Clean Power Plan Analysis
PJM Draft Modeling Document

PJM Interconnection
Updated November 17, 2015

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Introduction

On August 3, 2015, the U.S. Environmental Protection Agency (EPA) released its Final Clean Power Plan rule to regulate carbon dioxide (CO_2) emissions. Under section 111(d) of the Clean Air Act. The rule applies to existing and under-construction fossil resources satisfying EPA's eligibility criteria. Similar to the draft rule, the EPA developed what it considers to be the "best system of emissions reductions (BSER)" to develop interim and final compliance rate-based performance standards to be achieved by states and/or affected generating units within those states. The EPA has also provided state-level mass targets intended to represent an equivalent amount of emissions reductions as anticipated under the rate-based standard. Nationwide the regulation intends to reduce total CO_2 emissions from eligible sources by 32 percent relative to 2005 levels. For the PJM region, the regulation would result in a 36 percent decrease in CO_2 emissions from 2005, and a 23 percent reduction from 2012, the year for which the emissions baseline was established.

In addition to section 111(d) of the Clean Air Act, the EPA established performance standards for new, modified and reconstructed sources (New Source Performance Standards or NSPS) under section 111(b) of the Clean Air Act. The NSPS is based on emissions performance achievable by individual generating units. The combination of these rules will shift the way energy is produced and delivered within the PJM system, and influence future investments in generation sources. PJM's role as a Regional Transmission Organization (RTO) is to ensure cost-effective delivery of generation over the bulk transmission system. PJM does not engage in integrated resource planning, but does have a responsibility to ensure operational reliability through its Day-Ahead and Real-Time Energy Markets, resource adequacy through the Capacity Market, and long-term transmission security through the Regional Transmission Expansion Plan (RTEP) process.

Similar to its analysis of the proposed rule, PJM plans to study various future states of the electric system to assess economic and reliability impacts. This initial analysis will not be used to inform specific transmission upgrades to be included a future Regional Transmission Expansion Plan, nor is it definitive on what resource owners and resource developers may do in the future. Rather, this analysis should be used to assess potential implications of various future states -- to identify potential economic, operational, resource adequacy and transmission usage implications.

This draft modeling document is informed by input PJM has received from the Organization of PJM States, Inc. (OPSI) [1] and may be further refined based on additional input received from other state agencies and the PJM membership. PJM intends to finalize this modeling document, by early November 2015.

[1] http://www.pjm.com/~/media/about-pjm/who-we-are/public-disclosures/20151019-opsi-letter-regarding-modeling-economic-impacts.ashx

PJM Economic Modeling Framework

Business-As-Usual Scenario

In its analysis of the proposed rule, PJM used the RTEP Market Efficiency Model as the base case. From this model, PJM then developed a range of scenarios to study the compliance impacts of various sensitivities: natural gas prices, energy efficiency and the levels of zero or low-emitting generating resources. Some resource futures in the range of scenarios evaluated are less probable given market conditions and resource economics.

For analysis of the final Clean Power Plan regulation, PJM will develop a Business-as-usual model that is more representative of market conditions reasonably expected to occur. Business-as-usual represents a system state that is independent of the Clean Power Plan CO_2 emissions regulation.

The following describes the criteria PJM will use to develop its business-as-usual model for the 2018 model year:

- PJM utilizes its capacity market to competitively clear resources to meet the region's resource adequacy objectives. Queued resources capable of providing both capacity and energy will be included in the 2018 model if they also cleared the 2018/2019 capacity market auction.
- PJM will model the greater of "energy only" resources currently under-construction, and a level consistent with historical interconnection trends in PJM.
- Demand side management resources will be represented at the level cleared in the 2018/2019 PJM Capacity Market auction.
- Any announced generator deactivations will be removed from the business-as-usual model.

Post 2018, PJM will apply the following criteria to develop its business-as-usual model:

- Capacity resources will be added to the model to satisfy reliability criteria[2]
- Energy resources will enter the market when both short and long run market signals are sufficient to signify new entry.[3]
- Any announced generator deactivations will be removed from the business-as-usual model.
- Additional economic retirements allowed based on ability to recover fixed going-forward costs.[4]

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[2] Resource retirements and load growth will lead to additional new entrants.

[3] Some states within PJM have mandatory Renewable Portfolio Standards whereas other states have voluntary standards. Willingness to comply with the standard is a function of resource economics, Renewable Energy Credit Markets, and mandatory penalties known as Alternative Compliance Payments. In the long-run, state policies can change. Consequently, PJM will not model a fixed quota on renewable energy procurement.

The 2018 business-as-usual scenario will be used as a starting point for modeling the compliance scenarios and will enable PJM to study early actions associated with the beginning of the compliance period.

Simulation Tools

PJM will use Energy Exemplar's PLEXOS ® Integrated Energy Model (PLEXOS) to perform its analysis of both the business-as-usual and Clean Power Plan compliance scenarios. Compared to other commercial power systems analysis software, PLEXOS is an open platform that enables the user to develop customized constraints for co-optimization within unit commitment and dispatch.

After careful evaluation of simulation tools, PJM determined that PLEXOS provides the greatest capability to meet the specific modeling challenges for Clean Power Plan analysis within reasonable timeframes. Below is a subset of PLEXOS capabilities that PJM plans to use for its analysis:

- Minimization of short and long run (20 year) capital, fixed, and production costs associated with generation, and transmission[5] investments
- Chronological dispatch of generating resources subject to transmission constraints (SCED)
- Environmental limits analysis over long and short-time horizons for simultaneous evaluation of rate (lb/MWh) and mass-based (Tons) emissions limits
- Detailed hourly renewable generation modeling[6]

Study Years

PJM will study both the business-as-usual and compliance scenarios in 2023 and 2026 under Security Constrained Economic Dispatch (SCED). PJM will also study 2028 and 2030, but with a less comprehensive set of transmission constraints, thus focusing its transmission evaluation on monitoring regional transmission flows.

The reason for this focus beyond ten years is that absent transmission upgrades, production cost models can overstate transmission congestion in localized pockets of the system, and less significant transmission upgrades would likely be built independent of the Clean Power Plan to address load growth and to mitigate congestion in more localized areas of the transmission system.

[4] PJM is currently considering methods to represent a proxy for capacity market payments at the RTO level within the model. PJM will not have the ability to perform the CETL and CETO analysis to support identification of constrained LDA regions as part of a long-term generation entry/exit model.

[5] The initial compliance analysis described in this document will not be used to evaluate transmission investment options.

[6] PLEXOS also enable sub-hourly evaluation of renewables, which may be useful in follow-up studies to investigate impacts to Ancillary service markets.

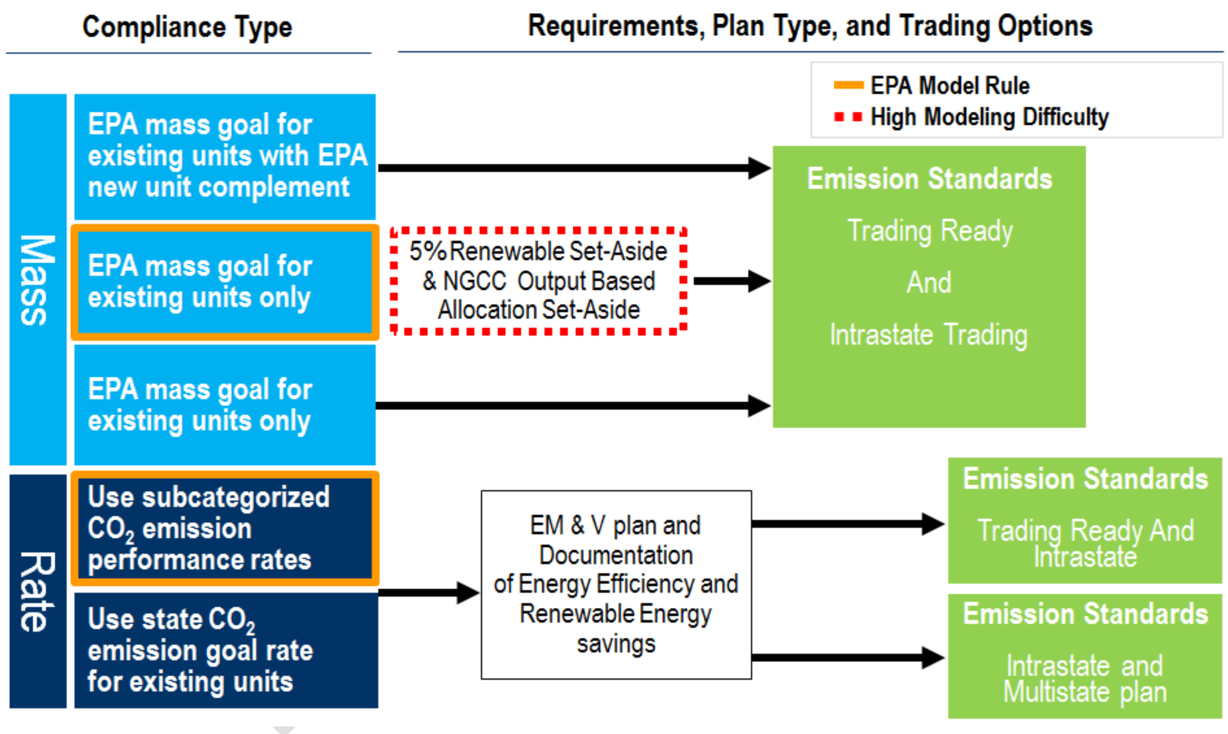
Compliance Scenarios

The final Clean Power Plan has a greater number of available compliance pathways than the proposed rule. As shown in Figure 1, the various compliance methods stem from the EPA's attempt to encourage the following objectives:

- Reduce the incentive to shift generation to units not covered by the existing source rule in both rate and mass-based standards,
- facilitate trading between the states and amongst affected electric generating units,
- and to reduce the incentive to shift generation from sources in one state to similar sources in another state

OPSI has requested that the business-as-usual (2018) scenario be studied for the rate and mass-based compliance pathways described below in Figure 1. Each of the compliance pathways is likely to yield different economic and reliability results for the PJM region over the interim (2022-2029) and final (2030 and beyond) compliance periods.

Figure 1. State and Multi-State Plan Compliance Pathways



Trading Ready within the PJM Analysis

PJM intends only to model energy and capacity resources that both participate in the PJM energy market and are located within a PJM state. Therefore, PJM will evaluate Trading Ready similar to how it evaluated multi-state compliance under the proposed rule. For ease of modeling, PJM will assume that generating units purchase allowances through an auction framework and thus reflect the full costs of allowances within their bid prices. Through application of an annual emissions limit, PLEXOS will identify the CO_2 price at which the market would clear accounting for unit-level operational constraints and transmission constraints.

Allowance Allocation Strategies

PJM recognizes that states can also directly allocate allowances to generating units, or could distribute potential auction market revenues. Assuming a liquid trading market, directly allocating allowances to generating units or auctioning allowances should lead to a similar market value for the allowances, but will affect the cash flows for individual generating units. While an important consideration for states in developing their overall compliance strategy and state policies, this consideration is beyond the scope of PJM's analysis.

Compliance Study Plan

PJM will study the five compliance pathways identified above for both individual state compliance and for Trading Ready or Multi-State compliance. Both the "State Measures" and "Mass-Based Standard" plan types have to comply with the EPA's final emissions guidelines CO_2 limit, and address leakage. Consequently, these two approaches, while distinct for implementation, represent a single compliance pathway from a modeling perspective.

PJM will study the pathway titled "EPA Mass Goal for Existing Sources" with and without the set-aside provisions described in the "Considerations for Compliance Modeling" section of this document. Although the EPA places no limitations on banking during either the interim or final compliance periods, PJM will evaluate compliance against discrete year emissions targets.

Scenario Study Plan

The various compliance pathways have varying levels of modeling difficulty. Computational requirements vary by compliance pathway, and will affect the model's solution time. For every compliance pathway, using PLEXOS simulation tool, PJM will run a 20-year economic entry/exit and resource adequacy assessment. The results of this analysis will first be supplied to PLEXOS' Mid-Term analysis tool to refine the emissions prices, and finally passed to PLEXOS' Security Constrained Economic Dispatch (SCED) engine to study the discrete model years with a more detailed transmission system representation.

Table 1 below shows a schedule of when PJM's preliminary analyses for the base model assumptions are expected to be completed. This schedule will enable PJM to have meaningful discussions with OPSI, state air regulators, and stakeholders. The final results will not be delivered until early 2016 Q2. PJM's "Compliance Pathways Economic Assessment" report will only contain results from the final analyses.

Table 1. Scenario Study Plan

Scenario	Trading	18	23	26	29	30	Jan	Feb	Mar	Apr
		2018-2030					Preliminary Analysis Targets			
Business-As-Usual	None	●	●	●	●	●		●		
Mass-Based Standard	Trade ready		●	●	●	●		●		
	Intrastate		●	●	●	●		●		
Rate-Based Standard (Sub-Category Rates)	Trade ready		●	●	●	●			●	
	Intrastate		●	●	●	●			●	
Rate-Based standard (Regional Goal)	Multi-State		●	●	●	●		●		
Mass-Based Standard (New Source Complement)	Trade ready		●	●	●	●			●	
	Intrastate		●	●	●	●			●	
Rate-Based Standard (State Goals)	Intrastate		●	●	●	●		●		
Mass-Based Standard (Model Rule Set-Asides)	Trade ready		●	●	●	●				●
	Intrastate		●	●	●	●				●

Key Inputs to the Model

Transmission Model

PJM will study the impacts of the final rule utilizing the 2015 PJM RTEP model including all transmission constraints consistent with the RTEP Market Efficiency Model. Below are guidelines PJM will use to adjust the transmission model for the Clean Power Plan analysis:

- Additional transmission constraints (230 kV and above) will be added based on the study year and the generation model represented in the simulation.
- Significant transmission upgrades associated with FSA[7] generators that are not also included in the economic model will not be included in the transmission model.
- Because the 2015 RTEP model is publicly available, PJM will post any changes in the transmission model along with other Clean Power Plan modeling files.[8]

In areas of the system where compliance leads to significantly different resource outcomes than the business-as-usual scenario, PJM will investigate whether additional transmission constraints are needed to adequately represent the bulk electric system.

[7] Facilities Study Agreement stage of Interconnection Queue Process

[8] PJM will not be able to release market sensitive data used for developing the business-as-usual scenario and subsequent Clean Power Plan compliance scenarios. This includes cleared resources, but may also include some resource parameters.

Load Forecast

PJM will utilize the 2016 PJM Load forecast to conduct the analysis. This forecast captures changing trends in consumption and provides a more granular view of variables that influence energy consumption and peak demand such as:

- Energy Efficiency,
- Behind the meter and distributed generation, and weather forecasting terms.

Forecast Fuel Prices

PJM will utilize the latest ABB Summer 2015 database for all fuel prices, except natural gas. The natural gas prices used, Henry Hub and Market Area basis differentials to Henry Hub, will reflect the most current forecast[9] and or futures price data.

Energy Efficiency Levels

PJM will use its 2016 energy and peak demand load forecast to represent Energy Efficiency.

Renewable Resource Levels

PJM's business-as-usual scenario will employ a level of renewable resource levels that is economic. Beyond 2018, PJM will use NREL's 2015 Annual Technology Baseline for capital cost assumptions to determine the economic level of entry for renewables. The best sites based on capacity factors will be selected first. The capacity factors and hourly shapes for renewables (wind and solar) resources will be based on the PJM Renewable Integration Study completed in 2013.

Unit Capital and Fixed O&M Cost

Using both publicly available and commercial datasets[10] PJM expects to conduct a thorough assessment of input assumptions before conducting simulations. PJM will use the EPA's assumptions for new unit capital costs, financing costs, and construction time-periods as a primary source. PJM will apply location adjustments to account for labor/materials differences as well as to adjust for different design criteria by region within the PJM footprint.

[9] PJM subscribes to "IHS Energy North American Monthly Gas Briefing", and regularly reviews the publicly available NYMEX Clearport futures. These data sources will inform the input assumptions and any subsequent sensitivity analysis.

[10] Both EIA and the EPA publish capital and fixed O&M costs for existing units. NREL's Annual Technology Baseline cites the EIA for thermal resource capital cost assumptions. PJM will supplement these datasets with commercial datasets including Velocity Suite and SNL. PJM also will review recent studies conducted by external consultants on unit capital and fixed O&M costs with the PJM footprint.

Unit-Level Operating Characteristics

PJM will use the ABB simulation ready dataset to conduct simulations of the electric power system. To ensure accuracy of PJM unit characteristics, PJM will review key parameters in the datasets[11], such as economic maximum and minimum capacities, heat rates, emissions rates and removal rates (SO_2 and NOx), start costs, and minimum on-line/off-line times.

Siting of New Entrants for Nodal Analysis

The economic entry/exit model will determine the level of new entrants and the type of resources entering or exiting the market. To maintain efficiency in modeling, but also to preserve the reasonableness of running a detailed Security Constrained Economic Dispatch model, PJM will add new entrants to the model according to the following criteria:

- PJM will assign locational cost factors to resources based upon PJM Locational Deliverability Areas (LDA)
  - Within the LDA, PJM will initially use its interconnection queue in order of study status and network upgrade costs to identify nodal locations to site the resources.
  - When the queue is no longer sufficient, resources will be located within the LDA based upon the most viable interconnection locations based on limited screening analysis.
- Technical potential will be used to limit the concentration of resources within a specific state
- PJM will account for state policies/regulations[12] reasonably expected to influence specific technologies' market potential within individual states or across the PJM footprint.
- Nuclear units will be allowed to uprate, but no new nuclear will be assumed to be constructed during the interim compliance period that has not received both an operating license from the Nuclear Regulatory Commission and applicable state permits to construct.
- The Clean Air Act 111(b) new source performance standards require partial carbon capture and sequestration for even super-critical coal resources; consequently, we do not expect new coal resources to be economic, except in a high gas scenario.

Sensitivity Analysis

PJM does not intend to represent the results of simulations as a forecast for future electric market outcomes. To the contrary, PJM recognizes that future states of the electric system and upstream fuels markets may be different from

[11] PJM will use Velocity Suite, and SNL online datasets to review the ABB simulation ready database.

[12] Can pertain to solar carve-outs or even IRP states

the inputs assumed in PJM's base case model. PJM values sensitivity analyses; such analyses recognize that markets are dynamic, but also enable planners to evaluate uncertainty.

PJM will conduct sensitivity analyses by exogenously changing key input assumptions while holding all other variables constant. PJM plans to run each of the sensitivities OPSI requested and may expand the sensitivities should PJM determine additional sensitivities would result in significant new insights.

Before doing sensitivities PJM will engage OPSI to identify which compliance pathway(s) and study years are most reasonable to conduct sensitivity analysis. Table 1 below describes the sensitivities specifically requested by OPSI:

Table 2. Planned Sensitivities

Sensitivity	Implementation	Modeling Reasoning
Natural Gas Price Forecast	Review historical variances in the Henry Hub futures price markets. Apply the historical variance to develop a high and low gas price forecast. Basis differentials relative to Henry Hub for different gas market regions will remain constant	Higher natural gas prices will cause compliance costs to increase and change economic competitiveness of resources
Clean Energy Incentive Program	Optimize renewable and energy efficiency buildout based upon state set-aside and matching EPA allowances for PJM region	Investment Incentive for 2020 and 2021 is expected to lead to higher renewable/energy efficiency generation supply or load reduction
High Energy Efficiency	Apply EPA's projections for energy efficiency used in its Regulatory Impact Analysis	Lowers load growth which in turn reduces compliance costs and the need to add supply side resources

In addition to the sensitivities that OPSI specifically requested, PJM recommends the following sensitivities for consideration.

Table 3. Optional Sensitivities

Sensitivity	Implementation	Modeling Reasoning
Capital and Financing Costs Assumptions	Increase overnight capital costs or the Weighted Average Costs of Capital by a factor (+/-)	Will impact ability of new resources to recover their long run investment costs
EPA Environmental Regulations	Enforce compliance with other environmental regulations by including environmental retrofit costs in resource fixed costs.	Increases revenue requirements for existing resources and makes new resource entry more attractive
Federal Incentives	Assume continuation of the Federal Production and Investment Tax Credit Programs.	Will lead to additional investment in renewable resources to support state Renewable Portfolio Standards
High Load growth	Develop a high load forecast based on PJM's Load Forecasting parameters.[13]	A high load forecast will drive new entry to meet the reserve margin targets but also put pressure on existing resources to run more
Rate and Mass-Based Standard	PJM will study some states as rate-based and others as mass-based within the same simulation.	To show interactions between resources dispatched with the same economic region, but that are located in states with different compliance strategies.

PJM will seek input from OPSI in prioritizing the sensitivity analyses in order to best support the states' consideration of compliance options. In coordination with OPSI, PJM will evaluate the sensitivities upon completion of the initial compliance analysis studied under base model assumptions.

OPSI Special Modeling Requests

PJM conducts an annual Market Efficiency analysis for identification of economic transmission projects to be included in the Regional Transmission Expansion. PJM typically does not modify the RGGI CO_2 price forecast that is included with the ABB simulation ready data release. However, the Clean Power Plan, a national regulation, creates a new dynamic for RGGI states, because generating units outside of RGGI states will also face a cost or limitation on their CO_2 emissions.

[13] A low-load forecast sensitivity is not needed because PJM is already modeling a high energy efficiency scenario. Potentially use the 90/10 Forecast to represent a high load condition relative to the base case (50/50) forecast.

In practice, because RGGI states are not electrically isolated from other states and participate in multiple ISO markets, the auctions may need to account for potential differences in CO_2 prices with the broader electric dispatch region. Disparate pricing can affect both generating units' economic competitiveness and their ability to achieve emissions reductions in response to the assumed clearing price. Specifically, Maryland and Delaware's CO_2 allowance budget represents about 25 percent of the RGGI CO_2 Base Allowance Budget in 2015[14]. Consequently, significant changes in allowance demand due to market prices in the PJM region can influence future RGGI auctions. As part of the initial compliance pathway assessment, OPSI requested that PJM only study Maryland and Delaware for mass-based compliance with the new source complement.

Mass-Based Trade-Ready Analysis

- PJM will study Maryland and Delaware as Trade Ready for the multi-state mass-based analysis.
    - The CO_2 allowance allocation within these states is tradeable and thus has economic value to resources beyond MD's and DE's border.
    - The market clearing price for CO_2 allowances will be the same for MD and DE as other Trade Ready states whose resources are dispatched within the model.
    - New thermal resources and simple cycle combustion turbine resources located in Maryland and Delaware will also bid in the CO_2 price determined by the analysis, consistent with their treatment in the current RGGI framework[15].

Rate-Based analysis and Mass-Based (Intra-state trading only)

- PJM will study Maryland and Delaware's thermal resources with the same forecasted RGGI CO_2 price as the RTEP Based Model, in which the Clean Power Plan is not enforced.
    - Imposing a CO_2 price will affect generation dispatch throughout the PJM footprint, but may not limit the CO_2 emissions from resources in Maryland and Delaware to remain below the CPP or RGGI limits.
    - Pending 2016 RGGI program review, PJM will review results against the current RGGI forecast and run sensitivity analysis on a single compliance pathway for non-RGGI states.

Potential Additional RGGI Modeling

The last RGGI program review resulted in the participating states agreeing to reduce the 2014 Base Allowance Budget to 91 million tons and adopting 2.5% reductions each successive year through 2020, resulting in a base allowance budget of 78 million tons. In contrast, the CPP uses a 2012 baseline and the reductions are phased in

[14] https://www.rggi.org/docs/CO2AuctionsTrackingOffsets/Allocation/2015_Allowance-Allocation.xls

[15] RGGI applies to CO_2 emitting units whose nameplate capacity is greater than 25 MW.

between 2022 and 2030, resulting in a final target of 79 million tons for RGGI participating states, less than 20% of the final goal for the PJM region. While RGGI has mechanisms in place such as the Cost Containment Reserve, and offsets intended to mitigate price increases, inclusion of peaking resources and set-asides are features of RGGI that would tend to increase near-term demand and/or costs for CO_2 allowances. Without dispatching generation in the seven non-PJM states in RGGI, it is difficult to assess whether the CO_2 reductions required by RGGI versus the CPP will put more upward pressure on the CO_2 auction prices within RGGI states.

At this time, PJM does not propose to perform analysis by the Spring of 2016 that dispatches the entire RGGI region. However, PJM may investigate doing so for sensitivity analysis after the initial study is completed, and only after consulting with New York ISO and ISO New England. The purpose of any sensitivity analysis will not be to compare either programs cost-effectiveness, but only to understand the interactions along the seams of market regions that potentially would influence generator and transmission operations.

Expected Deliverables

The analyses results will include by state and/or RTO region for each simulation year:

- Carbon dioxide emissions by fuel and prime mover, and by regulatory status[16]
- Emissions Rate Credits and Gas-Shift Emissions Rate Credits (GS-ERCs) produced and consumed
- Emissions allowance price[17], Emissions Rate Credit price, and Gas Shift-Emissions Rate Credit price[18]
- Locational Marginal Prices, and energy market load payments
- Aggregate facility level transmission congestion by voltage level
- Monthly peak hour wholesale electric sector natural gas demand
- Percentage of generation by prime mover and fuel type
- Generating capacity retired and added
- Fuel and variable O&M production cost
- Resource entry capital cost for replacement generation and load growth, and for CPP compliance

[16] 111(d) and 111(b) resource emissions will be identified separately.

[17] PJM recognizes that states can also directly allocate allowances to generating units, or could distribute potential auction market revenues. Assuming a liquid trading market, these options should lead to a similar market value for the allowances, but will affect the cash flows for individual generating units. While an important consideration for states in developing their overall compliance strategy and state policies, this consideration is beyond the scope of PJM's market based analysis.

[18] Consistent with the EPA's technical support documents, variable and constraint equations will be used to model ERCs produced by existing natural gas resources, and other eligible ERC generating measures.

To assess the complete range of compliance options available to states, PJM needs to have the ability to customize the model's representation of environmental characteristics. Consequently, PJM will use Energy Exemplar's PLEXOS ® Integrated Energy Model (PLEXOS) to perform detailed environmental analysis for long-term (20 years) entry and exit modeling, as well as shorter-term (annual) production costing analysis. [19]

Power Flow Analyses – Scope and Procedure

According to EPA's final emissions guidelines, states that do not take reliability concerns into consideration when establishing standards of performance are not in compliance with section 111(d)(1)(B) of the Clean Air Act. Although the EPA does not go as far as requiring states to consult with PJM during plan development, this is a way to increase the likelihood of plan approval and avoid potentially costly reliability issues in the future. Consistent with PJM's economic analysis, PJM plans to perform reliability analysis on the various compliance pathways available to states.

The economic study results will provide the generation portfolios including resource retirements and new entrants for study using the 2015 RTEP model. The purpose of the analysis is to compare transmission needs observed in a business-as-usual case or sensitivity case with and without the Clean Power Plan.

PJM will perform load and generator deliverability analysis (See Appendix B: PJM Reliability Test Descriptions for more detail) focused on monitored facilities at 230 kV and higher in an effort to identify the broader regional implications of the final Clean Power Plan. A cluster of conductor limit-based overloads into or within an area – as revealed by deliverability studies — would be indicative of a need for new transmission into the area. PJM will not attempt to identify reliability criteria violations below 230 kV, given the highly localized nature of the required upgrades in those instances.

In addition, studies will not focus on reliability criteria violations limited by terminal equipment. PJM's experience suggests that such limiting equipment could likely be upgraded within three years at nominal cost. By contrast, if larger scope upgrades — such as conductor replacements or new transmission lines — would be required, they would likely take more time to complete at much higher cost. The latter types of upgrades are of greater consequence in assessing whether a given compliance path will lead to reliability issues.

Consistent with PJM's established Regional Transmission Expansion Plan process, PJM will conduct studies to assess compliance with NERC and regional planning criteria. PJM's RTEP process rigorously applies NERC Planning Standards through the application of a wide range of reliability analyses, including load and generation deliverability tests. PJM's methodology will include:

[19] This approach is consistent with other Independent System Operators, including ERCOT and the Midwest Continent (MISO), who have also adopted PLEXOS for studying the Clean Power Plan's potential economic and reliability impacts. In ERCOT's latest assessment of the Clean Power Plan, ERCOT used PLEXOS for both its long-term resource entry/exit assessment as well as for its production cost analysis. While MISO plans to use EGEAS for its long-term resource entry/exit modeling, it will also use PLEXOS for the more detailed production cost modeling.

- Power flow case development for each scenario
- Identification of critical load deliverability areas (LDAs) to run based on the at-risk generation profile in each zone
- Capacity emergency transfer objective (CETO) value calculations for identified critical zones
- Load deliverability study tests to determine capacity emergency transfer limit (CETL) values for critical LDAs
- A system-wide generator deliverability test for single contingencies and a common mode outage study test for tower contingencies.

RTEP analyses assess system compliance with the thermal, voltage (reactive), stability and short circuit standards specified by NERC and made mandatory by FERC.

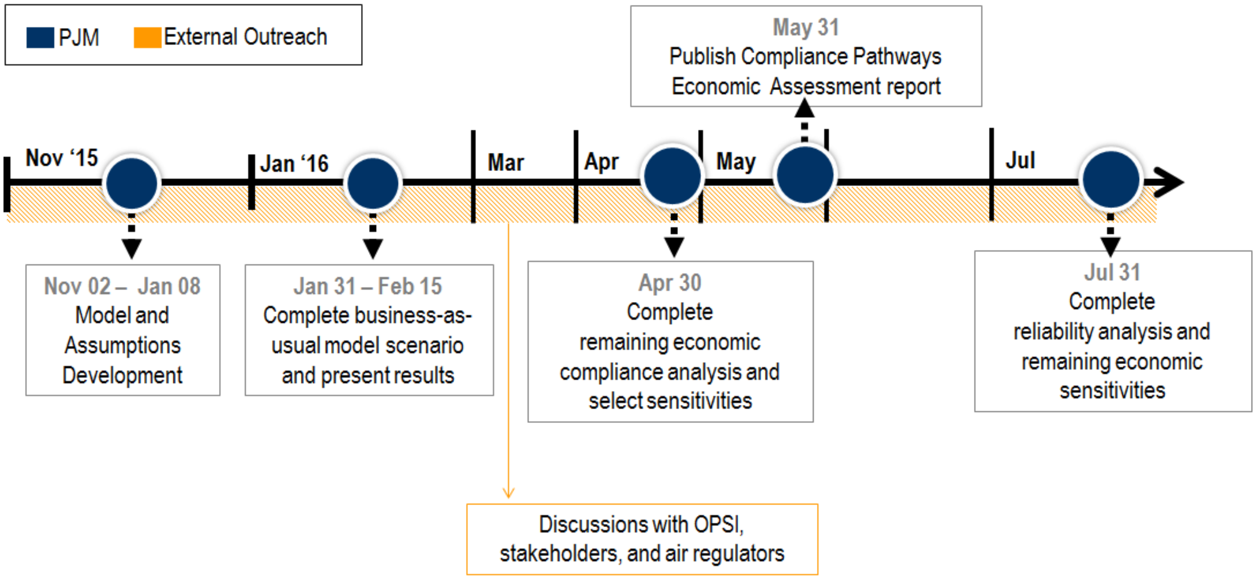
Clean Power Plan Analysis Timeline

The economic and reliability analysis of the final CPP rule should be completed in a timely fashion to be incorporated into compliance option discussions of state agencies and members in the spring of 2016.

- Prior to starting the compliance analysis, PJM will develop its business-as-usual model and review results with OPSI. The business-as-usual model results are expected to be completed for all study years by January 31, 2016.
- PJM expects to complete the remaining economic compliance analysis including a minimum of three sensitivities by April 30, 2016, and produce a "Compliance Pathways Assessment" report by May 31, 2016.
- PJM's reliability analysis depends on the results of the economic analysis. Reliability analysis will not be completed until after the economic analysis results are finalized. PJM expects to complete the reliability analysis by July 31, 2016.

Figure 2 below provides a graphical representation of PJM's analysis timeline.

Figure 2. PJM Clean Power Plan Analysis Timeline



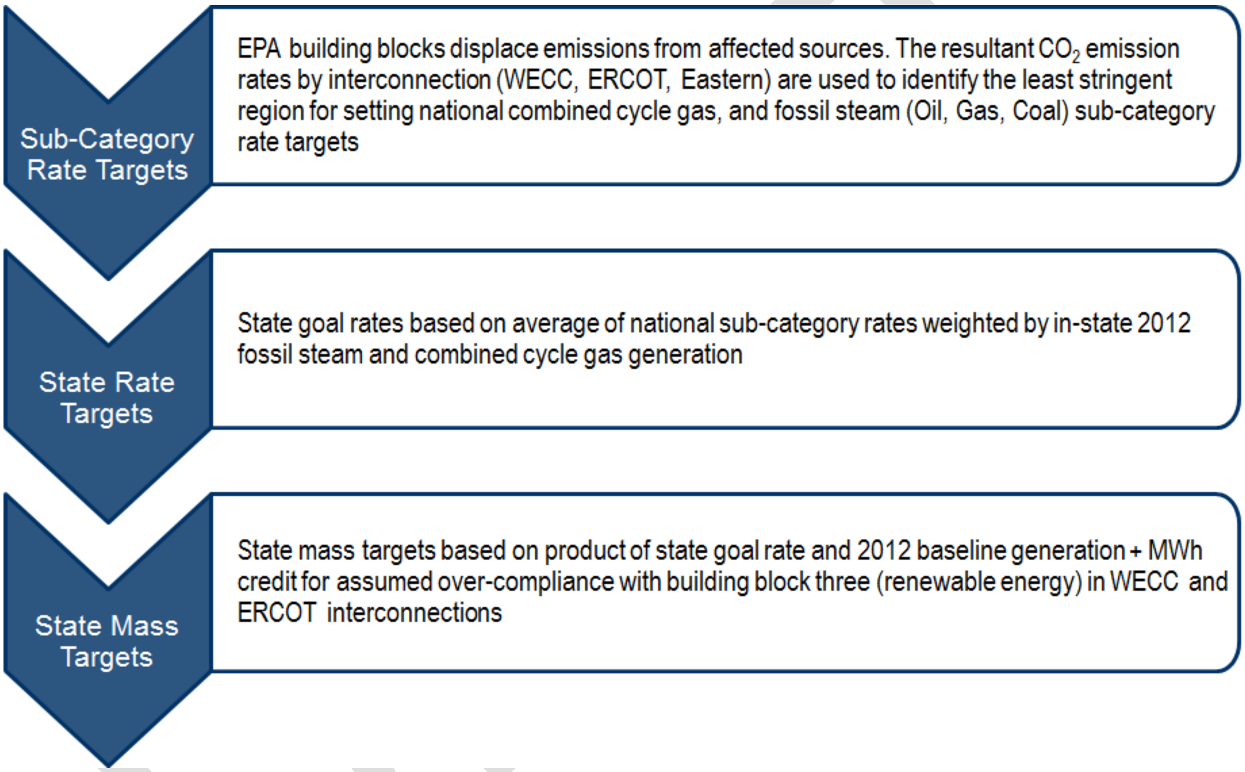
These proposed dates could change if the scope is adjusted or modeling features of the Clean Power Plan are more challenging than initially anticipated. PJM will keep OPSI, other state agencies, and the membership apprised of modeling progress.

Appendix A: Clean Power Plan Analysis Components

Final Clean Power Plan Target Setting

Under the proposed rule, the EPA identified a Best System of Emission Reduction (BSER) for each state to develop a state emissions rate target for all affected resources in the state. In contrast, under the final CPP rule, the EPA developed separate national sub-category emissions rate targets for steam turbine, and combined-cycle gas resources. Figure 3 depicts the procedure EPA used to develop the state rate-based and mass-based targets.

Figure 3. Procedure for Developing CO_2 Rate and Mass Targets



Within the final rule preamble, the EPA declared explicitly that affected electric generating units within a state could participate within multiple multi-state plans. This clarification is particularly useful for states such as Illinois, Kentucky, Indiana, North Carolina and Michigan in which affected resources participate in different balancing authorities. By establishing the national sub-category rate targets, there is less incentive to shift generation from one state to another since combined cycle gas or coal resources in one state have the same target as those in another state.

How do the State Rate Targets compare to the Draft Rule

As shown in Figure 4 and Figure 5, the EPA's target setting methodology results in all of the state rate-based goals being in between the sub-category rate-performance standard for steam turbine driven generators and combined cycle gas generators. States', whose 2012 generation was largely produced by steam turbine driven resources, targets are closer to the national steam turbine sub-category rate target. States', whose 2012 generation was produced primarily by combined cycle gas resources, targets are much closer to the NGCC sub-category rate target.

Figure 4. Final Rule versus Draft Rule Interim State Rate-Based CO_2 Emissions Targets for PJM Affected Electric Generating Units

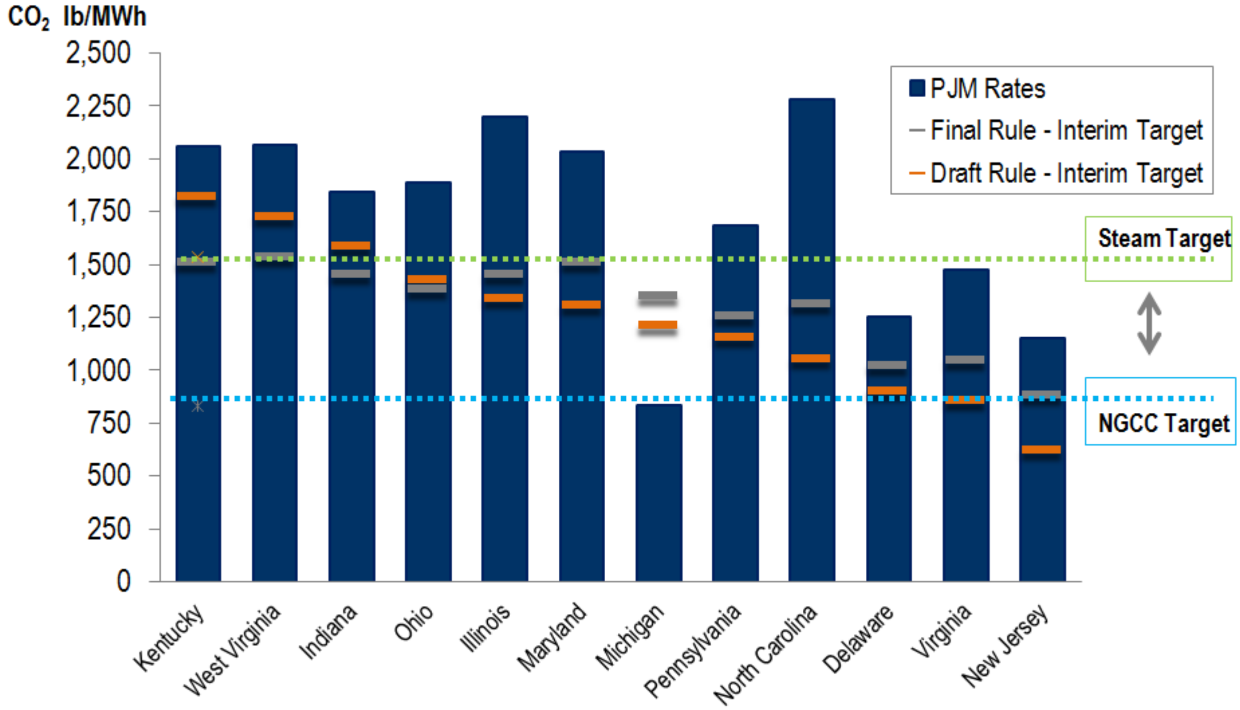


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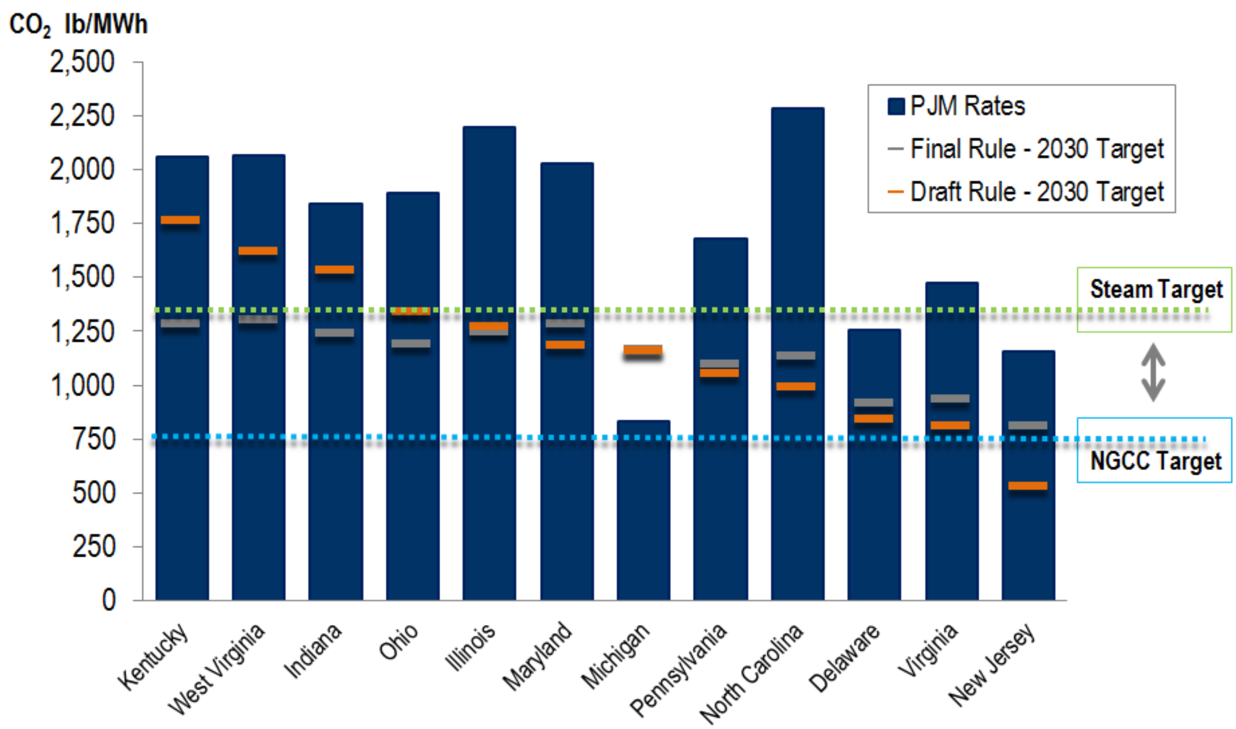
Figure 5. Final Rule versus Draft Rule 2030 State Rate-Based CO_2 Emissions Targets for PJM Affected Electric Generating Units



What Mass-targets will PJM use in Modeling

On a mass-basis, while states have discretion in the allocation of allowances, the simplest method prescribed by the EPA is to use the historical baseline approach used by the EPA to set the state mass goals. The product of each unit's 2012 baseline generation and the applicable state target rate is equivalent to the mass-target for each unit.[20] To develop equivalent mass-targets as the rate-targets, EPA assumed that the over-development of building block #3 generation, would enable the mass-targets to be higher nationwide. EPA calculated the credit allocated to each state based on the proportion of baseline generation in the state. Similarly, the credit is assigned to each individual unit based on its proportion of historical baseline generation.

Equation 1. Unit Level Mass-Target by Year

$$State\ Rate\ Target\ x\ [\ 2012\ EGU\ Generation + 2 * \frac{2012\ EGU\ Generation}{2012\ Total\ Generation}\ x\ (BB\#3\ Over\ compliance\ MWh\ \ )]$$

[20] PJM will update the method based on the Federal Plan guidance, which initially proposes to allocate unit level allowances based on 2010-2012 generation. This may influence the amount of allowances that can be assigned to units participating in the PJM region.

How do the State Mass Targets Compare to the Draft Rule?

After converting to a mass target, states in which combined cycle gas generation represented a more significant proportion of the total state generation relative to the national average have higher mass targets compared to the draft rule. This change in target setting causes a reduction in the stringency of North Carolina's, Virginia's, Pennsylvania's, and New Jersey's final rule targets compared to the proposed rule. Conversely, states like Kentucky and West Virginia characterized by lower than average 2012 combined cycle gas generation face more stringent targets than under the draft rule, in which building block #2 had little or no effect on target setting.

Figure 6. State Mass-Based Interim CO_2 Emissions Targets

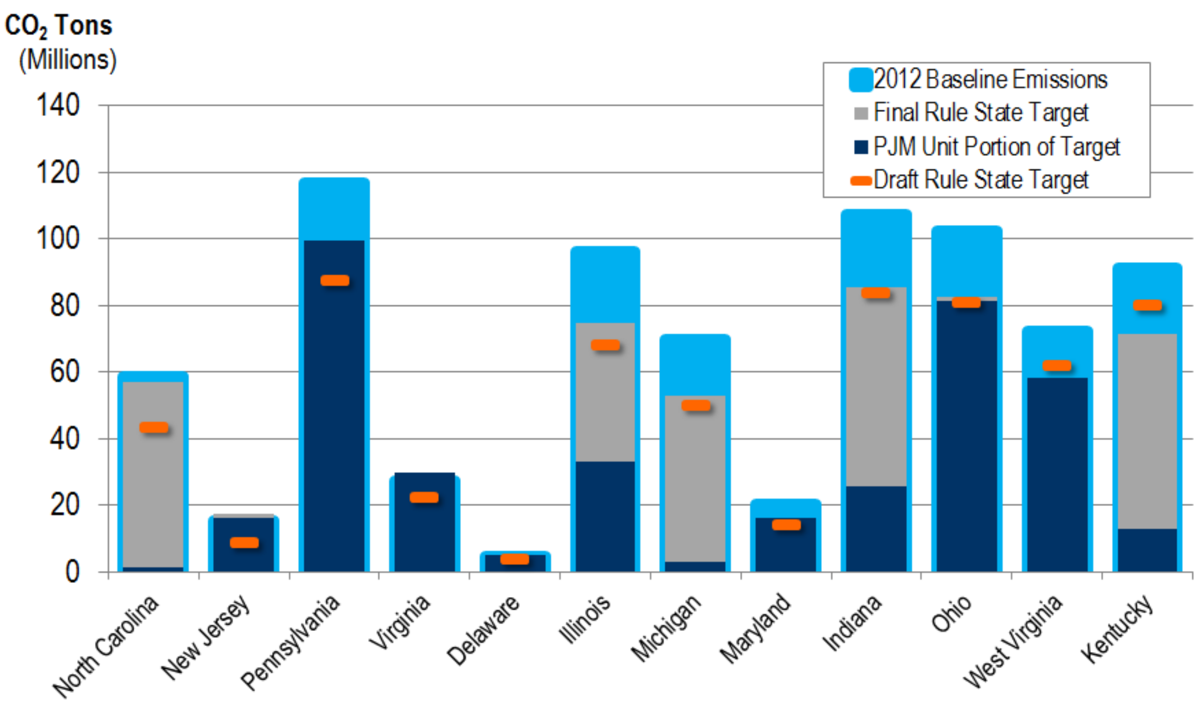
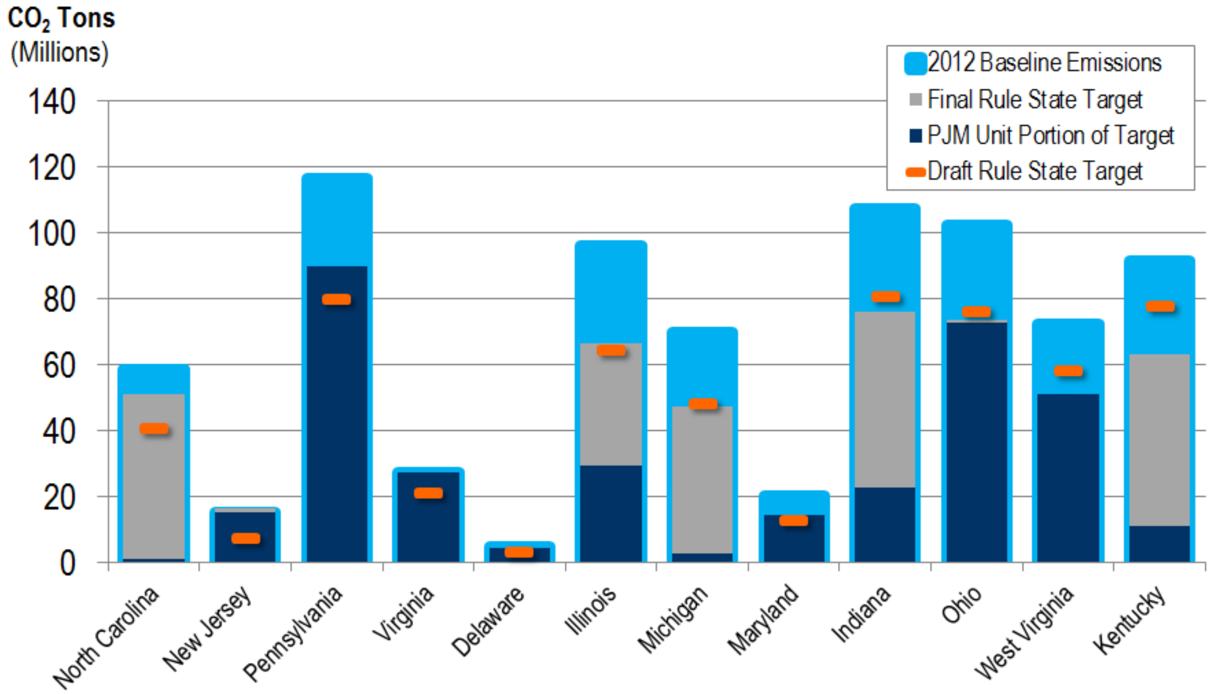


Figure 7. State Mass-Based Final (2030) CO_2 Emissions Targets



Upon calculating the aggregate CO_2 emissions targets for affected electric generating units across the PJM region - in its proposed rule analysis, PJM proceeded to run iterative analysis to identify a CO_2 price at which regional CO_2 emissions did not exceed the emissions target. However, the EPA has established additional requirements/rules in the final regulation to enforce the intent of the EPA's Best System of Emissions Reductions. These additional requirements increase the modeling complexity compared to PJM's proposed rule analysis.

What does it mean for a state's mass target to be lower than 2012 Baseline Emissions?

The target setting methodology results in some states target emissions being higher than the total emissions from in-service resources in 2012. This does not mean that the state will not have any further economic and reliability impacts associated with the Clean Power Plan. Power markets are dynamic systems. Between 2012 and 2022, many dynamics will change including resource entry/exit, load growth, and fuel prices. Modeling is therefore required to understand future interactions amongst the various components comprising the power system.

Why Perform Long-Term Entry/Exit Modeling

For the draft rule, PJM focused on resource interactions as opposed to the cause and effect relationship between choice of compliance, and the resources that market participants would be likely to find most attractive. In the final rule, the differences in compliance options are much more significant. Consequently, additional modeling is required to address the most significant questions that states and air regulators are likely to have.

Table 4. Modeling Reasoning for Long Term Economic Entry/Exit and Resource Adequacy Modeling

CPP Modeling Feature	Modeling Reasoning
Economic Model	PJM BRA results are not available beyond 2018/2019. Market conditions, unit level economics, and load growth will drive the need for new generation and potentially cause retirements.
CPP Compliance Models	Compliance pathways will change the relative economic attractiveness of different resource technologies.
Clean Energy Incentive Program	Investment Incentive for 2020 and 2021 is expected to lead to higher renewable/energy efficiency generation supply or load reduction
5% Renewable Energy Set-Aside	Expected distribution of future allowances creates investment incentive for development of new renewables
Existing NGCC Output Based Allocation	Expected distribution of future allowances creates production incentive for existing NGCC resources while not providing the same incentive for new NGCC resources.
State Enforces New Source Complements	Greater emissions performance standard stringency leads to more stress on the highest emitting existing resources

Considerations for Compliance Modeling

Eligible Measures under a Rate-Based and Mass-Based Standard

EPA clarified what measures can be allocated mass-based allowances and rate-based emissions rate credits under the final rule. Table 4 below contains a subset of eligible measures in rate and mass-based compliance frameworks. For a complete set of measures, see the final CPP rule preamble. Under either form of compliance, states have a range of options to achieve compliance.

Table 5. Resources Eligible to be Allocated Allowances or to Generate Emission Rate Credits[21]

Measure	Mass-Based Allowances		Rate-based ERC	
	State Plan	Federal Plan	State Plan	Federal Plan
111(b) Resources	Yes [1]	No	No	No
Existing NGCC[22]	Yes	Yes	Yes	Yes
Existing ST Oil/Gas/Coal	Yes	Yes	Yes	Yes
Retired Units (Post-2012)[23]	Yes	EPA Comment	No	No
Existing Nuclear	Yes	No	No	No
New/Uprate Nuclear (Post-2012)	Yes	No	Yes	Yes
New Renewables (Post-2012)[24]	Yes	Yes	Yes	Yes
Combined Heat and Power Projects	Yes	EPA Comment	Yes	EPA Comment
Demand Response (including EE)[25]	Yes	EPA Comment	Yes	EPA Comment

Rate-Based Program Considerations

In comments to the EPA, many commenters noted that differences in state-rate targets would provide perverse incentives for new resource development and potentially early retirement of resources in other states. Consequently, EPA developed the national sub-category rate targets for states participating in Trade-Ready programs. States participating in a regional program (partner states) have the option of using the sub-category rate targets or adopting a weighted average of the sub-category rate targets based on participating electric generating units. States' decision to adopt a trade-ready program versus a multi-state plan will have an impact on the amount of emission rate credits affected generating units can produce or are obligated to procure to achieve compliance. By enforcing compliance with the sub-category rates, sufficient emissions rate credits would not be produced to support the EPA's building

[21] This list is not exhaustive. There are other measures not included in the table that can be found in the Final CPP Emissions Guidelines.

[22] Only the states have the ability to regulate 111(b) source emissions using New Source Complements. However, there is not a limitation on the state issuing allowances to new resources

[23] EPA is proposing to initially distribute allowances from retired or modified/reconstructed sources to the RE Set-Aside.

[24] A revenue quality meter must directly meter renewable resource output for these resources to generate emissions rate credits.

[25] Demand side measures must be associated with grid-connected load.

block #2. Consequently, existing combined cycle gas resources that comply with the NGCC sub-category rate targets can generate two types of Emission Rate Credits (ERC):

- Incremental Gas-Shift Emission Rate Credits (GS-ERC) are always positive since their production is based on existing combined cycle gas resource's emissions performance relative to the steam turbine performance standard.
- Gas-Shift Emissions Rate Credits represent additional supply of Emissions Rate Credits, but only steam turbine resources can purchase them to demonstrate compliance.
- Emission Rate Credits are positive or negative depending on how well the combined cycle gas resource performs against the NGCC performance standard. There are no limitations on the use of Emission Rate Credits to demonstrate compliance by any affected source.

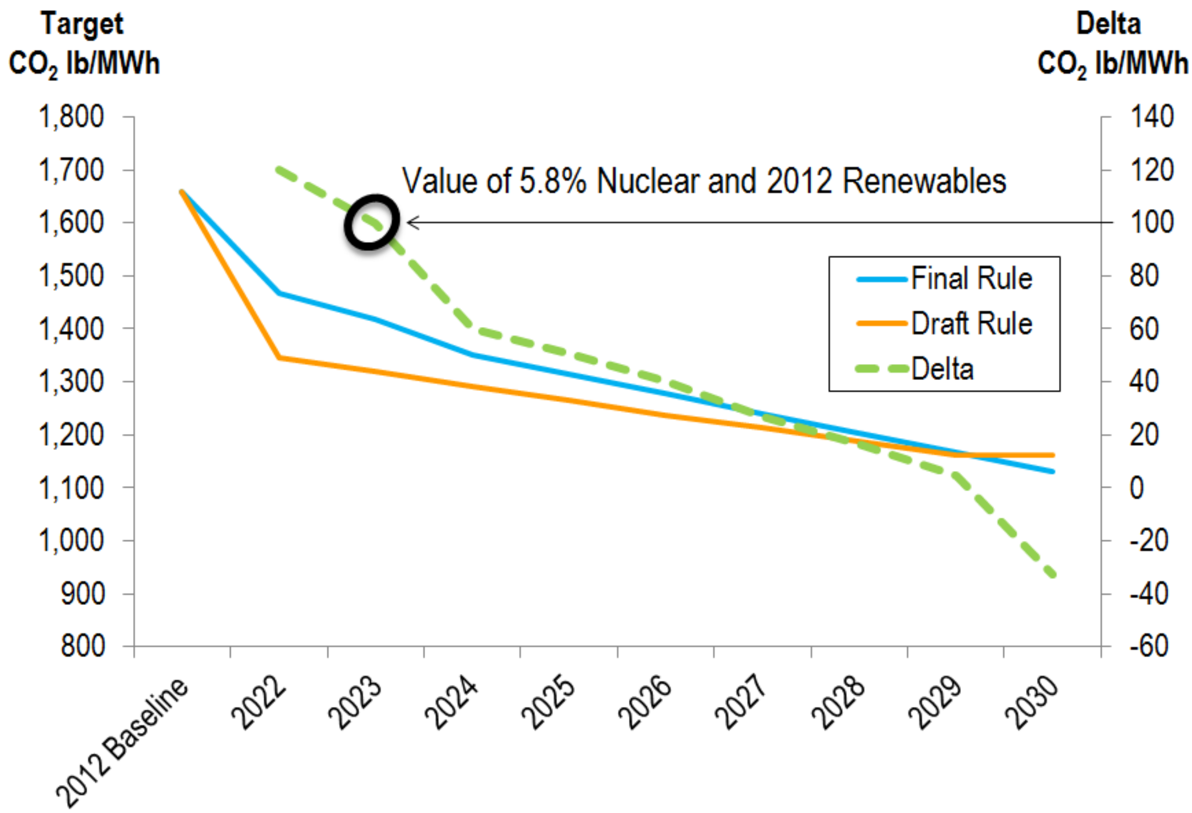
An emissions trading market, through a CO_2 price, must either clear sufficient ERCs and GS-ERCs or incentivize development of sufficient new eligible ERC producing sources to satisfy demand for emissions rate credits. The proposed Federal Plan covers the allocation rates and/or demand rates for these credits.[26] PJM will study the supply and demand balance of Gas-Shift Emission Rate Credits and Emissions Rate Credits within PLEXOS.

Rate-Based Eligible Measures

EPA has made several notable changes to the target setting and by extension to resources eligible to generate Emission Rate Credits. Although the final rule establishes higher emissions rate targets than the draft rule for the PJM region during the interim compliance period, the exclusion of existing renewables and "at-risk" nuclear from the set of eligible compliance measures diminishes the target delta. Combined, the 2012 renewables and "at-risk" nuclear would account for nearly 102 lb/MWh reduction in the PJM wide emissions rate based on 2012 CO_2 emissions. Figure 8 below shows a comparison of the PJM region's CO_2 emissions rate targets in the proposed rule versus the final rule.

[26] The EPA defines the calculation method for Gas-Shift Emission Rate Credits in the proposed Federal Plan, and is currently taking comment.

Figure 8. CO_2 Emissions Rate Targets for the PJM Region



The EPA does not allow new 111(b) combined cycle gas resources to generate Emission Rate Credits. This exclusion is consequential because these resources are the predominant technology in the PJM interconnection queue today. Assuming that gas prices remain low, new combined cycle gas resources will continue to be preferred for achieving both the regions load growth and reserve margins as non-economic resources retire. In contrast, the EPA's Best System of Emission Reductions implicitly assumes that new renewable resources will cover future load growth.

The EPA's Regulatory Impact assessment exogenously serves nearly all load growth via energy efficiency. Similar to the draft rule, EPA assumes energy efficiency is a least cost compliance option; and each state can eventually achieve one percent[27] incremental energy efficiency growth per annum. Rate-based compliance will influence the viable sources of energy just to satisfy the demand for Emission Rate Credits. Both long-run entry/exit modeling in addition to Security Constrained Economic Dispatch modeling are required to measure the PJM region's ability to meet both the system energy demand and maintain resource adequacy.

[27] In draft rule, EPA assumed that starting from 2017 each state would increase energy efficiency levels at an annual rate of up to 1.5 percent of electric sales.

Mass-Based Program Considerations

The EPA's requiring states that choose a mass-based emissions performance standard or state measures approach to address "leakage" is the most significant change in the final rule. The EPA developed this requirement to enforce equivalency between the rate-based targets and mass-based targets. Table 5 shows the various options available to states to address leakage.

Table 6. Addressing Leakage under a Mass-Based Standard

Options to Address Leakage	State Plan	Federal Plan	Approvability
Include 111(b) Sources using New Source Complements	Yes	N/A	Presumptively approved
• Establish 5% RE allowance set-aside, and an output based allocation set-aside for existing NGCC	Yes	Yes	Presumptively approved if both set-asides implemented
Prove that leakage is not occurring	Yes	N/A	Modeling required

While the options in Table 5 are each intended to address "leakage", each will have different impacts on the regulation's stringency and the emissions allowance distribution. For states that fail to submit an approvable plan, the EPA will automatically implement the five percent renewable energy allowance set-aside and the output based allocation set-aside.[28]

[28] EPA is taking comment on both the five percent renewable energy set-aside and the output based allocation set aside.

Table 7. CO_2 Tons Included in Leakage Reduction Program

State	Option 1		Option 2
	Existing NGCC Output Based Allocation	Average 5% RE Set-Aside (2022-2029)	Average New Source Complement
Delaware	649,190	253,143	78,842
Illinois	1,086,255	1,658,465	362,884
Indiana	487,231	1,282,838	281,492
Kentucky	0	638,128	134,663
Maryland	103,762	810,470	170,929
Michigan	469,231	150,597	35,403
New Jersey	3,127,837	804,888	289,621
North Carolina	74,438	59,889	14,547
Ohio	1,757,326	4,066,752	936,281
Pennsylvania	4,392,931	4,966,541	1,257,335
Virginia	3,011,811	1,479,004	450,038
West Virginia	0	2,904,154	602,940
PJM Total	15,160,011	19,074,869	4,614,976

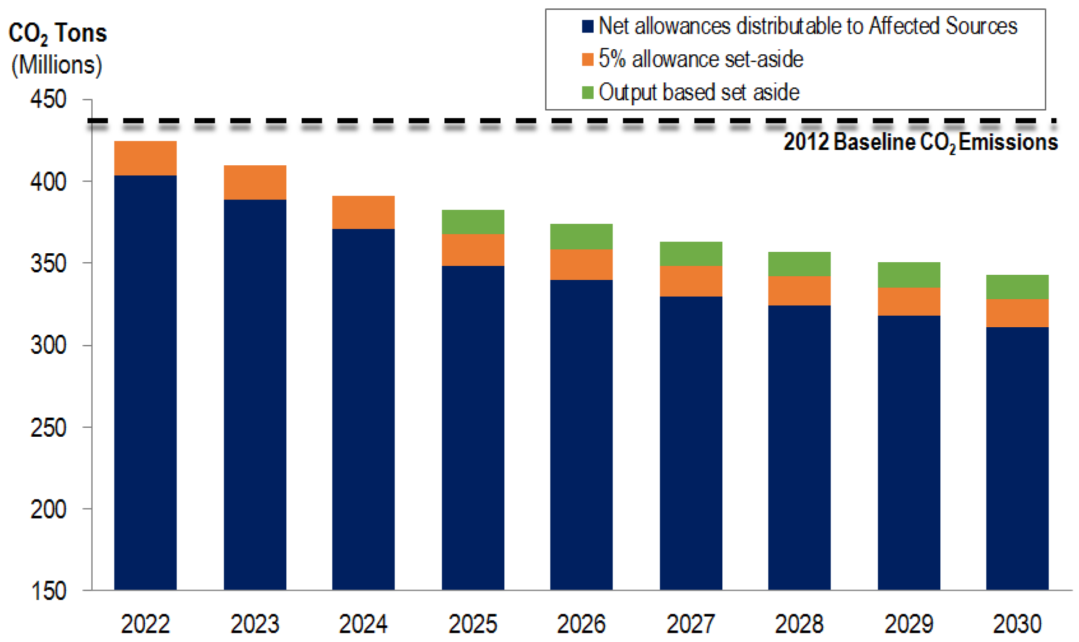
Comparing the Set Asides to the Mass Target

Both of the set-asides are limited by a cap as described below:

- The EPA proposes to set-aside five percent of the mass target for renewable resources that satisfy the same eligibility criteria that the EPA established for generating emission rate credits in states complying with a rate-based standard.
- The EPA proposes to limit the output-based allocation based upon the product of the New Source Performance standard (1,030 lb/MWh) for combined cycle gas and the total summer capacity of affected combined cycle gas within the state. Only ten percent, 876 hours, of the annual operating hours are used to set the cap.

Figure 9 illustrates the relative size of the set-asides compared to the aggregated electric generating units' mass-based targets in the PJM region.

Figure 9. Impact of Set Asides on Freely Distributable Allowances within PJM



Five Percent Renewable Energy Set Aside

The EPA created the five percent renewable energy set aside to provide an "investment credit/subsidy" to incentivize additional renewable resources. The EPA does not believe that this program will increase the stringency of complying with the Clean Power Plan because renewables are zero-emitting and do not need to retire allowances based on their generation. Instead, renewable resource owners can directly monetize the allowance credit through selling them to the market, thus resulting in a zero net change in the total allowances available.

However, there is no requirement for the renewable resources to sell their allowances immediately, which means the five percent renewable energy set aside can affect the stringency of the program and value of allowances in any given year or compliance period. Indirectly, such an action can increase energy market prices that would benefit renewable resources that effectively are price-takers. In either case, renewable energy developers must have confidence in both their future allowance allocation, but also in the allowance allocation's market value. After considering these factors, the renewable resource must be a more attractive investment than other alternatives. PJM will use PLEXOS' long-term entry/exit model to assess the set-aside's effectiveness in incentivizing new renewable development. The set aside does not need to be modeled under Security Constrained Economic Dispatch because the model assumes that intermittent resources, once constructed, deliver their full output unless curtailed.

Output Based Allocation Set Aside

The output-based allocation of allowances in theory reduces the CO_2 adder to running costs for existing units by providing allowances to existing combined cycle gas resources based upon their output (above 50 percent capacity factor in the proposed Federal Plan). Therefore, this should reduce the running cost differential between old and new gas combined cycle resources. Unlike the renewable energy set aside, the allowances allocated in this program are set aside from a future compliance period. While the program affects emissions allowance distribution, it does not reduce the amount of allowances.

From a modeling perspective, the output based allocation represents a unique modeling constraint that is not easily represented in deterministic production costing models. Generating units must increase their output in a current period based upon:

- An uncertain quantity of allowances earned in the future,
- And uncertainty in the value of those allowances.

PJM is currently working with Energy Exemplar and discussing with industry peers an appropriate representation of this set-aside to ensure consistency in modeling practices. PJM will analyze the production credit represented by this set aside using both PLEXOS' long-term entry/exit modeling tool and Security Constrained Economic Dispatch tool.

The EPA's New Source Complements

State compliance plans that regulate new sources using the EPA's new source complements will be presumptively approvable. However, the EPA's new source complements will represent a more stringent target in states expected to experience even modest development of combined cycle gas generation. The new source complement is determined by calculating the product of the NSPS (1,030 lb/MWh) and incremental demand growth.

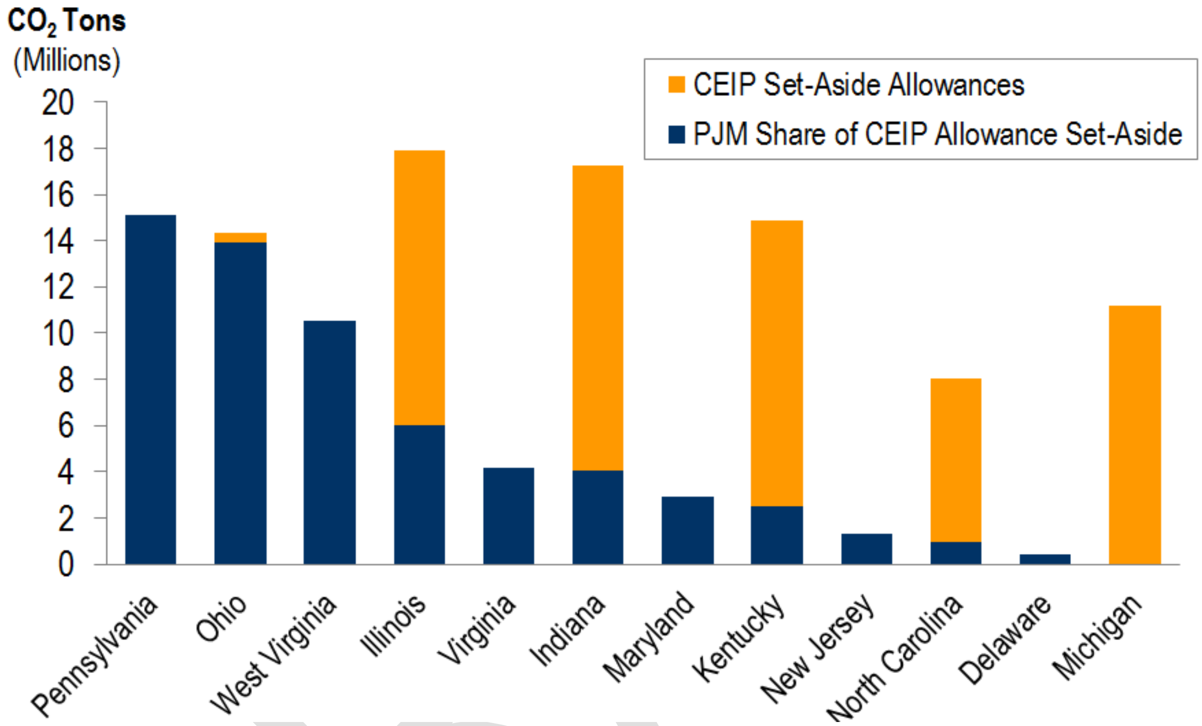
Unlike the set-asides, the EPA's new source complement increases the total allowances available, but for most states within PJM, the EPA's new source complement will also increase the number of resources competing for scarce allowances. Increasing the stringency of the targets will affect compliance cost and the economic viability of new and existing resources. Consequently, to address the EPA's new source complement impacts, PJM will use both PLEXOS' long-term resource entry/exit model and Security Constrained Economic dispatch tool.

Clean Energy Incentive Program

OPSI requested that PJM evaluate the effects of the Clean Energy Incentive Program (CEIP) in incentivizing new investments in energy efficiency. The Clean Energy Incentive Program incentivizes early CO_2 reductions associated with energy produced or reduced in 2020 and 2021. Only renewable resources that begin construction or energy efficiency that commence operation after a state submits its final state plan can qualify for the program. Furthermore, qualifying energy efficiency programs must be located in low-income communities. Qualifying resources receive either Emissions Rate Credits or emission allowances taken from a state set-aside for the first interim compliance step period (2022-2024). States that submit approved state plans can voluntarily participate in the Clean Energy Incentive Program. However, the EPA proposes an automatic set-aside for states subject to a Federal Plan. Set-asides reduce the freely distributable emissions allowances to affected electric generating units.

As an additional participation incentive, the EPA will provide matching credits up to 300 million CO_2 allowances. The EPA will distribute matching credits to states that either voluntarily participate in the Clean Energy Incentive Program or that are required to through the EPA's federal plan. The EPA will distribute the matching credits pro-rata based upon each state's share of CO_2 reduction responsibility. Figure 10 below shows the Clean Energy Incentive Program matching set-asides by state.

Figure 10. CEIP Allowance Matching Set-Aside for 2020 and 2021



While the total nationwide allowances is limited to 300 million CO_2 allowances, the program incentive to invest in energy efficiency is greater than for renewables because every MWh reduction generates two matching credits. Finally, if states submit a state plan but opt not to participate in the Clean Energy Incentive Program, the EPA will distribute their share of allowances to the participating states using the same pro-rata method as the initial distribution.

Similar to the set-asides intended to address leakage, the Clean Energy Incentive Program is intended to spur development of zero-emitting resources beyond that which would be expected for a business-as-usual case. The actual amount of incremental renewables or energy efficiency will depend on other potential investments and the expected allowance prices.

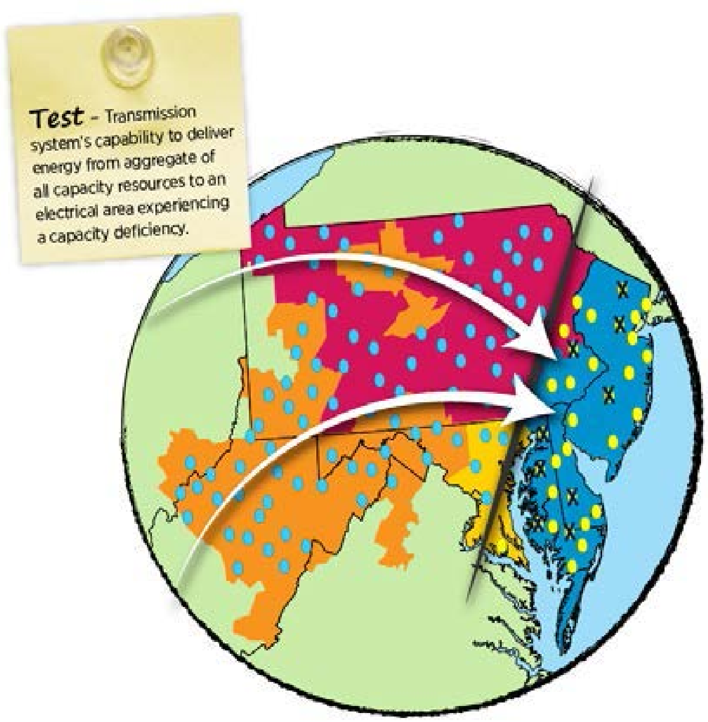
Appendix B: PJM Reliability Test Descriptions

Load Deliverability Test

When an area cannot meet its load-serving requirement from internally generated power – whether an individual LDA or the PJM area as a whole – it must import it. Transmission lines become more heavily loaded to the degree that generation is removed from an area and not replaced with the same quantity MW at the same location. If either or both location and quantity differ from what was originally there, transmission flows are altered. That is essentially the nature of deliverability tests from a transmission-planning perspective.

PJM's load deliverability test requires that the transmission system must be robust enough to deliver energy from an aggregate of all capacity resources to an LDA experiencing a capacity deficiency, shown conceptually in Figure 11. The test ensures that load inside an LDA can be served by generating resources outside that LDA. If sufficient generating capacity cannot be delivered to load as a result of one or more limiting transmission constraints, the LDA fails the load deliverability test. The methodology requires that each LDA under test be modeled at a higher than normal load level – 10 percent probability of occurring – with higher levels of unavailable generation than normal. Load deliverability studies test the transmission system's capability to import sufficient energy to meet a defined capacity emergency transfer objective.

Figure 11. Load Deliverability Test Concept



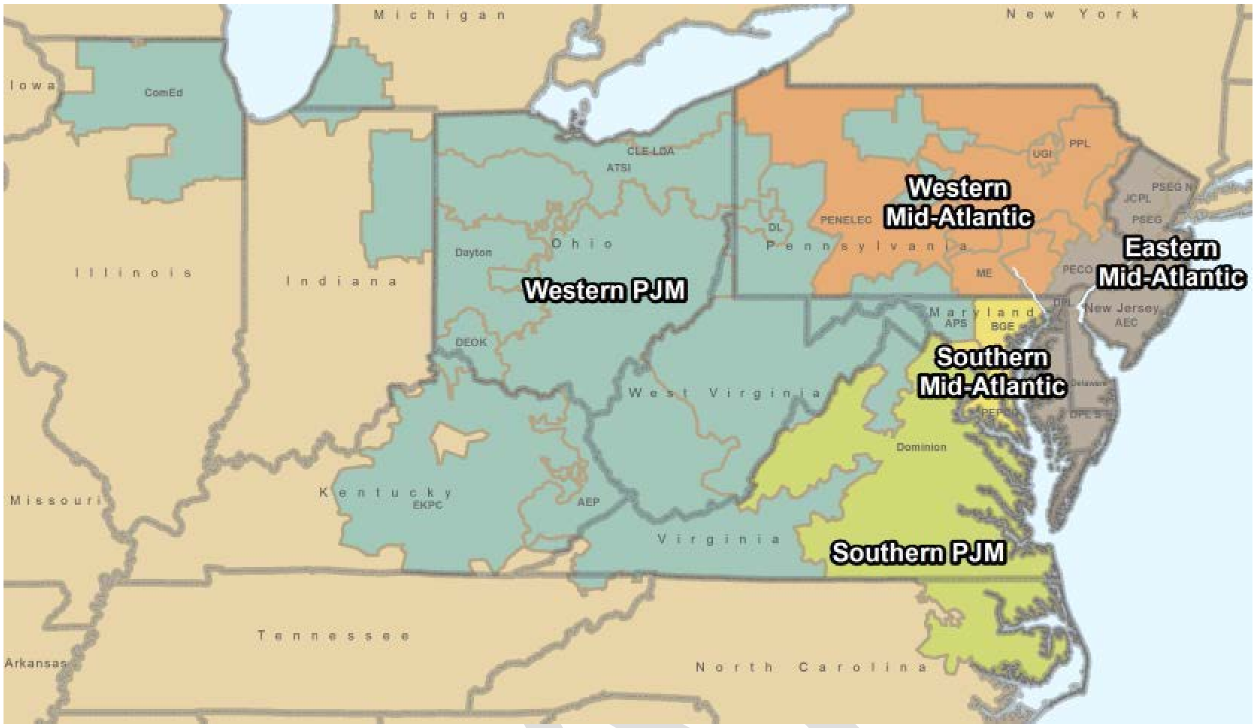
The CETO calculated for the load deliverability test is the import capability required for the area to meet a loss-of-load expectation risk level of one event in 25 years. The risk refers to the probability that an LDA would need to shed load due solely to its inability to import needed capacity assistance during a capacity emergency (i.e., the transmission system is not robust enough to import sufficient power during a capacity emergency). PJM calculates a CETO value for each of the LDAs using a realistic probable model of the load and capacity located within each LDA. The model recognizes, among other factors, historical load variability, load forecast error, generating unit maintenance requirements and generating unit forced outage rates. A number of factors drive CETO value increases, including the following:

- LDA peak load increase
- LDA capacity resource decreases including generation, demand resource programs and energy efficiency
- LDA capacity resources

CETO values calculated for the CPP analyses took into account the deactivation of at-risk generation within each LDA. Under PJM's RTEP process, load deliverability power flow analysis results identify the CETL for each LDA. This value represents the maximum megawatts that an LDA can import under specified peak-load test conditions.

Transmission system topology changes, including the addition (or removal) of transmission facilities and changes in the load distribution profile within a zone, impact CETL levels, as do the addition and retirement of generation facilities. Each LDA is tested for its expected import capability up to established transmission facility limits, indicating how much an area can actually be expected to import. If the CETL value is less than CETO, the test fails, indicating the need for additional transmission capability. Transmission limits are defined in terms of facility thermal ratings and voltage limits.

Figure 12. Locational Deliverability Areas

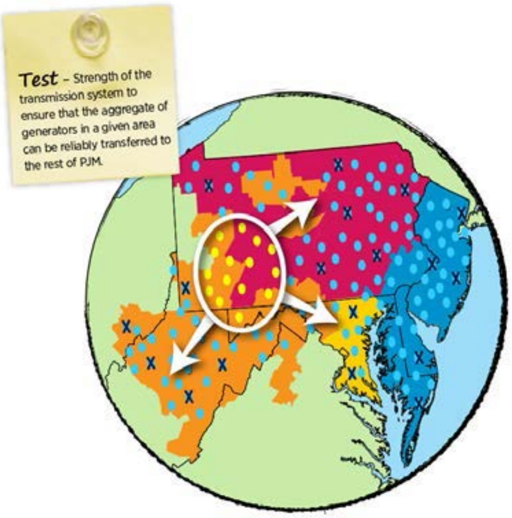


Generation Deliverability and Common Mode Analysis

Generator deliverability testing ensures that the transmission system will not limit delivery of capacity resources, so that generation is not “bottled” when needed. The test considers both the ramping impact of generators that are electrically close to a particular flowgate and the ramping impact of queued generation that is electrically further away. Generator deliverability testing ensures sufficient transmission capability to export generation capacity in excess of forecasted peak load from an area to the aggregate of PJM load. Specifically, the scope of generator deliverability tests the strength of the transmission system to ensure that the excess capacity of an aggregate of generators in a given area can be reliably transferred to the rest of PJM, as shown in Figure 13. Generator deliverability testing is used to assess Category A and B contingencies as part of baseline analysis, and as part of queued interconnection request studies.

PJM analysis also included Category C common mode contingencies. Common mode contingency studies determine the impact of losing multiple facilities that share a common element or system protection arrangement. These include bus faults, breaker failures, double circuit tower line outages and stuck breaker events.

Figure 13. Generation Deliverability Test



Transmission Limits

Transmission limits are defined in terms of facility thermal ratings and voltage limits. From a planning perspective, a thermal overload occurs on a bulk electric system facility if flow on that facility exceeds 100 percent of one of the following:

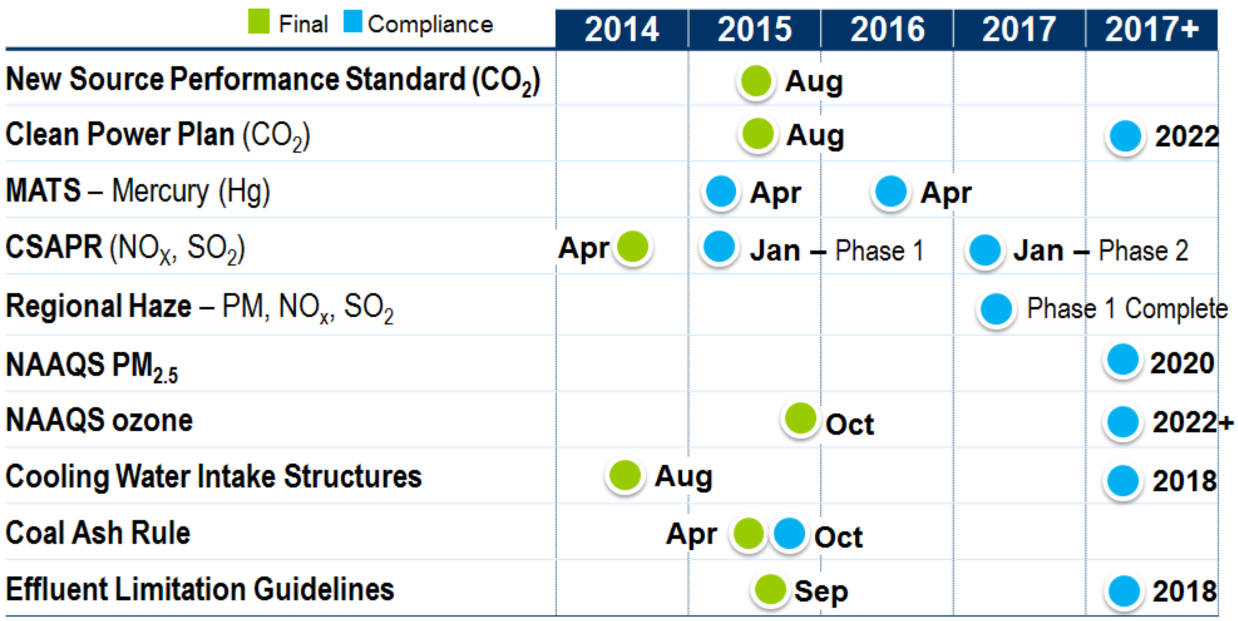
- The facility's normal rating with all facilities in service (NERC Category A)
- The facility's emergency rating following the loss of a single facility (NERC Category B)

Likewise, voltages are also monitored for compliance with existing voltage limits specified in terms of permissible bus voltage level and contingency voltage drop, as specified by PJM Operations. Consistent with deliverability studies for thermal criteria violations, PJM's load deliverability testing methodology also evaluates compliance with reliability voltage criteria.

Appendix C: EPA Environmental Regulations

EPA's Regulatory Impact Assessment used a base case in which all of the current EPA regulations are enforced to determine the system impacts independent of the Clean Power Plan. The other environmental regulations all have compliance deadlines that precede the Clean Power Plan's final emissions reduction targets. See Figure 14 below for current EPA emissions regulations and compliance dates.

Figure 14. EPA Regulations "on the books"



Hg – Mercury
NO_x – Nitrogen Oxides

PM – Particulate Matter
SO_2 – sulfur dioxide

NAAQS – National Ambient Air Quality Standards;
Coal Ash – impoundment retrofit or closure requirements take effect in 2019; monitoring requirements begin six months after the rule is final.

Resources are able to include environmental retrofit cost as part of their resource bids in the PJM Capacity Market. PJM resources already have capacity obligations for the 2018/2019 delivery year, which overlaps with the compliance deadlines for most of the above regulations.

The emissions regulations that result in effluent trading, such as CSAPR, are already represented in the ABB simulation ready data release with an SO_2 and NO_x price. As part of this phase of analysis, PJM does not plan to perform separate analysis to evaluate compliance with these other emissions regulations. In a later phase of analysis, PJM will review the results of future Capacity Market auctions to evaluate whether there are significant changes in the cleared resources that would impact compliance choices for states.