

EPA's Clean Power Plan

PJM Modeling Approach and Deliverables

PJM Interconnection
November 16, 2015

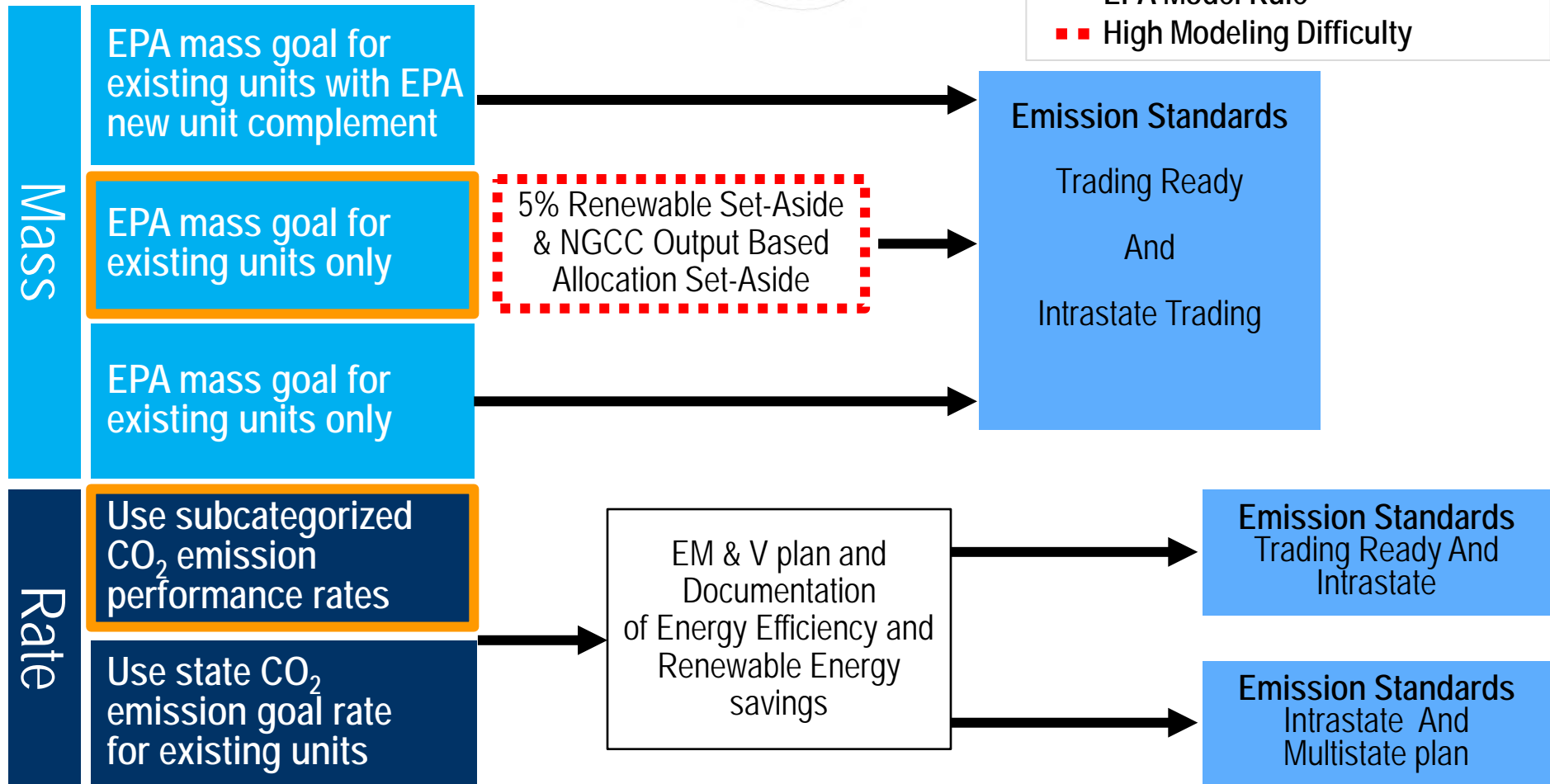
- What is it?
 - US EPA released its Final Clean Power Plan rule to regulate CO₂ emissions on August 3, 2015
 - For the PJM region, the regulation calls for a 36 percent reduction in CO₂ emissions versus 2005 levels and 23 percent reduction relative to 2012 CO₂ levels through enforcement of rate and/or mass based emissions standards
- What is PJM Doing?
 - Provide an assessment of the potential economic and reliability impacts of the EPA's Clean Power Plan compliance pathways
 - Primary study years: 2023, 2026
 - PJM will also study 2028, 2030 but with less detailed transmission modeling
- What is PJM not doing?
 - Initial analysis is not intended to be used to inform transmission upgrades for the PJM Regional Transmission Expansion Plan (RTEP)

Compliance Pathways Proposed for Study

Compliance Type

Requirements, Plan Type, and Trading Options

- EPA Model Rule
- High Modeling Difficulty



PLEXOS[®] enables PJM to perform the economic analysis required to evaluate the CPP Compliance Pathways and provide the necessary inputs for detailed reliability analysis:

- Long-term resource entry/exit optimization with enforcement of multiple emissions limits
- Security constrained economic dispatch analysis with enforcement of multiple emissions limits
- Detailed renewable generation modeling
- Representation of energy efficiency and demand response

- What is it?

Economic base case that will be compared to CPP compliance scenarios to determine compliance impacts
- What will be included?
 - New capacity resources based on PJM capacity market results for the 2018/2019 delivery year
 - Under-construction energy only (e.g. wind and solar) resources
 - Demand side management resources based on PJM capacity market results for the 2018/2019 delivery year
 - Announced deactivations will not be simulated
 - Incorporate compliance with other environmental regulations to the extent possible
 - Beyond 2018, new resources will enter/exit the market based upon market signals

Input	Primary Source for Data
Load Forecast	2016 PJM Load forecast
Transmission Model	2015 PJM Regional Transmission Expansion Plan
Forecast Fuel Prices	ABB NERC Summer 2015 database ^[1]
Energy Efficiency	Included in 2016 PJM load forecast
Renewable Resource Levels	Economic based on National Renewable Energy Laboratory Annual Technology Baseline
Unit Capital and Fixed O&M Cost	EPA's assumptions for new unit capital costs, financing and construction time adjusted by locational and design differences ^[2]
Unit-Level Operating Characteristics	ABB Simulation Ready database ^[3]
Unit Entry/Exit	PLEXOS [®] will determine economic resources based on long-term optimization
Siting of New Entrants	PJM interconnection queue by study status, network upgrade, and LDA region

[1] PJM will use IHS CERA Energy North American Monthly Gas Market Outlook for the natural gas price forecast. [2] The EPA data will be supplemented with other public (e.g. EIA) and commercial data sources (e.g. Velocity Suite and SNL) available to PJM. [3] PJM typically reviews ABB's base data using internal and commercial datasets.

Note: PJM is working with MISO to coordinate modeling assumptions where possible.

Clean Power Plan Feature	State Plan	Federal Plan	Consideration
Include 111(b) Sources using New Source Complements	Yes	Not Available	Plan presumptively approved
Establish 5% Renewable Energy allowance set-aside	Yes	Yes	Plan presumptively approved if both set-asides implemented
Establish output based allowance set-aside for existing Natural Gas Combined Cycle (NGCC)	Yes	Yes	

Sensitivity	Implementation	Modeling Reasoning
High Energy Efficiency	Use the EPA's projections for energy efficiency applied in the EPA's Regulatory Impact Analysis	Lowers load growth which in turn reduces compliance costs and the need to add supply side resources
Natural Gas Price Forecast	Review historical variances in the Henry Hub futures price markets and develop high/low scenario	Higher natural gas prices will cause compliance costs to increase and change economic competitiveness of resources
Capital and Financing Costs	Modify overnight capital costs or the Weighted Average Costs of Capital by a factor (+/-)	Levelized cost of energy differences can lead to different resource entry outcomes
States Meet Renewable Portfolio Standards	Implement carve-outs by state. Remaining renewable technology to satisfy the RPS will be selected based on interconnection queue distribution	Assume PTC and ITC receive a longer-term renewal before the start of compliance, thus removing investment uncertainty
EPA Environmental Regulations	Include environmental retrofit costs in resource fixed costs within capacity expansion model	Increases revenue requirements for existing resources and makes new resource entry more attractive
Clean Energy Incentive Program	Optimize renewable and energy efficiency buildout based upon state set-aside and matching EPA allowances for the PJM region	Investment Incentive for 2020 and 2021 is expected to lead to higher renewable/energy efficiency generation supply or load reduction
Trade Ready Rate and Mass Together	PJM will simultaneously study some states as achieving rate-based compliance and other states as achieving mass-based compliance	PJM expects some states may have a preference for mass- or rate-based compliance whereas other states may be indifferent

- Excel Results by individual state and/or PJM region:
 - Carbon dioxide price, total emissions and emissions rate
 - Locational Marginal Prices and energy market load payments
 - Aggregate facility level transmission congestion by voltage level
 - Monthly peak hour natural gas flows
 - Percentage of generation by prime mover and fuel type
 - Capacity retired and added by Locational Deliverability Area
 - Fuel, and variable operations and maintenance production cost
 - Resource expansion capital costs
- Compliance Pathways Economic Assessment Report
- Generation and Load Deliverability tests based on resulting compliance pathway generation portfolio

Analysis of Final CPP Rule – Timeline

