eighty years of the electric industry, policymakers wanted utilities to build, build, build. To meet demand, utilities simply predicted how much electricity their customers needed on the hottest day of the year and built large centralized power plants to meet those needs plus a bit more in case they guessed wrong or a plant unexpectedly went offline. Whatever the customers' appetite for electricity, the utilities filled it through building new power plants.

Times have changed. Policymakers now want utilities to focus on efficient electricity service. Rather than simply taking the customers' appetite for electricity as a given, customers are encouraged, educated and in some cases incentivized to use electricity more efficiently and to shift some of their usage to non-peak periods. (By shifting the demand for electricity away from peak periods, utilities can avoid building some of the power plants, or transmission and distribution (T&D) systems that are only needed during those peak periods.) Indeed, significant reductions in electricity usage have been achieved through changing customers' behavior. Utilities must still ensure their customers have sufficient electricity. But that no longer means just building power plants.

Transporting Electricity

Electricity has its own transportation system called the extra high-voltage transmission grid, which will be referred to as “the Grid” in this report. Early in the industry, when utilities built their own large power plants, they also built the highways (transmission lines) necessary to transport electricity to their own customers. The entire nation was essentially comprised of transmission fiefdoms, where each utility took care of its own customers and not its neighbors.

That began to change in earnest in 1978 with a new law allowing outside parties to install power plants anywhere. In response, non-utilities built new plants and sold electricity in the market. This began to break down the fiefdoms.

Then in 1992, Congress mandated that transmission owners provide open access on the Grid. Utilities could buy electricity from far away and transport it to their customers through other utilities' service territories. As a result, generation service became more competitive, the Grid became more interconnected over a larger area, and utilities became more dependent on that interconnection. The degree of interconnectedness is highlighted by blackouts, such as when a seemingly benign occurrence—trees touching transmission lines in Ohio—initiated a cascading blackout over eight states and two Canadian provinces. This is a demonstration of the Grid's unreliability.

A reliable Grid means that there are sufficient highways (transmission lines) to provide safe and timely transport of the commodity (electricity) from the manufacturing facility (the power plant) to the consumer (electricity customer). It's that simple. Using this highway analogy, the reliability of the transport system is measured by the following:

- (1) The size of the highways (the number of lanes to accommodate the expected traffic on a peak day with an extra margin for safety);
- (2) The location of the highways and on- and off-ramps (they must be located to move the commodity from the plant to the consumer);
- (3) The quality of the highway to ensure safe and timely passage of the commodity; and
- (4) Sufficient redundancy within the highway system to ensure that even if one bad thing happens between the manufacturing plant and the consumer—such as an accident closing all lanes of traffic—that the commodity can be re-routed onto another highway and delivered in a safe and timely manner.

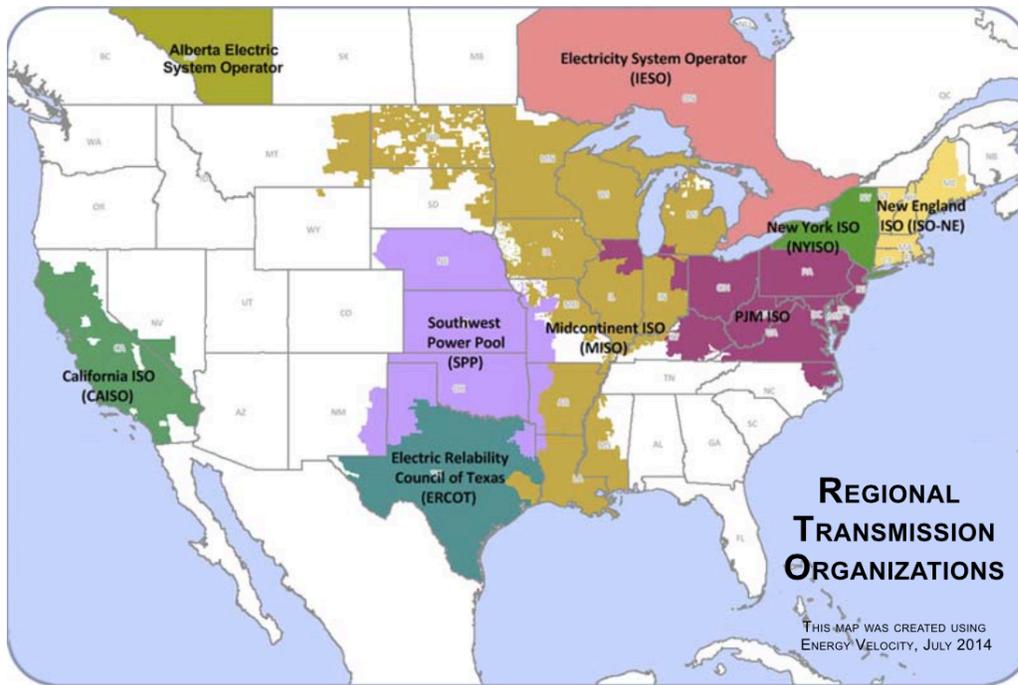
Of course, a reliable transport system is useless unless you have a commodity to transport. Some critics of the CPP claim that the rule will jeopardize the “reliability of the Grid.” As will be explained later, those critics are not actually concerned about Grid reliability *per se*, but about whether the U.S. will have sufficient electricity to transport over the Grid. Their concerns are mostly focused on generation supply, which is called “resource adequacy.” Using our highway analogy, having sufficient resource adequacy means that we have an adequate supply of the commodity to meet consumer demand.

The Grid is one component of an overall electric system that depends on a delicate, time-sensitive balancing of supply and demand. When a customer turns on their clothes dryer, they create a small amount of demand that must be instantly met by their utility. If enough dryers are used simultaneously, a lot of demand is created and utilities must meet it within seconds.

The inverse is also true. If power plants put too much electricity onto the Grid and it is not consumed immediately, the balance is upset. This balance becomes less time-sensitive as more electricity storage is built. But for now, the entity operating the Grid is responsible for ensuring this intricate, real-time balance between supply and demand.

To coordinate Grid operations, the Federal Energy Regulatory Commission (FERC)—the federal agency responsible for the reliability of the Grid—encourages utilities to create regional transmission operators (RTOs) or Independent System Operators (ISOs). RTOs and ISOs operate the Grid over a larger area than a single utility's service territory.

As shown below, the U.S. has four RTOs and three ISOs.



Source: FERC⁴

In areas not covered by an RTO or ISO, individual utilities continue to operate the Grid and are supposed to coordinate with its neighboring operators. As discussed below, that coordination is sometimes lacking.⁵

In addition to “balancing” consumers’ demand and power generators’ supply within their territory, Grid operators are also responsible for ensuring there is not too much traffic on a specific line such that the line is overloaded, and for re-routing traffic when a line is overloaded or goes down.

Reliability and Vulnerability of the U.S. Transmission Grid

A “reliable” Grid must be able to keep the lights on even when one bad thing happens. But as history demonstrates, the U.S. Grid sometimes cannot accommodate even a single unexpected event:

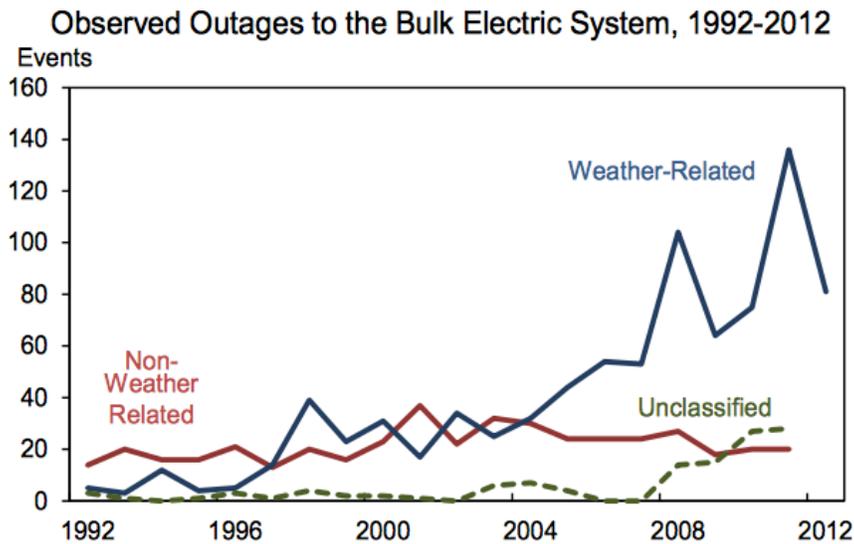
- On August 14, 2003, a utility worker accidentally caused a power plant to go offline, which set the stage for a blackout.⁶ Shortly thereafter, trees in Ohio hit three power lines causing all three lines to fail. Between these two events, the utility lost situational awareness of its Grid, meaning they lacked awareness of what was actually happening versus what they expected to happen, and how the events would play out across the larger Grid. It took just 114 minutes for the Grid over Ohio, Michigan, New York, Pennsylvania, New Jersey, Connecticut, Massachusetts, Vermont, and the Canadian provinces of Ontario and Quebec to fail, leaving approximately 50 million customers without power. There were at least two other causes of this blackout: the utility that started the event did not understand its own Grid and was not operating it correctly; and the multi-state reliability organizations failed to provide real-time diagnostics to Grid operators.⁷

- On September 8, 2011, a utility worker at an Arizona substation made a minor human error.⁸ Within 11 minutes, parts of Arizona, California and Mexico lost power ultimately affecting approximately 2.7 million people. Of course, human errors occur all the time, but one error should not cause local problems, let alone a domino effect of failures in two countries. In the end, the investigation into the 2011 blackout showed multiple causes including Grid operators focusing only on their own service territory and lacking real-time situational awareness of the larger Grid. These findings were especially startling since they were the same problems identified eight years earlier in the 2003 blackout.

Although the electric industry learned a great deal from these two blackouts, new challenges are emerging: extreme weather, aging assets, physical and cyber threats, and the need to expand the Grid.⁹

Extreme Weather

The largest threat to Grid reliability comes from extreme weather. The U.S. Department of Energy (DOE) reports that weather-related outages have increased significantly since 1992 and that 58% of the electricity outages observed since 2002 were caused by extreme weather.¹⁰



Source: Energy Information Administration

Extreme weather threatens not only the Grid, but also power plants themselves through increasing droughts. Plants like the Hoover Dam, which are powered by surface water, are directly impacted by droughts. Many carbon-emitting power plants are also impacted because they require a cooling water supply and, without sufficient cooling water, they must shut down.

The irony of extreme weather threatening high-carbon power plants should not be lost. American power plants are a large contributor to the carbon emissions fueling increasingly extreme weather, meaning the plants are threatened by the very problem they helped to create and sustain.

Aging Assets

The Grid is the largest machine designed by humankind. It is a patchwork of technologies, some new but many old. In *Failure to Act, the Economic Impact of Current Investment Trends in Electricity Infrastructure*, the American Society of Civil Engineers dates the Grid's infrastructure:

“Nationally, 70% of transmission lines and power transformers are 25 years or older, while 60% of circuit breakers are more than 30 years old.”¹¹

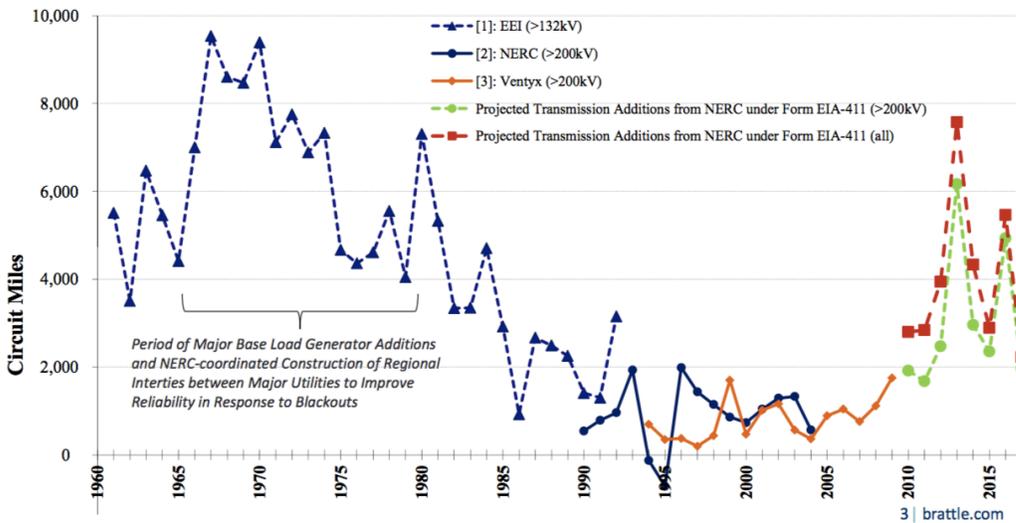
Older technology contributes to the number and length of weather-related outages, e.g. older equipment is more prone to failure under stress. Also, a lack of updated, automated sensors in some areas makes it difficult for operators to identify where equipment has failed, thereby slowing down repairs.¹²

As the age of the Grid’s assets increases, so do the outages.¹³ When compared with other developed nations, the U.S. has the highest average annual outage time per customer.¹⁴ This poor performance is attributed, in part, to the age of our Grid.¹⁵

While the current development rate for new transmission is increasing, it lags behind the rates between 1960 and 1980¹⁶, as the following graph shows.

Historical Circuit-Mile Additions Document Aging Grid

- Most of the existing grid was built 30-50+ years ago
- Even relatively high recent and projected circuit miles additions are below levels of additions in 1960s and 1970s



Source: The Brattle Group, Johannes Pfeifenberger, Judy Chang and John Tsoukalis, at TransForum East 12/2/2014.

The U.S. needs to update its transmission system, with or without the encouragement of the CPP.

Physical and Cyber Threats

The number of physical and cyber attacks on our nation’s Grid is increasing precipitously.¹⁷ While such attacks are not new, they are becoming more sophisticated.¹⁸

In 2013, a substation in California was attacked by people who are still at large. The attackers cut the fiber optic cables and fired upon the 17 transformers located at the substation. One of the many vulnerabilities of our Grid is the lack of spare transformers and the time it takes to manufacture and receive replacement transformers.¹⁹ It can take years to obtain a new tailor-made large transformer.²⁰

Perhaps more significantly, those who want to do harm to our Grid no longer need to be located on our shores. Our Grid receives cyber attacks on a regular basis. In 2007, the Idaho National Laboratory demonstrated that a cyber attack could destroy a generating facility.

To date, there have been no public reports of large-scale problems from cyber attacks on our electric infrastructure. But, enemies of the U.S. have that capability. Admiral Michael Rogers, Commander, U.S. Cyber Command and Director of the National Security Agency told Congress last year:

“[There isn’t] any doubt in our minds that there are nation-states and groups out there that have the capability....to enter our systems.... to tell power turbines to go offline and stop generating power....We see them attempting to steal information on how our systems are configured, the very specific schematics of most of our control systems, down to engineering level of detail so they can look at where the vulnerabilities, how are they constructed, how could I get in and defeat them?”²¹

Based on a leaked FERC report, the Wall Street Journal revealed:

“[T]he U.S. could suffer a coast-to-coast blackout if saboteurs knocked out just nine of the country’s 55,000 electric-transmission substations on a scorching summer day.”²²

Some experts believe it’s not “if”, but “when” a cyber attack will successfully cause a significant problem on our Grid.

Grid Expansion Needs

The mix of power plants within a specific geographic footprint—such as a utility’s service territory, an RTO region, or the entire nation—is called the “generation portfolio” for that area. Over the last decade, three waves of new power plants have changed our nation’s generation portfolio. As explained earlier, transmission lines are essentially the highway system that transports electricity from large power plants to consumers. When the locations of those plants change, new transmission highways may be required to accommodate those new plant locations. Therefore, when the nation’s generation portfolio changes, there is a need to expand the Grid.

The first wave started around 2000 when states began to require or encourage their utilities to generate a certain portion of their electricity from renewable fuels, such as the wind or sun. Today, 38 states have such laws or voluntary goals.²³ In these states, utilities continue to build large arrays of renewable power plants (called “utility-scale renewables”). These new plants sometimes require the building of new transmission to deliver that electricity to customers.

The second wave—a tsunami of new natural gas plants—was driven purely by economics. This wave started when independent power producers saw a business opportunity in deregulated energy markets. Then in 2007, through a newly refined technique called “fracking”, the U.S. began extracting vast quantities of natural gas at a very low cost.²⁴ Faced with a seemingly endless supply of cheap natural gas, the utilities were quick to build new natural gas power plants. The results were remarkable: between 2000 and 2010, nearly 237 gigawatts (GW) of new natural gas generating capacity was added,²⁵ the equivalent of the peak power that could be generated by 120 Hoover Dams.

The portfolio changes in this second wave also included retirement of old plants. At the precise moment that natural gas prices were declining, electricity demand also decreased. The economic downturn and

increased energy efficiency meant less demand. The double whammy of new gas plants and the need for less electricity forced the retirement of many of the older, costlier, and inefficient power plants, which were often fueled by coal.²⁶

In addition to the economic pressures of cheap natural gas and lower demand, operators of older, inefficient plants now face additional pressure from the mercury and air toxics standard (MATS), which ushered in the third wave of change. MATS, which took effect in April 2015,²⁷ limits mercury and other harmful air pollution from power plants. Plants that were already on the economic edge are now retiring because it is too costly to install the equipment needed to control toxic emissions, leaving the newer, cleaner plants running.²⁸

These three waves collectively resulted in a dramatic change to our nation's generation portfolio. In response, utilities have had to build new transmission to accommodate this changing portfolio.

Part One Summary

Today's electric Grid faces many serious challenges that have required and will continue to require significant investments in new infrastructure. The Grid's age and vulnerability to extreme weather are the primary threats to current reliability and the Clean Power Plan gives utilities an opportunity to address these vulnerabilities as they make other decisions to comply with the EPA's regulations. Utilities have shown time and time again that they can respond to challenges, and indeed they are doing so today.

Part Two: The EPA's Clean Power Plan

Under the final CPP, which was released in August 2015, the EPA specifies how much CO₂ may be emitted from existing power plants in each state. In response to the draft rule, some parties claimed that the CPP would threaten the reliability of the Grid and we expect the same charges will be levied against the final rule. We have heard those assertions before; indeed, we hear it every time the EPA issues a new rule affecting the electric industry.²⁹

It is important for us to evaluate and understand the potential impacts of the EPA's rule on the Grid. But, the ugly truth is that many of these attacks on EPA are politically based or come from narrow economic interests seeking to preserve their share of the electricity market.³⁰ So far, no EPA rule has ever caused a blackout on our Grid. The weather and Grid operators have caused blackouts; the EPA has not. The question is: Will this specific EPA rule be different from all of the others and cause a reliability problem? Our nation deserves an honest answer to that question, not political theatre.

CPP Requirements and Tools for Compliance

In the CPP, the EPA requires states to reduce their statewide emissions of CO₂. States have the flexibility to reduce CO₂ through the mechanism(s) of their choice. Along with creating incentives to use electricity more efficiently, the rule will force additional changes in our nation's generation portfolio: carbon-free or low-carbon power plants will be favored over high-carbon emitters. When facing a large-scale change in the generation portfolio, two questions are key:

- Will there be enough power plants to meet the needs of consumers (resource adequacy)?

- Will the Grid be able to reliably convey the electricity from those new power plants to consumers (Grid reliability)?³¹

To answer these questions, we need to know how quickly the generation portfolio must change. The rule requires compliance by 2030, a 15-year period. The rule also has an interim period (2022-2029) that is separated into three steps—each having its own interim goal—with flexibility for states to set their own “glide path” to the 2030 final target.

Claims about the threat to Grid reliability are mostly based on a timing issue: will there be enough time to build new infrastructure? More specifically, most of this criticism focuses on building new generation, i.e. the resource adequacy issue. It is noteworthy that most critics are not claiming the CPP is undoable, they are only arguing that more time is required to simultaneously comply with the CPP and maintain resource adequacy.³² But the following four subsections belie those claims.

Critical Power Plants Need Not Retire

The CPP does not require any specific power plant to be retired.³³ So if a high carbon plant is either critically located or needed for resource adequacy, then the state can develop a plan to ensure that the Critical Plant remains operational.

Unlike other pollutants, the climate impacts of eliminating a ton of CO₂ at one power plant (in State A) is the same as eliminating a ton at another power plant (in State B). So, the two states may work together to collectively comply with the new rule by having a plant in State A decrease its CO₂ emissions further and allow the plant in State B to operate (and emit) more. Indeed, the rule facilitates this type of collaboration by explicitly allowing states to opt into an emission rate credit (ERC) or allowance trading market. In addition, even without formal state collaboration agreements, the CPP lets states adopt “trading-ready” approaches that give affected power plants the ability to trade across state lines.

The same trading principle also applies to power plants within a state or within a utility: a state or utility can decrease the CO₂ emissions by other means (e.g. energy efficiency) to allow the Critical Plant to remain operational. For example, energy efficiency savings or zero-emitting generation could replace some high-emitting power plants, which would allow other Critical Plants to remain online longer. A state plan could also enable companies to purchase carbon allowances or credits to allow the Critical Plant to remain operational.

Because Critical Plants can remain operational by offsetting excess emissions elsewhere, the states will have sufficient time to build new infrastructure while maintaining resource adequacy.

Sufficient Natural Gas Plants Can Be Built by 2030

Many expect the CPP to prompt replacement of coal plants with lower-carbon natural gas power plants. Can enough natural gas plants and pipelines as well as attendant electric transmission be built in time? If history is any indication, the answer is a resounding “Yes”. With the recent natural gas boom, industry has demonstrated just how quickly they can build power plants and the pipelines to fuel them. Over a ten-year period beginning in 2000, nearly 237 GW of natural gas plants were built.³⁴

When it issued the final rule, the EPA also released estimates on how many new GW of

natural gas plants would be required under two “illustrative scenarios”:

	2020	2025	2030
GW Required under Rate-Based Compliance Scenario	7.1	7.1	13.9
GW Required under Mass-Based Compliance Scenario	9.3	13.6	27.2

SOURCE: Table 3-13, Regulatory Impact Analysis for the Clean Power Plan Final Rule.³⁵

EPA estimates at most 13.6 GW of new natural gas plants would be required in the next 10 years (by 2025) — and industry has already proven it can build a whopping 237 GW in that same time frame! Applying that build rate to 2030, industry could build 355 GW of new natural gas plants by 2030. Industry should have no problems building the new natural gas plants needed for the three interim goals and for the final target in 2030.³⁶

In calculating how much new natural gas generation would be required, EPA assumed a significant uptick in energy efficiency efforts between now and 2030. While stakeholders may debate how much energy efficiency is achievable by 2030, they are missing the overall message: industry has proven that it can build over 13 times the amount of natural gas plants to meet the three interim and final goals, which will maintain resource adequacy.

Natural gas plants aren’t the only things that must be built: pipelines are also needed to feed those plants. EPA states:

“In both the rate-based and mass-based [illustrative] scenarios, pipeline capacity construction through 2020 is projected to increase by less than two percent beyond base case projections. By 2030, however, the total cumulative pipeline capacity construction built is projected to decrease compared to the base case.”³⁷

Also, DOE recently estimated that even a heavy demand³⁸ for new natural gas could be met by adding the equivalent of about one third of the pipeline capacity built over the last 15 years.³⁹ Given how quickly industry can build them, we can safely conclude that sufficient natural gas pipelines can be built to comply with the final CPP.

Natural gas power plants, which emit less carbon than coal plants, can be built at or near the location of retiring plants.⁴⁰ Because the new power plants can rely on the existing transmission lines of the retiring plant, few to no changes in the Grid should be required to accommodate them. If they are not built on an existing plant site, natural gas plants can be built close to population centers; consequently, the need for new transmission lines can be minimized. Even if long, multi-state transmission lines are required, as discussed in the next section, states would have sufficient time to build any necessary transmission for new natural gas power plants if the states act promptly and responsibly.

In sum, the electric industry has already proven it can build the amount of new natural gas generation necessary to comply with the CPP’s interim goals and the final goal in 2030.

Sufficient Renewables and Any Attendant Transmission Can be Built by 2030

History also demonstrates that utilities can build enough renewables to comply with the CPP. Under its two “illustrative scenarios”, EPA estimates needing between 81 and 84 GW of new non-hydroelectric renewables⁴¹ by 2030:

	2020	2025	2030
GW Required under Rate-Based Compliance Scenario	36	47	84
GW Required under Mass-Based Compliance Scenario	32	44	81

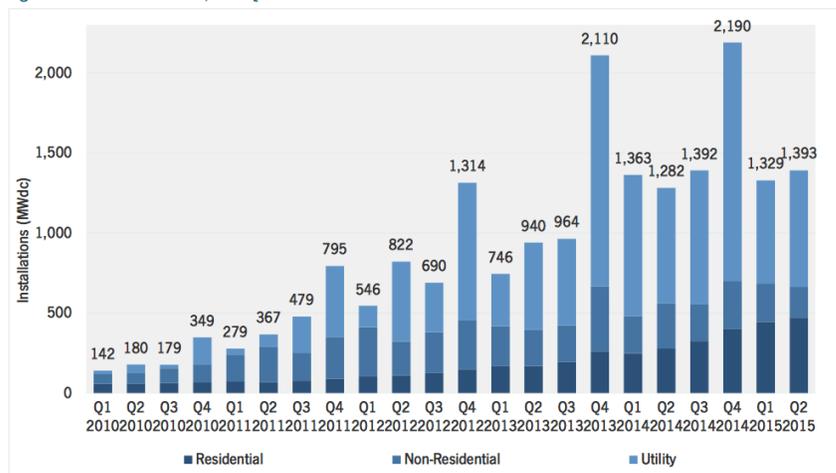
SOURCE: Rate-Based and Mass-Based SSR documents from the EPA’s IPM run files.⁴²

In one year (2014), almost 7 GW of solar⁴³ and 4.9 GW of wind⁴⁴ was installed, totaling nearly 12 GW of renewables. If that same rate is applied over the next five, ten and 15 years, the U.S. would add 60 GW by 2020, 119 GW by 2025 and 179 GW of new solar and wind generation by 2030. In other words, industry has already demonstrated it can build nearly twice as much solar and wind as EPA estimates would be needed to comply with the three interim goals and the final goal in 2030.⁴⁵

New electric transmission lines will be needed for some, but not all utility-scale renewables. Unlike natural gas, which can be transported to any location in the U.S., most renewable fuels cannot be transported. Accordingly, utility-scale renewables are located where the renewable fuels are found, e.g. where the sun shines strongly and the wind blows hard. Since the sun shines strongly in many areas, utility-scale solar arrays can be built close to population centers thereby minimizing the amount of new transmission required.

The growth in utility-scale solar generation has jumped in the last five years. The following provides information on new photovoltaic solar from 2010 to 2015.

Figure 1.1 U.S. PV Installations, 2010-Q2 2015



Source: “GTM Research/SEIA U.S. Solar Market Insight®⁴⁶

The above graph also demonstrates the rise of rooftop solar (residential and non-residential), which requires no transmission and has the effect of reducing load on the existing Grid.

In contrast to solar, utility-scale wind plants are often placed far away from population centers and require long-transmission lines to transport their electricity to consumers. For example, the Great Plains is called the “Saudi Arabia for wind.” But the Great Plains is not population-dense so transmission lines must be built eastward or westward to where consumers live. While the design and construction of long-distance transmission lines only takes a few years, obtaining permission to construct those lines can take between six and ten years.⁴⁷ There are a number of lines that are currently being developed, which will assist in meeting the CPP’s early interim goals. Moreover, if states begin planning right now for new multi-state transmission lines—even with the current pace for permitting—those states should be able build those lines needed for new generation to meet the CPP’s later interim and final goals.

Sufficient renewables can be built to comply with the CPP’s goals. However, dramatically increasing the percentage of renewables may create a challenge at the localized level, because some renewables generate electricity intermittently, e.g. when the sun shines and the wind blows. Utilities are overcoming this challenge through a number of mechanisms including, but not limited to, obtaining their renewable energy from geographically diverse areas, forecasting when renewables will generate electricity, as well as installing electricity storage and power controls. For example, 40.7 MW of electricity storage was installed in the 2nd quarter of 2015, which is a 600% increase over the 1st quarter of 2015 and a 900% increase over the 2nd quarter of 2014.⁴⁸

Energy Efficiency and Peak-Use Reductions will Diminish the Need for New Power Plants

Simply building new lower-carbon and carbon-free generation and transmission is not the only way to comply with the CPP. States could use the following methods to reduce the number of new power plants required, which would have the added benefit of saving costs for consumers:

- New energy-efficient products like appliances are enabling customers to easily save electricity. Less electricity demand means fewer new plants are needed;
- New technologies like timers for dishwashers and clothes dryers are making it easier for customers to shift their electricity use to non-peak times. By decreasing peak usage, fewer new plants would be needed to accommodate peak usage;
- Increasing the efficiency of our existing power plants; and
- New technologies like voltage and var optimization that increase the efficiency of the T&D system. Our current Grid loses approximately 6% of its commodity in transport from the power plant to the consumer.⁴⁹ As a consequence, utilities must overbuild power plants to compensate for this lost electricity. New and emerging technologies are able to reduce these losses in transport, thereby eliminating the need to overbuild power plants. For example, dynamic line-rating technology can increase the operating capacity of transmission lines over 25%⁵⁰ and the use of direct current (DC) transmission lines can lower line losses by 25%.⁵¹

In short, CPP allows 15 years for compliance. Based on historical performance, states and utilities have time to comply.

Assurance Mechanisms for Grid Reliability under the CPP

Given the importance of electricity, if the unexpected happens—that is, compliance with the CPP actually threatens Grid reliability or resource adequacy—the federal government must have mechanisms in place to discharge that threat. The CPP includes such a mechanism.

As explained above, the threat would come if a Critical Plant or Plants were forced not to run to prevent that specific plant or a state from exceeding its CO₂ emissions limit. The simplest way to avoid this problem is to keep the Critical Plant(s) running until the reliability threat is solved. There are numerous mechanisms to ensure the CPP will not cause a reliability emergency.

First and most importantly, the CPP includes a “reliability safety valve” that, in the wake of an unanticipated event or other extraordinary circumstance, a Critical Power Plant could continue to run if needed for reliability purposes. Under the CPP, each state is required to submit an implementation plan to the EPA (called a state plan).⁵² Once the safety valve is triggered, any exceedances from a Critical Power Plant would not be counted against the state’s overall goal or rate for the first 90 days. After this initial 90-day period, if the reliability emergency remains, then the state must revise its state plan to accommodate the changes needed to respond to any ongoing reliability requirements.

But states and utilities should not have to rely on that safety valve because the CPP provides sufficient flexibility to avoid reliability problems in the first place. The state could establish a mechanism by which any single power plant (e.g. a Critical Plant) may remain operational by reducing emissions at other plants either within the same state or another state.

Also, the CPP requires states to demonstrate that they have considered reliability issues in developing their state plans. If an unanticipated or significant reliability challenge arises, a state may seek a revision to its plan.

In addition to the assurance mechanisms built into the CPP, the state or Critical Plant owner could negotiate a consent agreement with the EPA over its non-compliance with the CPP. The EPA Administrator has committed to ensuring the Grid remains reliable through the implementation of the CPP. Under a consent agreement, the EPA and the state or plant owner would negotiate the terms under which the Critical Plant(s) would continue to run until a new plant(s) becomes operational.

Though controversial due to their complexity, the federal government has two other means to address reliability emergencies:

- The state may petition the U.S. DOE under Section 202(c) of the Federal Power Act⁵³ to allow the plant to remain operational if needed for Grid reliability or resource adequacy. DOE has issued six orders under section 202(c) mandating that specified power plants or transmission lines operate to maintain Grid reliability and/or resource adequacy.⁵⁴
- The state could also seek reprieve from FERC. Section 207⁵⁵ of the Federal Power Act provides FERC with the authority to order public utilities to furnish electricity service if it finds that a utility is providing “inadequate or insufficient” interstate service.”⁵⁶

In sum, if Grid reliability or resource adequacy is threatened because new generation and transmission cannot be built in time for compliance, Critical Plants can continue to run through a number of assurance mechanisms. (Indeed, suggesting that EPA would force a blackout in its enforcement of the CPP is political theatre.) Put simply, the CPP will not jeopardize our nation’s electricity supply or Grid.

Conclusion

Power plants emit about 37% of all CO₂ emissions in the United States. EPA's 2015 Clean Power Plan (CPP) aims, by 2030, to reduce national CO₂ emissions by 32% from 2005 levels. Each state has an individualized target and the path to meeting those targets is up to each state. There will be three primary types of actions that states will likely take:

- (1) States could replace their high-carbon plants with new, cleaner ones and they may improve the efficiency of existing plants that emit low or no CO₂. New power plants are expected to be fueled mostly by natural gas or renewable energy. States may also switch how they operate their existing plants, namely to operate their low-emitting plants more often than high-emitting plants;
- (2) States could allow their utilities to work with other utilities either within their state or in other states. For example, if Utility A has lower CO₂ emissions than are required by the CPP, Utility A could sell ERCs or emission allowances to Utility B, which would allow Utility B to continue to operate its Critical Plants even if they are exceeding a CO₂ emissions limit; and
- (3) States could also reduce consumers' use of electricity through any number of efficiency mechanisms, e.g. reducing customers' demand for electricity through such things as more efficient appliances.

Everyone agrees that the type, location and operation of electric power plants will change as a result of the CPP. This change can and will be accomplished without threatening Grid reliability. So far, no EPA rule has caused reliability problems on our Grid.

Our utilities have time and time again demonstrated that they can respond to changes in market conditions and public policy. When recently speaking about the changing the electric industry, an Edison Electric Industry (EEI) executive said:

"The industry is alive and well; we're a resilient industry; we've always been able to adapt to change and in fact even lead change."⁵⁷

Although critics claim we will not be able to build enough new power plants in the time provided by the EPA, history suggests otherwise. States can meet the CPP's interim and final goals if they act promptly and responsibly.

Given the importance of electricity to our nation, no one wants to threaten the reliability of the Grid. Even if the unexpected happens and a state is faced with choosing to violate the CPP or undermine Grid reliability, the Grid will not go dark.⁵⁸ Under the CPP and other federal laws, there are numerous ways that a state could exceed its CO₂ target and not be penalized by the EPA: obtain offsets from another plant, invoke the CPP's reliability safety valve, request a revision to the state plan, negotiate a consent agreement with EPA or apply for reprieve under either sections 202(c) or 207 of the Federal Power Act.

Electricity generation in the U.S. has been transforming since about the year 2000 in response to changing market conditions and public policy. The CPP will carry that transformation into the future. With the building of this new infrastructure, we have the opportunity to build a newer and better Grid that is powered by cleaner generation.

About the Author

Lauren Azar is a leading consultant and legal advisor to the electric industry. Since 1994, she has participated in the industry from the federal, state and local levels:

- Azar was a Senior Advisor to the Secretary of the DOE from 2011-2013, focusing on the Grid, including Grid reliability, and on the institutional barriers in the electric industry. She also co- led the negotiations over nine federal agencies to overhaul the federal evaluation of electric transmission.
- Azar was a Commissioner at the Public Service Commission of Wisconsin from 2007-2011 regulating public and municipal utilities. She also organized and led states and Canadian provinces east of the Rockies through transmission planning in the Eastern Transmission Interconnection. As President of the Organization of MISO states, Azar also initiated and chaired the planning and cost allocation for developing a suite of transmission lines over 13 states and one Canadian province.
- Prior to her public service, Azar worked in the private sector as a lawyer representing utilities (electric) and utility customers (water).

Azar is respected by the White House administration, state and federal regulators, CEOs of utilities, industry financiers, and tech companies that are bringing new products to market. Learn more at AzarConsultingLLC.com.

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Endnotes

¹ The Clean Power Plan (CPP) limits emissions from existing power plants. At the same time as issuing the CPP, EPA also issued a final rule regulating emissions from new power plants. This report addresses the CPP only. The CPP is available at <http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants>. The rule regulating new power plants is available at <http://www2.epa.gov/cleanpowerplan/carbon-pollution-standards-new-modified-and-reconstructed-power-plants>

² Edward Klump, Nathaniel Gronewold and Mike Lee, Energywire, *EPA's McCarthy tells industry to ignore "doomsday" talk, focus on innovation*, April 24, 2015, available at <http://www.eenews.net/energywire/stories/1060017378/print> (subscription required).

³ Today, in some parts of the United States, the reverse is happening: technology and economics are driving the manufacturing process back towards the customers. Indeed, in some regions, customers are generating their own electricity primarily through rooftop solar panels.

⁴ FERC, Regional Transmission Organizations (RTO)/Independent System Operators (ISO), available at <http://www.ferc.gov/industries/electric/indus-act/rto.asp>

⁵ Reliability standards for the Grid were first established in response to a 1965 blackout in the northeast that left 30 million people without power. Facing the threat of regulation, utilities agreed to create an organization called the National Electric Reliability Council (NERC) that established voluntary reliability standards. Another blackout in 2003 prompted Congress to make Grid reliability standards mandatory. Congress also required FERC to select an "electric reliability organization" that would create those standards. FERC selected NERC to be that organization.

⁶ NERC, *Technical Analysis of the August 14, 2003, Blackout: What Happened, Why, and What Did We Learn?*, July 13, 2004, pages 27-28, available at http://www.nerc.com/docs/docs/blackout/NERC_Final_Blackout_Report_07_13_04.pdf

⁷ DOE and the Canadian Ministry of Natural Resources, *The Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations*, April 2004, pages 18-19, available at <http://energy.gov/oe/downloads/blackout-2003-final-report-august-14-2003-blackout-united-states-and-canada-causes-and>

⁸ FERC, *Arizona-Southern California Outages on September 8, 2011*, April 2012, available at <http://www.ferc.gov/legal/staff-reports/04-27-2012-ferc-nerc-report.pdf>

⁹ See annual compilations of the causes of electricity emergencies and disturbances at https://www.oe.netl.doe.gov/OE417_annual_summary.aspx

¹⁰ Executive Office of the President, *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, August, 2013, p. 8, available at http://energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf

¹¹ ASCE, *Failure to Act: the Economic Impact of Current Investment Trends in Electricity*, 2011, p. 19, available at http://www.asce.org/uploadedFiles/Issues_and_Advocacy/Our_Initiatives/Infrastructure/Content_Pieces/failure-to-act-electricity-report.pdf

¹² *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, p. 7.

¹³ Congressional Research Service, *Weather-related Power Outages and Electric Resiliency*, August 28, 2012, pages 5-6, available at <http://www.fas.org/sgp/crs/misc/R42696.pdf>

¹⁴ *Id.*

¹⁵ *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, p. 7; DOE, *Hardening and Resiliency: U.S. Energy Industry Response to Recent Hurricane Seasons*, August 2010, p. 6, available at

<http://energy.gov/sites/prod/files/Enery%20Industry%20Response%20to%20Recent%20Hurricane%20Seasons%20-%20August%202010.pdf>

¹⁶ *Economic Benefits of Increasing Electric Grid Resilience to Weather Outages*, p. 7.

¹⁷ DOE, Electric Disturbance Events (OE-417) Annual Summaries, available at https://www.oe.netl.doe.gov/OE417_annual_summary.aspx

¹⁸ Physical attacks on substations are becoming more elaborate. In March 2015, intruders removed the supervisory control and data acquisition (SCADA) equipment, powered down the remote terminal unit, and dealt "extensive" damage to the communications and alarm system" to another California substation. The actions essentially "blinded the utility" to what was happening. SNL, *Experts Warn Utilities to Watch for Cyberattacks via Substations Break-Ins*, June 8, 2015, available at <https://www.snl.com/InteractiveX/Article.aspx?cid=A-32908752-9781>

¹⁹ *Quadrennial Energy Review: Energy, Transmission, Storage and Distribution, Infrastructure (QER)*, April 2015, p. 2-2, available at http://energy.gov/sites/prod/files/2015/05/f22/QER%20Full%20Report_0.pdf

²⁰ *Id.*, p. 2-11.

²¹ Admiral Michael Rogers testimony before the House (Select) Intelligence Commission, Cybersecurity Threats: The Way Forward, November 20, 2014, available at https://www.nsa.gov/public_info/_files/speeches_testimonies/ADM.ROGERS.Hill.20.Nov.pdf

²² Wall Street Journal, *U.S. Risks National Blackout From Small-Scale Attack*, March 12, 2014, available at <http://www.wsj.com/articles/SB10001424052702304020104579433670284061220>

²³ The count of 38 includes the District of Columbia. North Carolina Clean Energy Technology Center, Database of State Incentives for Renewables and Efficiency (DSIRE), available at <http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2014/11/Renewable-Portfolio-Standards.pdf>

²⁴ Amy Ferrell Testimony at FERC's Technical Conference on Environmental Regulations and Electric Reliability, Wholesale Electricity Markets, and Energy Infrastructure, March 31, 2015, available at <http://www.ferc.gov/CalendarFiles/20150327132803-Farrell,%20ANGA.pdf>

²⁵ U.S. Energy Information Administration (EIA), *Today in Energy*, July 5, 2011, available at <http://www.eia.gov/todayinenergy/detail.cfm?id=2070>

²⁶ EIA, *Today in Energy*, February 24, 2014, AEO2014 projects more coal-fired power plant retirements by 2016 than have been scheduled, available at <http://www.eia.gov/todayinenergy/detail.cfm?id=15031>

²⁷ On June 29, 2015, the United States Supreme Court ruled that EPA had not adequately considered the rule's costs when promulgating the MATS rule and the Court remanded the rule back to the EPA. *Michigan et al. v. EPA*, slip opinion 14-46, June 29, 2015. While the impacts of this case are currently unknown, much of the compliance investment has already occurred.

²⁸ EIA, AEO2014 projects more coal-fired power plant retirements by 2016 than have been scheduled, available at <http://www.eia.gov/todayinenergy/detail.cfm?id=15031>

²⁹ Examples include the following: Scott Segal, Testimony before the Subcommittee on Energy and Power of House Committee on Energy and Commerce, April 12, 2013, available at http://www.electricreliability.org/sites/default/files/media_files/Segal%20Testimony%20on%20Energy%20Consumers%20Relief%20Act%202013.pdf; Institute for Energy Research, *EPA Regulations Could Cause Potentially Serious Capacity Problems*, November 2, 2010, available at <http://instituteforenergyresearch.org/analysis/epa-regulations-could-cause-potentially-serious-capacity-problems/>

³⁰ Those arguing that the rule will threaten reliability often are concerned that the rule will financially hurt them or their constituencies. Hence, reliability is a guise for their own financial interests.

³¹ While the second question is related to Grid reliability, the first is not. However, because many of the critics conflate these two issues, this report addresses both questions.

³² Because it was just released, critics have not yet had an opportunity fully to comment on the final rule. Therefore, this report focuses on their criticisms to the draft rule, which will likely be similar to the final rule.

³³ In contrast to the CPP, many EPA regulations limit the emissions at each power plant. If a specific power plant cannot meet those emission limits, then that specific power plant must retire. In contrast,

under the CPP, each state has the opportunity to comply with the rule by addressing the totality of its state's carbon emissions thereby obviating emissions limits on specific power plants.

³⁴ EIA, *Today in Energy*, July 5, 2011, available at <http://www.eia.gov/todayinenergy/detail.cfm?id=2070>

³⁵ EPA, *Regulatory Impact Analysis for the Clean Power Plan Final Rule* (RIA) available at <http://www.epa.gov/airquality/cpp/cpp-final-rule-ria.pdf>. Though Table 3-13 of the RIA pertains only to combined-cycle units, EPA estimates that only one GW of other types of natural gas units would be installed by 2025 and none between 2025 and 2030. See the summary tab in the SSR documents (both the rate-based and mass-based) from the IMP run files which can be found at <http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html>

³⁶ When evaluating the draft CPP, NERC estimated that the U.S. would need between 133 to 142 GW of new natural gas plants by 2030. Industry has demonstrated that it can build about 355 GW by 2030, which is significantly more than NERC's high estimate of 142 GW. See NERC, *Potential Reliability Impacts of EPA's Proposed Clean Power Plan, Phase I*, April 2015, pages 14, 16, and 19 available at <http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/Potential%20Reliability%20Impacts%20of%20EPA's%20Proposed%20Clean%20Power%20Plan%20-%20Phase%20I.pdf>. While NERC was analyzing the draft rule, which called for 30% CO₂ reductions, the final rule calls for 32%. However, even with that increase to 32%, based on the past, one could safely conclude that the industry will be able to build enough new natural gas plants to comply with the final rule.

³⁷ EPA, *Regulatory Impact Analysis for the Clean Power Plan Final Rule*, pages 3-34 to -35.

³⁸ For the high-demand scenario, DOE modeled the volume of natural gas that would be needed if "all coal-fired power plants that lacked scrubber-type emissions controls as of the first quarter of 2014 are assumed to retire in 2017. This assumption results in an incremental reduction of 104 GW of coal-fired capacity beyond the 25 GW of capacity that retires in the Reference and Intermediate Demand Cases." DOE, *Natural Gas Infrastructure Implications of Increased Demand from the Electric Power Sector*, February 2015, p. 11, available at http://energy.gov/sites/prod/files/2015/02/f19/DOE%20Report%20Natural%20Gas%20Infrastructure%20V_02-02.pdf

³⁹ DOE estimates that between 38-42 Bcf/d of additional natural-gas pipeline capacity would be required between 2015 and 2030. DOE also noted that from 1998 to 2013—a fifteen-year period—the United States added 127 Bcf/d of pipeline capacity. *Id.*, p. v.

⁴⁰ While a water supply is necessary for natural gas plants, it is a reasonable assumption that the old retiring plant also needed a water supply.

⁴¹ For total renewables (not just solar and wind), EPA estimates the following capacity additions would be required by the CPP: between 54.9 and 57.4 GW by 2025, and between 91.9 and 94.4 GW by 2030. See EPA, *Regulatory Impact Analysis for the Clean Power Plan Final Rule*, Table 3-14 on p. 3-33.

⁴² EPA, IPM run files, SSR documents, see lines 61-64 on the Summary tab, at <http://www.epa.gov/airmarkets/programs/ipm/cleanpowerplan.html>

⁴³ Specifically, 6.2 GW of photovoltaic and 767 MW of concentrating solar power were installed in 2014. Greentech Solar, *The U.S. Installed 6.2 GW of Solar in 2014, Up 30% Over 2013*, March 10, 2015, available at <http://www.greentechmedia.com/articles/read/the-us-installed-6.2-gw-of-solar-in-2014-up-30-over-2013>. Experts are expecting approximately 16 GW of utility-scale solar to be built in 2015 and 2016. IHS, *32 GW of Utility-Scale Solar to Come Online Ahead of US 2017 ITC Deadline*, June 8, 2015, available at <http://press.ihs.com/press-release/technology/32-gw-utility-scale-solar-come-online-ahead-us-2017-itc-deadline-ihs-says>

⁴⁴ American Wind Energy Association, *American Wind Power Rebounded in 2014, Adding over Four Times as much as Year Before*, January 28, 2015, available at <http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=7181>

⁴⁵ As noted above, under the draft rule, NERC predicted needing up to 142 GW of new natural gas generation, in part because it estimated only minimal installations of new renewables: 12-20 GW of solar and 23-26 GW of wind between 2016 and 2030. NERC April 2015 Report, pages 13 and 19.

NERC's report was critically received, in part, because of these low estimates. Industry has already demonstrated that it can build 179 GW of new renewable generation in 15 years.

⁴⁶ GTM Research, *U.S. Solar Mark Insight*, Q2 2015, available at <http://www.seia.org/sites/default/files/resources/US%20Solar%20Market%20Insight%20-%20Q2%202015%20-%20Executive%20Summary.pdf>

⁴⁷ Policymakers recognize that, regardless of the CPP, our nation must develop transmission more quickly. There is currently a bipartisan energy bill in the Senate that includes provisions intended to streamline the permitting for transmission. See Energy Policy Modernization Act of 2015. Similarly, DOE has been drafting a new rule that would facilitate faster federal permitting specifically for transmission lines.

⁴⁸ Herman Trabish, Utility Dive, *What's Behind the 900% Growth in Energy Storage in Q2 2015*, 9/8/15, available at <http://www.utilitydive.com/news/whats-behind-the-900-growth-in-energy-storage-in-q2-2015/405186/>

⁴⁹ Pete Behr, E&E Energywire, *Technology – a Missing Building Block in the Clean Power Plan?* 5/5/15, available at <http://www.eenews.net/energywire/2015/05/05/stories/1060017947> (subscription required).

⁵⁰ DOE, *Dynamic Line Rating Systems for Transmission Lines, Topical Report*, April 2014, Abstract and p. v, available at https://www.smartgrid.gov/files/SGDP_Transmission_DLR_Topical_Report_04-25-14_FINAL.pdf

⁵¹ ABB Inc., *Energy Efficiency in the Power Grid*, p. 6, available at <https://www.nema.org/Products/Documents/TDEnergyEff.pdf>

⁵² States that fail to submit a state plan will be subject to the final version of the federal plan, a draft of which was released in August 2015. Sadly, some are calling on states to “just say no” to compliance with the law, and at least, two states—Oklahoma and Mississippi—have already declared that they will not submit their own compliance plans.

⁵³ “[W]henever an emergency exists by reason of a sudden increase in the demand for electric energy, or a shortage of electric energy, or of facilities for the generation or transmission of electric energy, or of the fuel or water for generating facilities, or other causes, the Secretary of Energy may require by order temporary connections of facilities, and generation, delivery, interchange, or transmission of electricity as the Secretary determines will best meet the emergency and serve the public interest.” 16 U.S.C. § 824a(c).

⁵⁴ DOE's Use of Federal Power Act Emergency Authority, available at <http://energy.gov/oe/does-use-federal-power-act-emergency-authority>.

⁵⁵ Under the DOE Organization Act, § 207 of the FPA is a DOE Secretarial authority that has been delegated to FERC. FERC does not have regulations on its § 207 authority and has only used it on one occasion.

⁵⁶ Section 207 (16 USC § 824f) provides as follows:

“Whenever the Commission, upon complaint of a State commission, after notice to each State commission and public utility affected and after opportunity for hearing, shall find that any interstate service of any public utility is inadequate or insufficient, the Commission shall determine the proper, adequate, or sufficient service to be furnished, and shall fix the same by its order, rule, or regulation: Provided, That the Commission shall have no authority to compel the enlargement of generating facilities for such purposes, nor to compel the public utility to sell or exchange energy when to do so would impair its ability to render adequate service to its customers.”

⁵⁷ Rod Kuckro, Energywire, June 8, 2015, *Leaders Eye New Partnerships As Grid, Business Model Evolve*, available at <http://www.eenews.net/energywire/2015/06/08/stories/1060019813> (subscription required).

⁵⁸ Suggesting that our federal government would undermine the lifeblood of our society through the CPP is nothing short of fear-mongering and is a disservice to our political discourse.