

Environmental and Renewable Energy Regulations

Environmental requirements and renewable energy mandates have a significant impact on PJM markets. The Mercury and Air Toxics Standards Rule (MATS) requires significant investments for some fossil-fired power plants in the PJM footprint in order to reduce heavy metal emissions. The EPA has promulgated intrastate and interstate air quality standards and associated emissions limits for states. The most recent interstate emissions rule, the Cross-State Air Pollution Rule (CSAPR), will, when implemented, also require investments for some fossil-fired power plants in the PJM footprint in order to reduce SO₂ and NO_x emissions. New Jersey's high electric demand day (HEDD) rule limits NO_x emissions on peak energy demand days and requires investments for noncompliant units. CO₂ costs resulting from RGGI affect some unit offers in the PJM energy market. The investments required for environmental compliance have resulted in higher offers in the capacity market, and when units do not clear, in the retirement of units.

Renewable energy mandates and associated incentives by state and federal governments have resulted in the construction of substantial amounts of renewable capacity in the PJM footprint, especially wind and solar powered resources. Renewable energy credit (REC) markets created by state programs and federal tax credits have potentially significant impacts on PJM wholesale markets.¹

Overview

Federal Environmental Regulation

- **EPA Mercury and Air Toxics Standards Rule.** On December 16, 2011, the U.S. Environmental Protection Agency (EPA) issued its Mercury and Air Toxics Standards rule (MATS), which applies the Clean Air Act (CAA) maximum achievable control technology (MACT) requirement to new or modified sources of emissions of mercury and arsenic, acid gas, nickel,

selenium and cyanide.² The rule establishes a compliance deadline of April 16, 2015.

In addition, in a related EPA rule issued on the same date regarding utility New Source Performance Standards (NSPS), the EPA requires new coal and oil fired electric utility generating units constructed after May 3, 2011, to comply with amended emission standards for SO₂, NO_x and filterable particulate matter (PM). On March 28, 2013, the EPA issued a rule that raised the new source limits for new coal- and oil-fired power plants based on new information and analysis.³

- **Air Quality Standards (NO_x and SO₂ Emissions).** The CAA requires each state to attain and maintain compliance with fine PM and ozone national ambient air quality standards (NAAQS). Much recent regulatory activity concerning emissions has concerned the development and implementation of a transport rule to address the CAA's requirement that each state prohibit emissions that significantly interfere with the ability of another state to meet NAAQS.⁴

On April 29, 2014, the U.S. Supreme Court upheld EPA's Cross-State Air Pollution Rule (CSAPR), clearing the way for the EPA to implement this rule and to replace the Clean Air Interstate Rule (CAIR) now in effect.⁵

- **National Emission Standards for Reciprocating Internal Combustion Engines.** On January 14, 2013, the EPA signed a final rule regulating emissions from a wide variety of stationary reciprocating internal combustion engines (RICE).⁶ RICE includes certain types of electrical generation facilities like diesel engines typically used for backup, emergency or supplemental power. RICE includes facilities located behind the meter. The rule exempts from its requirements one hundred hours of RICE operation in emergency demand response programs, provided

¹ For quantification of the economics of new entrant wind and solar installations, see the 2013 *State of the Market Report for PJM*, Volume II, Section 7, "Net Revenue."

² *National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units*, EPA Docket No. EPA-HQ-OAR-2009-0234, 77 Fed. Reg. 9304 (February 16, 2012).

³ *Reconsideration of Certain New Source Issues: National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units*, EPA Docket No. EPA-HQ-OAR-2009-0234, 78 Fed. Reg. 24073 (April 24, 2013).

⁴ CAA § 110(a)(2)(D)(i)(I).

⁵ See EPA et al. v. EME Homer City Generation, L.P. et al., No. 12-1182.

⁶ *National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; New Source Performance Standards for Stationary Internal Combustion Engines*, Final Rule, EPA Docket No. EPA-HQ-OAR-2008-0708, 78 Fed. Reg. 9403 (January 30, 2013).

that RICE uses ultra low sulfur diesel fuel (ULSD). Otherwise, a 15-hour exception applies. Emergency demand response programs include Demand Resources in RPM.

Pending initiatives in Pennsylvania and the District of Columbia would reverse the EPA's exception in those jurisdictions and apply comparable regulatory standards to generation with similar operational characteristics.⁷

In PJM's recent filing to improve its ability to dispatch DR prior to emergency system conditions, PJM proposed to retain the PJM Emergency Load Response Program apparently for the sole purpose of allowing RICE to continue to use the EPA's exception.⁸ The MMU protested retention of the emergency program, particularly for the purpose of according discriminatory preference to resources that are not good for reliability, the markets or the environment.⁹ An order from the Commission in this matter is now pending.

- **Greenhouse Gas Emissions Rule.** On September 20, 2013, the EPA proposed standards placing national limits on the amount of CO₂ that new power plants would be allowed to emit.¹⁰ The proposed rule includes two limits for fossil fuel fired utility boilers and IGCC units based on the compliance period selected: 1,100 lb CO₂/MWh gross over a 12 operating month period, or 1,000–1,050 lb CO₂/MWh gross over an 84 operating month (7-year) period. The proposed rule also includes two standards for natural gas fired stationary combustion units based on the size (MW): 1,000 lb CO₂/MWh gross for larger units (> 850 mmBtu/hr), or 1,100 lb CO₂/MWh gross for smaller units (≤ 850 mmBtu/hr). Contemporaneously, the EPA withdrew its proposed rule on the same matter, published April 13, 2012.¹¹
- **Cooling Water Intakes.** Section 316(b) of the Clean Water Act (CWA) requires that cooling water intake structures reflect the best available

technology for minimizing adverse environmental impacts. A final rule implementing this requirement is expected to be issued by May 16, 2014.

State Environmental Regulation

- **NJ High Electric Demand Day (HEDD) Rule.** New Jersey addressed the issue of NO_x emissions on peak energy demand days with a rule that defines peak energy usage days, referred to as high electric demand days or HEDD, and imposes operational restrictions and emissions control requirements on units responsible for significant NO_x emissions on such high energy demand days.¹² New Jersey's HEDD rule, which became effective May 19, 2009, applies to HEDD units, which include units that have a NO_x emissions rate on HEDD equal to or exceeding 0.15 lbs/MMBtu and lack identified emission control technologies.¹³
- **Regional Greenhouse Gas Initiative (RGGI).** The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap CO₂ emissions from power generation facilities. Auction prices in 2014 for the 2012-2014 compliance period were at \$4.00 per ton, above the price floor for 2014. The clearing price is equivalent to a price of \$4.41 per metric tonne, the unit used in other carbon markets.

Emissions Controls in PJM Markets

Environmental regulations affect decisions about emission control investments in existing units, investment in new units and decisions to retire units lacking emission controls. As a result of environmental regulations and agreements to limit emissions, many PJM units burning fossil fuels have installed emission control technology. On March 31, 2014, 70.6 percent of coal steam MW had some type of FGD (flue-gas desulfurization) technology to reduce SO₂ emissions from coal steam units, while 98.7 percent of coal steam MW had some type of particulate control, and 91.7 percent of fossil fuel fired capacity in PJM had NO_x emission control technology.

⁷ See Pennsylvania House of Representatives, House Bill No. 1699; Council of the District of Columbia bill 20-569.

⁸ PJM Tariff filing, FERC Docket No. ER14-822 (December 24, 2013).

⁹ Comments, Complaint and Motion to Consolidate of the Independent Market Monitor for PJM, FERC Docket No. ER14-822 (January 14, 2014) at 3-6.

¹⁰ *Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, Propose Rule*, EPA-HQ-OAR-2013-0495.

¹¹ *Withdrawal of Proposed Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units*, EPA-HQ-OAR-2011-0660 (September 20, 2013).

¹² N.J.A.C. § 7:27-19.

¹³ CIs must have either water injection or selective catalytic reduction (SCR) controls; steam units must have either an SCR or and selective non-catalytic reduction (SNCR).

State Renewable Portfolio Standards

Many PJM jurisdictions have enacted legislation to require that a defined percentage of utilities' load be served by renewable resources, for which there are many standards and definitions. These are typically known as renewable portfolio standards, or RPS. As of March 31, 2014, Delaware, Illinois, Indiana, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, and Washington D.C. had renewable portfolio standards. Virginia has enacted a voluntary renewable portfolio standard. Kentucky and Tennessee have not enacted renewable portfolio standards. West Virginia has enacted a renewable portfolio standard, but it will not be in effect until 2015.

Renewable energy credits (RECs) provide out of market payments to qualifying resources, primarily wind and solar. The out of market payments in the form of RECs and federal production tax credits mean that these units have an incentive to generate MWh until the LMP is equal to the marginal cost of producing power minus the credit received for each MWh. As the net of marginal cost and credits can be negative, the credits can provide an incentive to make negative energy offers. These subsidies affect the offer behavior of these resources in PJM markets and thus the market prices and the mix of clearing resources.

Conclusion

Environmental requirements and renewable energy mandates at both the federal and state levels have a significant impact on the cost of energy and capacity in PJM markets. Renewable energy credit markets are markets related to the production and purchase of wholesale power, but are not subject to FERC regulation or any other market regulation or oversight. RECs markets are not transparent. Data on RECs prices and markets are not publicly available. RECs markets are, as an economic fact, integrated with PJM markets including energy and capacity markets, but are not formally recognized as part of PJM markets.

PJM markets provide a flexible mechanism for incorporating the costs of environmental controls and meeting environmental requirements in a cost

effective manner. PJM markets also provide a flexible mechanism that incorporates renewable resources and renewable energy credit markets, and ensures that renewable resources have access to a broad market. PJM markets provide efficient price signals that permit valuation of resources with very different characteristics when they provide the same product.

Federal Environmental Regulation

The U.S. Environmental Protection Agency (EPA) administers the Clean Air Act (CAA), which, among other things, comprehensively regulates air emissions by establishing acceptable levels of and regulating emissions of hazardous air pollutants. The EPA issues technology based standards for major sources and certain area sources of emissions.^{14,15} The EPA actions have and are expected to continue to affect the cost to build and operate generating units in PJM, which in turn affects wholesale energy prices and capacity prices.

The EPA also regulates water pollution, and its regulation of cooling water intakes under section 316(b) of the Clean Water Act (CWA) affects generating plants that rely on water drawn from jurisdictional water bodies.¹⁶

Control of Mercury and Other Hazardous Air Pollutants

Section 112 of the CAA requires the EPA to promulgate emissions control standards, known as the National Emission Standards for Hazardous Air Pollutants (NESHAP), from both new and existing area and major sources.

On December 21, 2011, the U.S. Environmental Protection Agency (EPA) issued its Mercury and Air Toxics Standards rule (MATS), which applies the Clean Air Act (CAA) maximum achievable control technology (MACT) requirement to new or modified sources of emissions of mercury and arsenic, acid gas,

¹⁴ 42 U.S.C. § 7401 et seq. (2000).

¹⁵ The EPA defines "major sources" as a stationary source or group of stationary sources that emit or have the potential to emit 10 tons per year or more of a hazardous air pollutant or 25 tons per year or more of a combination of hazardous air pollutants. An "area source" is any stationary source that is not a major source.

¹⁶ The CWA applies to "navigable waters," which are, in turn, defined to include the "waters of the United States, including territorial seas." 33 U.S.C. § 1362(7). An interpretation of this rule has created some uncertainty on the scope of the waters subject to EPA jurisdiction, (see *Rapanos v. U.S., et al.*, 547 U.S. 715 (2006)), which the EPA continues to attempt to resolve.

nickel, selenium and cyanide.¹⁷ The rule establishes a compliance deadline of April 16, 2015.

In addition, in a related EPA rule issued on the same date regarding utility New Source Performance Standards (NSPS), the EPA requires new coal and oil fired electric utility generating units constructed after May 3, 2011, to comply with amended emission standards for SO₂, NO_x and filterable particulate matter (PM). On March 28, 2013, the EPA issued a rule that raised the new source limits for new coal- and oil-fired power plants based on new information and analysis.¹⁸

Air Quality Standards: Control of NO_x, SO₂ and O₃ Emissions Allowances

The CAA requires each state to attain and maintain compliance with fine particulate matter and ozone national ambient air quality standards (NAAQS). Under NAAQS, the EPA establishes emission standards for six air pollutants, including NO_x, SO₂, O₃ at ground level, PM, CO, and Pb, and approves state plans to implement these standards, known as “SIPs.” Standards for each pollutant are set and periodically revised, most recently for SO₂ in 2010, and SIPs are filed, approved and periodically revised accordingly.

Much recent regulatory activity concerning emissions has concerned the development and implementation of a transport rule to address the CAA’s requirement that each state prohibit emissions that significantly interfere with the ability of another state to meet NAAQS.¹⁹

On April 29, 2014, the U.S. Supreme Court upheld EPA’s Cross-State Air Pollution Rule (CSAPR), clearing the way for the EPA to implement this rule and to replace the Clean Air Interstate Rule (CAIR) now in effect.²⁰

¹⁷ *National Emission Standards for Hazardous Air Pollutants From Coal and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units*, EPA Docket No. EPA-HQ-OAR-2009-0234, 77 Fed. Reg. 9304 (February 16, 2012); *aff’d*, *White Stallion Energy Center, LLC v. EPA*, No. 12-1100 (D.C. Cir. April 15, 2014).

¹⁸ *Reconsideration of Certain New Source Issues: National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units*, EPA Docket No. EPA-HQ-OAR 2009-0234, 78 Fed. Reg. 24073 (April 24, 2013).

¹⁹ CAA § 110(a)(2)(D)(i)(I).

²⁰ See *EPA et al. v. EME Homer City Generation, LP et al.*, No. 12-1182.

EPA finalized the CSAPR on July 6, 2011. CSAPR requires specific states in the eastern and central United States to reduce power plant emissions of SO₂ and NO_x that cross state lines and contribute to ozone and fine particle pollution in other states, to levels consistent with the 1997 ozone and fine particle and 2006 fine particle NAAQS.²¹ The CSAPR covers 28 states, including all of the PJM states except Delaware, and also excluding the District of Columbia.²²

CSAPR establishes two groups of states with separate requirements standards. Group 1 includes a core region comprised of 21 states, including all of the PJM states except Delaware, and also excluding the District of Columbia.²³ Group 2 does not include any states in the PJM region.²⁴ Group 1 states must reduce both annual SO₂ and NO_x emissions to help downwind areas attain the 24-Hour and/or Annual Fine Particulate Matter²⁵ NAAQS and to reduce ozone season NO_x emissions to help downwind areas attain the 1997 8-Hour Ozone NAAQS.

Under the original timetable for implementation, emission reductions were expected to become effective starting January 1, 2012, for SO₂ and annual NO_x reductions and May 1, 2012, for ozone season NO_x reductions. CSAPR requires reductions of emissions for each state below certain assurance levels, established separately for each emission type. Assurance levels are the state budget for each type of emission, determined by the sum of unit-level allowances assigned to each unit located in such state, plus a variability limit, which is meant to account for the inherent variability in the state’s yearly baseline emissions. Because allowances are allocated only up to the state emissions budget, any level of emissions in a state above its budget must be covered by allowances obtained through trading for unused allowances allocated to units located in other states included in the same group.

²¹ *Federal Implementation Plans: Interstate Transport of Fine Particulate Matter and Ozone and Correction of SIP Approvals*, Final Rule, Docket No. EPA-HQ-OAR-2009-0491, 76 Fed. Reg. 48208 (August 8, 2011) (CSAPR); *Revisions to Federal Implementation Plans To Reduce Interstate Transport of Fine Particulate Matter and Ozone*, Final Rule, Docket No. EPA-HQ-2009-0491, 77 Fed. Reg. 10342 (February 21, 2012) (CSAPR II).

²² *Id.*

²³ Group 1 states include: New York, Pennsylvania, New Jersey, Maryland, Virginia, West Virginia, North Carolina, Tennessee, Kentucky, Ohio, Indiana, Illinois, Missouri, Iowa, Wisconsin, and Michigan.

²⁴ Group 2 states include: Minnesota, Nebraska, Kansas, Texas, Alabama, Georgia and South Carolina.

²⁵ EPA defines Particulate Matter (PM) as “[a] complex mixture of extremely small particles and liquid droplets. It is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles.” Fine PM (PM_{2.5}) measures less than 2.5 microns across.

Under the original implementation timetable, significant additional SO₂ emission reductions would have taken effect in 2014 from certain states, including all of the PJM states except Delaware, and also excluding the District of Columbia.

The rule provides for implementation of a trading program for states in the CSAPR region. Sources in each state may achieve those limits as they prefer, including unlimited trading of emissions allowances among power plants within the same state and limited trading of emission allowances among power plants in different states in the same group. Thus, units in PJM states may only trade and use allowances originating in Group 1 states.

If state emissions exceed the applicable assurance level, including the variability limit, a penalty would be assessed that is allocated to resources within the state in proportion to their responsibility for the excess. The penalty would be a requirement to surrender two additional allowances for each allowance needed to cover the excess.

Because of the delay resulting from judicial review, the initial timetable for implementation is not feasible and must be replaced. In the meantime, EPA advises that CAIR remains in effect and “no immediate action from States or affected sources is expected.”²⁶

Emission Standards for Reciprocating Internal Combustion Engines

On January 14, 2013, the EPA signed a final rule regulating emissions from a wide variety of stationary reciprocating internal combustion engines (RICE).²⁷ RICE include certain types of electrical generation facilities like diesel engines typically used for backup, emergency or supplemental power. RICE include facilities located behind the meter. These rules include: National Emission Standard for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE); New Source Performance Standards (NSPS)–

Standards of Performance for Stationary Spark Ignition Internal Combustion Engines; and Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (collectively “RICE Rules”).²⁸

The RICE Rules apply to emissions such as formaldehyde, acrolein, acetaldehyde, methanol, CO, NO_x, volatile organic compounds (VOCs) and PM. The regulatory regime for RICE is complicated, and the applicable requirements turn on the location of the engine (area source or major source), and the starter mechanism for the engine (compression ignition or spark ignition).

On May 22, 2012, the EPA proposed amendments to the RICE NESHAP Rule.²⁹ The proposed rule allowed owners and operators of emergency stationary internal combustion engines to operate them in emergency conditions, as defined in those regulations, as part of an emergency demand response program for 100 hours per year or the minimum hours required by an Independent System Operator’s tariff, whichever is less. The MMU objected to the proposed rule, as it had to similar provisions in a related proposed settlement released for comment, explaining that it was not required for participation by demand resources in the PJM markets, nor for reliability.³⁰ The final rule approves the proposed 100 hours per year exception, provided that RICE uses ultra low sulfur diesel fuel (ULSD).³¹ Otherwise a 15-hour exception applies.³² The exempted emergency demand response programs include demand resources in RPM.³³

Pending initiatives in Pennsylvania and New Jersey would reverse the EPA’s exception in those jurisdictions and apply comparable regulatory standards to generation with similar operational characteristics in those jurisdictions.³⁴ The MMU and PJM have stated that these state measures would not, if enacted,

²⁶ See EPA, “Cross-State Air Pollution Rule (CSAPR),” <<http://www.epa.gov/airtransport/CSAPR/>>.

²⁷ *National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; New Source Performance Standards for Stationary Internal Combustion Engines*, Final Rule, EPA Docket No. EPA-HQ-OAR-2008-0708, 78 Fed. Reg. 6674 (January 30, 2013) (“Final NESHAP RICE Rule”).

²⁸ EPA Docket No. EPA-H-OAR-2009-0234 Et -2011-0044, codified at 40 CFR Part 63, Subpart ZZZZ; EPA Dockets Nos. EPA-HQ-OAR-2005-0030 Et EPA-HQ-OAR-2005-0029, -2010-0295, codified at 40 CFR Part 60 Subpart JJJJ.

²⁹ *National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; New Source Performance Standards for Stationary Internal Combustion Engines*, Proposed Rule, EPA Docket No. EPA-HQ-OAR-2008-0708.

³⁰ See Comments of the Independent Market Monitor for PJM, Docket No. EPA-HQ-OAR-2008-0708 (August 9, 2012); *In the Matter of: EnerNOC, Inc., et al.*, Comments of the Independent Market Monitor for PJM, Docket No. EPA-HQ-OGC-2011-1030 (February 16, 2012).

³¹ Final NESHAP RICE Rule at 31–24.

³² *Id.* at 31.

³³ If FERC approves the PJM Interconnection Docket No. ER14-822-000, demand resources that utilize behind-the-meter generators will maintain emergency status and not have to curtail during pre-emergency events.

³⁴ See Pennsylvania House of Representatives, House Bill No. 1699; Council of the District of Columbia bill 20-569.

have any harmful impact on system reliability.³⁵ The MMU has also explained that such measures would improve markets.³⁶

On December 24, 2013, PJM filed revisions to the rules providing for a PJM Pre-Emergency Load Response Program that allows PJM to dispatch resources participating in the program with no prerequisite for system emergency conditions.³⁷ PJM retained the PJM Emergency Load Response Program (ELRP), but proposed to restrict participation in the ELRP to DR based on “generation that is behind the meter and has strict environmental restrictions on when it can operate.”³⁸ Such restrictions refer to the EPA’s amended RICE NESHAP Rule. EPA created an exception to and weakened its NESHAP RICE Rule based on arguments that markets such as PJM needed RICE for reliability. PJM created an exception to and weakened its rule intended to enhance reliability in order to avoid interfering with the EPA exception. The MMU protested retention of the emergency program, particularly for the purpose of according discriminatory preference to resources that are not good for reliability, the markets or the environment.³⁹ An order from the Commission on PJM’s filing is now pending.

Regulation of Greenhouse Gas Emissions

On April 2, 2007, the U.S. Supreme Court overruled the EPA’s determination that it was not authorized to regulate greenhouse gas emissions under the CAA and remanded the matter to the EPA to determine whether greenhouse gases endanger public health and welfare.⁴⁰ On December 7, 2009, the EPA determined that greenhouse gases, including carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride,

endanger public health and welfare.⁴¹ In a decision dated June 26, 2012, the U.S. Court of Appeals for the D.C. Circuit upheld the endangerment finding, rejecting challenges brought by industry groups and a number of states.⁴²

On September 20, 2013, the EPA proposed standards placing national limits on the amount of CO₂ that new power plants would be allowed to emit.⁴³ The standards would require advanced technologies like efficient natural gas units and efficient coal units implementing partial carbon capture and storage (CCS). The proposed rule includes two limits for fossil fuel fired utility boilers and IGCC units based on the compliance period selected: 1,100 lb CO₂/MWh gross over a 12 operating month period, or 1,000–1,050 lb CO₂/MWh gross over an 84 operating month (seven year) period. The proposed also includes two standards for natural gas fired stationary combustion units based on the size (MW): 1,000 lb CO₂/MWh gross for larger units (> 850 mmBtu/hr), or 1,100 lb CO₂/MWh gross for smaller units (≤ 850 mmBtu/hr). Contemporaneously, the EPA withdrew its proposed rule on the same matter, published April 13, 2012.⁴⁴

Federal Regulation of Environmental Impacts on Water

On March 28, 2011, the EPA issued a proposed rule intended to ensure that the location, design, construction, and capacity of cooling water intake structures reflects the best technology available (BTA) for minimizing adverse environmental impacts, as required under Section 316(b) of the CWA.⁴⁵ A settlement in a federal court, as modified, obligates the EPA to issue a final

35 See Comments of the Independent Market Monitor for PJM, EPA Docket No. EPA-HQ-OAR-0708 (August 9, 2012); Comments of the Independent Market Monitor for PJM, EPA Docket No. EPA-HQ-OGC-2011-1030 (February 16, 2012); Market Monitor, Comments of the Independent Market Monitor for PJM, Supporting Testimony before the Pennsylvania House of Representatives Environmental and Energy Committee re House Bill 1699, An Act Providing for the Regulation of Certain Reciprocal Internal Combustion Engines (November 20, 2013), which can be accessed at: <http://www.monitoringanalytics.com/reports/Reports/2013/IMM_Comments_to_PA_CERE_1699_20131120.pdf>; Letter from Terry Boston, President & CEO, PJM to Hon. Chris Ross re Pennsylvania House Bill 1999 (November 11, 2013) (“With regards to your inquiry of potential impacts to grid reliability, PJM does not anticipate the emergence of system reliability issues, should HB 1699 become law.”); Letter from Terry Boston, President & CEO, PJM to Hon. Mary M. Cheh re District of Columbia Bill 20-569 (December 19, 2013).

36 *Id.*

37 PJM Tariff filing, FERC Docket No. ER14-822 (December 24, 2014).

38 *Id.* at 8–9.

39 Comments, Complaint and Motion to Consolidate of the Independent Market Monitor for PJM, FERC Docket No. ER14-822 (January 14, 2014) at 3–6.

40 Massachusetts v. EPA, 549 U.S. 497.

41 See *Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act*, 74 Fed. Reg. 66496, 66497 (December 15, 2009).

42 Coalition for Responsible Regulation, Inc., et al. v. EPA, No 09-1322.

43 *Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units*, Proposed Rule, EPA-HQ-OAR-2013-0495, 79 Fed. Reg. 1430 (January 8, 2014); The President’s Climate Action Plan, Executive Office of the President (June 2013); Presidential Memorandum—Power Sector Carbon Pollution Standards, Environmental Protection Agency (“June 25, 2013); Presidential Memorandum—Power Sector Carbon Pollution Standards (June 25, 2013) (June 25th Presidential Memorandum”).

44 *Withdrawal of Proposed Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units*, EPA-HQ-OAR-2011-0660, 79 Fed. Reg. 1352 (January 8, 2014).

45 EPA, *National Pollutant Discharge Elimination System—Cooling Water Intake Structures at Existing Facilities and Phase I Facilities*, Proposed Rule, Docket No. EPA-HQ-OW-2008-0667, 76 Fed. Reg. 22174 (April 20, 2011) (Cooling Water Proposed Rule).

rule no later than April 17, 2014.⁴⁶ By letter dated April 16, 2014, EPA notified the court of its intention to complete the rulemaking by May 16, 2014.⁴⁷

State Environmental Regulation

New Jersey High Electric Demand Day (HEDD) Rules

The EPA's transport rules apply to total annual and seasonal emissions. Units that run only during peak demand periods have relatively low annual emissions, and have less incentive to make such investments under the EPA transport rules.

New Jersey addressed the issue of NO_x emissions on peak energy demand days with a rule that defines peak energy usage days, referred to as high electric demand days or HEDD, and imposes operational restrictions and emissions control requirements on units responsible for significant NO_x emissions on such high energy demand days.⁴⁸ New Jersey's HEDD rule, which became effective May 19, 2009, applies to HEDD units, which include units that have a NO_x emissions rate on HEDD equal to or exceeding 0.15 lbs/MMBtu and lack identified emission control technologies.⁴⁹

Table 8-1 shows the HEDD emissions limits applicable to each unit type. Emissions limits for coal units became effective December 15, 2012.⁵⁰ Emissions limits for other unit types will become effective May 1, 2015.⁵¹

46 Settlement Agreement among the United States Environmental Protection Agency, Plaintiffs in Cronin, et al. v. Reilly, 93 Civ. 314 (LTS) (SDNY), and Plaintiffs in Riverkeeper, et al. v. EPA, 06 Civ. 12987 (PKC) (SDNY), dated November 22, 2010, *modified*, Fifth Amendment to Settlement Agreement among the Environmental Protection Agency, the Plaintiffs in Conin, et al. v. Reilly, 93 Civ. 314 (LTS) (SDNY), and the Plaintiffs in Riverkeeper, et al. v. EPA, 06 Civ. 12987 (PKC) (SDNY), etc.

47 Letter from Preet Bharara, Counsel for EPA, to the Hon. Laura Taylor Swain, U.S. Dist. Judge, re: *Riverkeeper, Inc., et al. v. Jackson*, 93 Civ. 324 (LTS), dated April 16, 2014.

48 N.J.A.C. § 7:27-19.

49 CTs must have either water injection or selective catalytic reduction (SCR) controls; steam units must have either an SCR or and selective non-catalytic reduction (SNCR).

50 N.J.A.C. § 7:27-19.4.

51 N.J.A.C. § 7:27-19.5.

Table 8-1 HEDD maximum NO_x emission rates⁵²

Fuel and Unit Type	Emission Limit (lbs/MWh)
Coal Steam Unit	1.50
Heavier than No. 2 Fuel Oil Steam Unit	2.00
Simple Cycle Gas CT	1.00
Simple Cycle Oil CT	1.60
Combined Cycle Gas CT	0.75
Combined Cycle Oil CT	1.20
Regenerative Cycle Gas CT	0.75
Regenerative Cycle Oil CT	1.20

State Regulation of Greenhouse Gas Emissions

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap CO₂ emissions from power generation facilities.^{53,54}

Table 8-2 shows the RGGI CO₂ auction clearing prices and quantities for the 14 2009-2011 compliance period auctions and additional auctions for the 2012-2014 compliance period held as of December 31, 2013. Prices for auctions held in 2014 for the 2012-2014 compliance period were at the highest clearing price yet at \$4.00 per allowance (equal to one ton of CO₂), which is above the current price floor for RGGI auctions.⁵⁵ The price increased to \$4.00 due to a 45 percent reduction in the quantity offered in this auction. The 23,491,350 allowances sold include the original allowances offered for sale in the market of 18,491,350 as well as 5,000,000 additional cost containment reserves (CCR). This auction included the additional CCRs for the first time, due to the demand for allowances above the CCR trigger price of \$4.00 per ton. There are no additional CCRs available for sale in 2014. Table 8-3 converts the RGGI CO₂ clearing prices and quantities to metric tonnes for comparison to other CO₂ markets.

52 Regenerative cycle CTs are combustion turbines that recover heat from its exhaust gases and uses that heat to preheat the inlet combustion air which is fed into the combustion turbine.

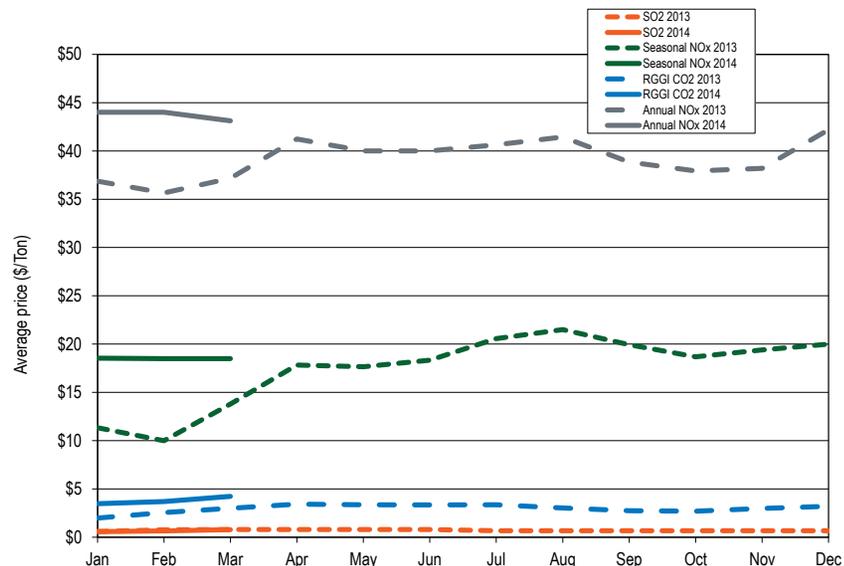
53 RGGI provides a link on its website to state statutes and regulations authorizing its activities, which can be accessed at: <http://www.rggi.org/design/regulations>.

54 For more details see the *2013 State of the Market Report for PJM*, Volume 2: Section 8, "Environmental and Renewables."

55 RGGI measures carbon in short tons (short ton equals 2,000 pounds) while world carbon markets measure carbon in metric tonnes (metric tonne equals 1,000 kilograms or 2,204.6 pounds).

Figure 8-1 shows average, daily settled prices for NO_x, CO₂ and SO₂ emissions.⁵⁶ In the first three months of 2014, NO_x prices were 5.3 percent higher than in the first three months of 2013. SO₂ prices were 17.2 percent lower in the first three months of 2014 compared to the first three months of 2013. Figure 8-1 also shows the average, daily settled price for the Regional Greenhouse Gas Initiative (RGGI) CO₂ allowances. RGGI allowances are required by generation in participating RGGI states. This includes PJM generation located in Delaware and Maryland.

Figure 8-1 Spot monthly average emission price comparison: 2013 and January through March of 2014⁵⁷



⁵⁶ The NO_x prices result from the Clean Air Interstate Rule (CAIR) established by the EPA covering 28 states. The SO₂ prices result from the Acid Rain cap and trade program established by the EPA. The CO₂ prices are from RGGI.
⁵⁷ See *Evolution Markets*, <<http://www.evomarkets.com>> (Accessed April 8, 2014).

Table 8-2 RGGI CO2 allowance auction prices and quantities in short tons: 2009–2011 and 2012–2014 Compliance Periods⁵⁸

Auction Date	Clearing Price	Quantity Offered	Quantity Sold
September 25, 2008	\$3.07	12,565,387	12,565,387
December 17, 2008	\$3.38	31,505,898	31,505,898
March 18, 2009	\$3.51	31,513,765	31,513,765
June 17, 2009	\$3.23	30,887,620	30,887,620
September 9, 2009	\$2.19	28,408,945	28,408,945
December 2, 2009	\$2.05	28,591,698	28,591,698
March 10, 2010	\$2.07	40,612,408	40,612,408
June 9, 2010	\$1.88	40,685,585	40,685,585
September 10, 2010	\$1.86	45,595,968	34,407,000
December 1, 2010	\$1.86	43,173,648	24,755,000
March 9, 2011	\$1.89	41,995,813	41,995,813
June 8, 2011	\$1.89	42,034,184	12,537,000
September 7, 2011	\$1.89	42,189,685	7,847,000
December 7, 2011	\$1.89	42,983,482	27,293,000
March 14, 2012	\$1.93	34,843,858	21,559,000
June 6, 2012	\$1.93	36,426,008	20,941,000
September 5, 2012	\$1.93	37,949,558	24,589,000
December 5, 2012	\$1.93	37,563,083	19,774,000
March 13, 2013	\$2.80	37,835,405	37,835,405
June 5, 2013	\$3.21	38,782,076	38,782,076
September 4, 2013	\$2.67	38,409,043	38,409,043
December 4, 2013	\$3.00	38,329,378	38,329,378
March 5, 2014	\$4.00	23,491,350	23,491,350

⁵⁸ See Regional Greenhouse Gas Initiative, "Auction Results," <http://www.rggi.org/market/co2_auctions/results> (Accessed April 8, 2014).

Table 8-3 RGGI CO2 allowance auction prices and quantities in metric tonnes: 2009–2011 and 2012–2014 Compliance Periods⁵⁹

Auction Date	Clearing Price	Quantity Offered	Quantity Sold
September 25, 2008	\$3.38	11,399,131	11,399,131
December 17, 2008	\$3.73	28,581,678	28,581,678
March 18, 2009	\$3.87	28,588,815	28,588,815
June 17, 2009	\$3.56	28,020,786	28,020,786
September 9, 2009	\$2.41	25,772,169	25,772,169
December 2, 2009	\$2.26	25,937,960	25,937,960
March 10, 2010	\$2.28	36,842,967	36,842,967
June 9, 2010	\$2.07	36,909,352	36,909,352
September 10, 2010	\$2.05	41,363,978	31,213,514
December 1, 2010	\$2.05	39,166,486	22,457,365
March 9, 2011	\$2.08	38,097,972	38,097,972
June 8, 2011	\$2.08	38,132,781	11,373,378
September 7, 2011	\$2.08	38,273,849	7,118,681
December 7, 2011	\$2.08	38,993,970	24,759,800
March 14, 2012	\$2.13	31,609,825	19,558,001
June 6, 2012	\$2.13	33,045,128	18,997,361
September 5, 2012	\$2.13	34,427,270	22,306,772
December 5, 2012	\$2.13	34,076,665	17,938,676
March 13, 2013	\$3.09	34,323,712	34,323,712
June 5, 2013	\$3.54	35,182,518	35,182,518
September 4, 2013	\$2.94	34,844,108	34,844,108
December 4, 2013	\$3.31	34,771,837	34,771,837
March 5, 2014	\$4.41	21,311,000	21,311,000

Renewable Portfolio Standards

Many PJM jurisdictions have enacted legislation to require that a defined percentage of utilities' load be served by renewable resources, for which there are many standards and definitions. These are typically known as renewable portfolio standards, or RPS. As of March 31, 2014, Delaware, Illinois, Indiana, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, and Washington D.C. had renewable portfolio standards. Virginia has enacted a voluntary renewable portfolio standard. Kentucky and Tennessee have enacted no renewable portfolio standards. West Virginia has enacted a renewable portfolio standard, but it will not be in effect until 2015.

Under the proposed standards, a substantial amount of load in PJM is required to be served by renewable resources by 2024. As shown in Table 8-4, New Jersey will require 24.1 percent of load to be served by renewable resources in 2024, the most stringent standard of all PJM jurisdictions. Renewable generation earns renewable energy credits (RECs) (also known as alternative energy credits) when they generate. These RECs are bought by utilities and load serving entities to fulfill the requirements for renewable generation. Standards for renewable portfolios differ from jurisdiction to jurisdiction. For example, Illinois only requires utilities to purchase renewable energy credits, while Pennsylvania requires all load serving entities to purchase renewable energy credits (known as alternative energy credits in Pennsylvania).

Renewable energy credit markets are markets related to the production and purchase of wholesale power, but are not subject to FERC regulation or any other market regulation or oversight. RECs markets are, as an economic fact, integrated with PJM markets including energy and capacity markets, but are not formally recognized as part of PJM markets. Revenues from RECs markets are out of market revenues for PJM resources and are in addition to revenues earned from the sale of the same MWh in PJM markets. Many jurisdictions allow various types of renewable resources to earn multiple RECs per MWh, though typically one REC is equal to one MWh. For example, West Virginia allows one credit per MWh for generation from alternative energy resources including waste coal and pumped-storage hydroelectric, and allows two credits per MWh of electricity generated by renewable energy resources, which include wind, solar, and run of river hydroelectric. PJM Environmental Information Services (EIS), an unregulated subsidiary of PJM, operates the generation attribute tracking system (GATS), which is used by many jurisdictions to track these renewable energy credits.

⁵⁹ See Regional Greenhouse Gas Initiative, "Auction Results," <http://www.rggi.org/market/co2_auctions/results> (Accessed April 8, 2014).

Table 8-4 Renewable standards of PJM jurisdictions to 2024^{60,61}

Jurisdiction	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Delaware	11.50%	13.00%	14.50%	16.00%	17.50%	19.00%	20.00%	21.00%	22.00%	23.00%	24.00%
Illinois	8.00%	9.00%	10.00%	11.50%	13.00%	14.50%	16.00%	17.50%	19.00%	20.50%	22.00%
Indiana	4.00%	4.00%	4.00%	4.00%	4.00%	7.00%	7.00%	7.00%	7.00%	7.00%	7.00%
Kentucky	No Standard										
Maryland	12.80%	13.00%	15.20%	15.60%	18.30%	17.40%	18.00%	18.70%	20.00%	20.00%	20.00%
Michigan	6.75%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%	10.00%
New Jersey	12.53%	13.76%	14.90%	15.99%	18.03%	19.97%	21.91%	23.85%	23.94%	24.03%	24.12%
North Carolina	3.00%	6.00%	6.00%	6.00%	10.00%	10.00%	10.00%	12.50%	12.50%	12.50%	12.50%
Ohio	2.50%	3.50%	4.50%	5.50%	6.50%	7.50%	8.50%	9.50%	10.50%	11.50%	12.50%
Pennsylvania	10.72%	11.22%	13.72%	14.22%	14.72%	15.22%	15.72%	18.02%	18.02%	18.02%	18.02%
Tennessee	No Standard										
Virginia	4.00%	4.00%	4.00%	7.00%	7.00%	7.00%	7.00%	7.00%	12.00%	12.00%	12.00%
Washington, D.C.	10.50%	12.00%	13.50%	15.00%	16.50%	18.00%	20.00%	20.00%	20.00%	20.00%	20.00%
West Virginia		10.00%	10.00%	10.00%	10.00%	10.00%	15.00%	15.00%	15.00%	15.00%	15.00%

Table 8-5 Pennsylvania weighted average AEC price and AEC price range for 2010 to 2014 Delivery Years⁶²

	2010/2011 Delivery Year		2011/2012 Delivery Year		2012/2013 Delivery Year		2013/2014 Delivery Year	
	Weighted Average Price	Price Range	Weighted Average Price	Price Range	Weighted Average Price	Price Range	Weighted Average Price	Price Range
Solar AEC	\$325.00	\$235.00-\$415.00	\$247.82	\$25.00-\$653.00	\$180.39	\$10.00-\$675.00	\$109.23	\$5.50-\$600.00
Tier I	\$4.77	\$0.50-\$24.15	\$3.94	\$0.14-\$50.00	\$5.23	\$0.20-\$23.00	\$8.31	\$0.13-\$100.00
Tier II	\$0.32	\$0.01-\$1.75	\$0.22	\$0.01-\$20.00	\$0.17	\$0.01-\$5.00	\$0.22	\$0.01-\$20.00

REC prices are required to be disclosed in Maryland, Pennsylvania and the District of Columbia, but in the other states REC prices are difficult to determine. Few sources provide public REC price data. Table 8-5 has the Pennsylvania weighted average price and price range for 2010 through 2014 delivery years. The weighted average price of solar credits in Pennsylvania decreased from \$325.00 in the 2010/2011 Delivery Year to \$109.23 in the 2013/2014 Delivery Year. Tier I credits increased from \$4.77 in the 2010/2011 Delivery year to \$8.31 in the 2013/2014 Delivery Year, while Tier II resources dropped \$0.10

⁶⁰ This shows the total standard of renewable resources in all PJM jurisdictions, including Tier I, Tier II and Tier III resources.

⁶¹ Michigan in 2012-2014 must make up the gap between 10 percent renewable energy and the renewable energy baseline in Michigan. In 2012, this means baseline plus 20 percent of the gap between baseline and 10 percent renewable resources, in 2013, baseline plus 33 percent and in 2014, baseline plus 50 percent.

⁶² See PAPUC. Pennsylvania AEPs Alternative Energy Credit Program, "Pricing." <<http://paaeps.com/credit/pricing.do>> (Accessed April 8, 2014).

from \$0.32 in the 2010/2011 Delivery Year to \$0.22 in the 2013/2014 Delivery Year.⁶³

Many PJM jurisdictions have also added specific requirements for the purchase of solar resources. These solar requirements are included in the standards shown in Table 8-4 but must be met by solar RECs (SRECs) only. Delaware, Illinois, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, and Washington, D.C., all have requirements for the proportion of load served by solar units by 2023.⁶⁴ Indiana, Kentucky, Michigan, Tennessee, Virginia, and West Virginia have no specific solar standards. In 2014, New Jersey had the most stringent standard in PJM, requiring that 2.05 percent of load be served by solar resources. As Table 8-6 shows, by 2024, New Jersey will continue to have the most stringent standard, requiring that at least 3.74 percent of load be served by solar resources.

⁶³ Tier I resources are solar photovoltaic and thermal energy, wind power, low-impact hydropower, geothermal energy, biologically derived methane gas, biomass and coal mine methane. Tier II resources are waste coal, distributed generation, demand-side management, large-scale hydropower, municipal solid waste and integrated combined coal gasification technology.

⁶⁴ Pennsylvania and Delaware allow only solar photovoltaic resources to fulfill the solar requirement.

Table 8-6 Solar renewable standards of PJM jurisdictions 2014 to 2024

Jurisdiction	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Delaware	0.80%	1.00%	1.25%	1.50%	1.75%	2.00%	2.25%	2.50%	2.75%	3.00%	3.25%
Illinois	0.12%	0.27%	0.60%	0.69%	0.78%	0.87%	0.96%	1.05%	1.14%	1.23%	1.32%
Indiana	No Solar Standard										
Kentucky	No Standard										
Maryland	0.35%	0.50%	0.70%	0.95%	1.40%	1.75%	2.00%	2.00%	2.00%	2.00%	2.00%
Michigan	No Solar Standard										
New Jersey	2.05%	2.45%	2.75%	3.00%	3.20%	3.29%	3.38%	3.47%	3.56%	3.65%	3.74%
North Carolina	0.07%	0.14%	0.14%	0.14%	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%
Ohio	0.12%	0.15%	0.18%	0.22%	0.26%	0.30%	0.34%	0.38%	0.42%	0.46%	0.50%
Pennsylvania	0.08%	0.14%	0.25%	0.29%	0.34%	0.39%	0.44%	0.50%	0.50%	0.50%	0.50%
Tennessee	No Standard										
Virginia	No Solar Standard										
Washington, D.C.	0.60%	0.70%	0.83%	0.98%	1.15%	1.35%	1.58%	1.85%	2.18%	2.50%	2.50%
West Virginia	No Solar Standard										

Table 8-7 Additional renewable standards of PJM jurisdictions 2014 to 2024

Jurisdiction		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Illinois	Wind Requirement	6.00%	6.75%	7.50%	8.63%	9.75%	10.88%	12.00%	13.13%	14.25%	15.38%	16.50%
Illinois	Distributed Generation	0.04%	0.68%	0.10%	0.12%	0.13%	0.15%	0.16%	0.18%	0.19%	0.21%	0.22%
Maryland	Tier II Standard	2.50%	2.50%	2.50%	2.50%	2.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
New Jersey	Class II Standard	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%	2.50%
New Jersey	Solar Garve-Out (in GWh)	772	965	1,150	1,357	1,591	1,858	2,164	2,518	2,928	3,433	3,989
North Carolina	Swint Waste	0.07%	14.00%	14.00%	14.00%	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%	0.20%
North Carolina	Poultry Waste (in GWh)	700	900	900	900	900	900	900	900	900	900	900
Pennsylvania	Tier II Standard	6.20%	6.20%	8.20%	8.20%	8.20%	8.20%	8.20%	10.00%	10.00%	10.00%	10.00%
Washington, D.C.	Tier II Standard	2.50%	2.50%	2.00%	1.50%	1.00%	0.50%	0.00%	0.00%	0.00%	0.00%	0.00%

Some PJM jurisdictions have also added other specific requirements to their renewable portfolio standards for other technologies. The standards shown in Table 8-7 are also included in the base standards. Illinois requires that a percentage of utility load be served by wind resources, increasing from 6.00 percent of load served in 2014 to 16.50 percent in 2024. Maryland, New Jersey, Pennsylvania and Washington D.C. all have “Tier II” or “Class 2” standards, which allow specific technology types, such as waste coal units in Pennsylvania, to qualify for renewable energy credits.⁶⁵ North Carolina also requires that 0.2 percent of power be generated using swine waste and

⁶⁵ Pennsylvania Tier II credits includes energy derived from waste coal, distributed generation systems, demand-side management, large-scale hydropower, municipal solid waste, generation from wood pulping process, and integrated combined coal gasification technology.

poultry waste to fulfill their renewable portfolio standards by 2018 (Table 8-7).

PJM jurisdictions include various methods for complying with required renewable portfolio standards. If an LSE is unable to comply with the renewable portfolio standards required by the LSE’s jurisdiction, LSEs may make alternative compliance payments, with varying standards. These alternative compliance payments are a way to make up any shortfall between the RECs required by the state and those the LSE actually purchased. In New Jersey, solar alternative compliance payments are \$339.00 per MWh.⁶⁶ Pennsylvania requires that the alternative compliance payment for solar credits be 200 percent of the average market value of solar RECs sold in the RTO. Compliance methods differ from jurisdiction to jurisdiction. For example, Illinois requires that 50 percent of the state’s renewable portfolio standard be met through alternative compliance payments. Standard alternative compliance payments can replace solar, wind energy, organic biomass and hydro power. Table 8-8 shows the alternative

compliance standards in PJM jurisdictions, where such standards exist. These alternative compliance methods can have a significant impact on the traded price of RECs.

⁶⁶ See Database of State Incentives for Renewables & Efficiency (DSIRE), New Jersey Incentives/Policies for Renewables & Efficiency, “Renewables Portfolio Standard,” <http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ05R&re=0&tee=0> (Accessed April 8, 2013).

Table 8-8 Renewable alternative compliance payments in PJM jurisdictions: As of March 31, 2014⁶⁷

Jurisdiction	Standard Alternative Compliance (\$/MWh)	Tier II Alternative Compliance (\$/MWh)	Solar Alternative Compliance (\$/MWh)
Delaware	\$25.00		\$400.00
Illinois	\$1.89		
Indiana	Voluntary standard		
Kentucky	No standard		
Maryland	\$40.00	\$15.00	\$400.00
Michigan	No specific penalties		
New Jersey	\$50.00		\$339.00
North Carolina	No specific penalties		
Ohio	\$47.56		\$350.00
Pennsylvania	\$45.00	\$45.00	200% market value
Tennessee	No standard		
Virginia	Voluntary standard		
Washington, D.C.	\$50.00	\$10.00	\$500.00
West Virginia	\$50.00		

Table 8-9 shows renewable generation by jurisdiction and resource type in the first three months of 2014. This includes only units that would qualify for REC credits by primary fuel type, including waste coal, battery, and pumped-storage hydroelectric, which can qualify for Pennsylvania Tier II credits if they are located in the PJM footprint. Wind units account for 4,811.0 GWh of 7,464.7 Tier I GWh, or 64.4 percent, in the PJM footprint. As shown in Table 8-9, 13,542.5 GWh were generated by resources that were renewable, including both Tier II and Tier I renewable credits, of which, Tier I type resources accounted for 55.1 percent. Landfill gas, solid waste, and waste coal were 4,950.7 GWh of renewable generation or 36.6 percent of the total Tier I and Tier II.

⁶⁷ See PJM – EIS (Environmental Management System). "Program Information," <<http://www.pjm-eis/program-information.aspx>>. (Accessed April 8, 2014)

Table 8-9 Renewable generation by jurisdiction and renewable resource type (GWh): January through March 2014

Jurisdiction	Landfill Gas	Pumped-Storage Hydro	Run-of-River Hydro	Solar	Solid Waste	Waste Coal	Wind	Tier I Credit Only	Total Credit GWh
Delaware	13.2	0.0	0.0	0.0	0.0	0.0	0.0	13.2	26.3
Illinois	44.3	0.0	0.0	0.0	0.0	0.0	1,970.5	2,014.7	2,014.7
Indiana	0.0	0.0	12.0	0.0	0.0	0.0	766.5	778.4	778.4
Kentucky	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maryland	24.6	0.0	500.1	11.9	0.0	0.0	103.7	640.2	640.2
Michigan	6.5	0.0	16.7	0.0	0.0	0.0	0.0	23.2	23.2
New Jersey	79.7	151.8	4.9	39.5	0.0	0.0	3.5	127.5	279.3
North Carolina	0.0	0.0	236.1	0.0	0.0	0.0	0.0	236.1	236.1
Ohio	82.5	0.0	96.7	0.7	0.0	0.0	363.0	542.8	542.8
Pennsylvania	202.6	608.9	575.4	0.3	77.4	2,674.2	1,083.7	1,862.0	5,222.4
Tennessee	0.0	0.0	0.0	0.0	84.7	0.0	0.0	0.0	84.7
Virginia	118.5	939.8	185.2	0.0	313.2	967.2	0.0	303.7	2,524.0
Washington, D.C.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West Virginia	1.8	0.0	400.8	0.0	0.0	260.5	520.2	922.9	1,183.3
Total	573.5	1,700.6	2,028.0	52.3	475.3	3,901.9	4,811.0	7,464.7	13,542.5

Table 8-10 shows the capacity of renewable resources in PJM by jurisdiction, as defined by primary or alternative fuel types.⁶⁸ This capacity includes various coal and natural gas units that have a renewable fuel as a secondary fuel, and thus are able to earn renewable energy credits based on the fuel used to generate energy. Coal and natural gas units are considered to generate renewable energy only when generating using a renewable fuel, like waste coal in West Virginia. West Virginia has the largest amount of renewable capacity in PJM, 10,254.7 MW, or 22.7 percent of the total renewable capacity. West Virginia allows coal technology, coal bed methane, waste coal and fuel produced by a coal gasification facility to be counted as alternative energy resources. New Jersey has the largest amount of solar capacity in PJM, 180.5 MW, or 75.7 percent of the total solar capacity. Wind resources are located primarily in western PJM, in Illinois and Indiana, which include 3,635.7 MW, or 58.0 percent of the total wind capacity.

⁶⁸ Defined by fuel type, or a generator being registered in PJM GATS. Includes only units that are interconnected to the PJM system.

Table 8-10 PJM renewable capacity by jurisdiction (MW), on March 31, 2014

Jurisdiction	Landfill		Natural Gas	Oil	Pumped-Storage		Run-of-River Hydro	Solar	Solid Waste	Waste Coal	Wind	Total
	Coal	Gas			Hydro	Hydro						
Delaware	0.0	8.1	1,797.0	13.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,818.1
Illinois	0.0	79.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2,383.4	2,462.9
Indiana	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.0	0.0	0.0	1,252.4	1,260.6
Iowa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	185.0	185.0
Kentucky	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maryland	0.0	25.1	0.0	69.0	0.0	0.0	494.0	48.8	0.0	0.0	120.0	757.0
Michigan	0.0	8.0	0.0	0.0	0.0	0.0	13.9	0.0	0.0	0.0	0.0	21.9
New Jersey	0.0	86.5	0.0	0.0	0.0	453.0	3.5	180.5	0.0	0.0	4.5	728.1
North Carolina	0.0	0.0	0.0	0.0	0.0	0.0	325.0	0.0	0.0	0.0	0.0	325.0
Ohio	11,613.0	64.7	580.0	156.0	0.0	0.0	47.4	1.1	0.0	0.0	403.0	12,865.2
Pennsylvania	0.0	222.0	2,346.0	0.0	0.0	1,269.0	757.3	8.0	103.0	1,647.0	1,337.7	7,690.0
Tennessee	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0
Virginia	0.0	214.9	0.0	20.0	0.0	5,166.2	350.5	0.0	321.9	585.0	0.0	6,658.5
West Virginia	8,772.0	2.2	519.0	0.0	0.0	0.0	213.2	0.0	0.0	165.0	583.3	10,254.7
PJM Total	20,385.0	711.0	5,242.0	258.0	0.0	6,888.2	2,213.0	238.5	474.9	2,397.0	6,269.2	45,076.9

Table 8-11 Renewable capacity by jurisdiction, non-PJM units registered in GATS^{69,70} (MW), on March 31, 2014

Jurisdiction	Coal	Hydroelectric	Landfill Gas	Natural Gas	Other Gas	Other Source	Solar	Solid Waste	Wind	Total
Georgia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	258.9	0.0	258.9
Illinois	0.0	6.6	92.4	0.0	0.0	0.0	34.5	0.0	302.5	436.1
Indiana	0.0	0.0	44.0	584.5	6.0	94.6	1.4	0.0	49.5	780.1
Iowa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	185.0	185.0
Kentucky	600.0	2.0	16.0	0.0	0.0	0.0	0.6	88.0	0.0	706.6
Maryland	65.0	0.0	13.7	129.0	0.0	0.0	112.1	0.0	0.3	320.2
Michigan	55.0	0.0	1.6	0.0	0.0	0.0	0.3	0.0	0.0	56.9
Minnesota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Missouri	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	146.0	146.0
New Jersey	0.0	0.0	59.9	0.0	8.3	23.3	953.3	0.0	4.9	1,049.8
New York	0.0	146.7	0.0	0.0	0.0	0.0	0.4	0.0	0.0	147.1
North Carolina	0.0	0.0	0.0	0.0	0.0	0.0	8.6	0.0	0.0	8.6
Ohio	0.0	1.0	30.4	119.6	9.4	1.0	93.9	109.3	21.9	386.5
Pennsylvania	109.7	37.0	41.7	91.0	1.4	0.3	179.4	60.0	3.2	523.7
Virginia	0.0	17.4	15.9	0.0	0.0	0.0	6.2	287.6	0.0	327.1
West Virginia	0.0	9.0	0.0	0.0	0.0	0.0	0.4	44.6	0.0	54.0
Wisconsin	0.0	42.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	43.8
District of Columbia	0.0	0.0	0.0	0.0	0.0	0.0	8.8	0.0	0.0	8.8
Total	829.7	261.7	315.7	924.2	25.1	119.2	1,455.1	848.4	715.5	5,494.6

69 There is a 0.00216 MW solar facility registered in GATS from Minnesota that can sell solar RECs in the PJM jurisdictions of Pennsylvania and Illinois.

70 See PJM – EIS (Environmental Information Services), "Renewable Generators Registered in GATS," <<https://gats.pjm-eis.com/reports-and-news/public-reports.aspx>> (Accessed April 8, 2013).

Table 8-11 shows renewable capacity registered in the PJM generation attribute tracking system (GATS), a system operated by PJM EIS. This includes solar capacity of 1,455.1 MW of which 953.3 MW is in New Jersey. These resources can also earn renewable energy credits, and can be used to fulfill the renewable portfolio standards in PJM jurisdictions. All capacity shown in Table 8-11 is registered in PJM GATS, and may sell renewable energy credits through PJM EIS. Some of this capacity is located in jurisdictions outside PJM, but that may qualify for specific renewable energy credits in some jurisdictions. This includes both behind-the-meter generation located inside PJM, and generation connected to other RTOs outside PJM.

Emissions Controlled Capacity and Renewables in PJM Markets

Emission Controlled Capacity in the PJM Region

Environmental regulations may affect decisions about emission control investments in existing units, investment in new units and decisions to retire units lacking emission controls. Many PJM units burning fossil fuels have installed emission control technology.

Coal and heavy oil have the highest SO₂ emission rates, while natural gas and light oil have low SO₂ emission rates. Of the current 70,153.8 MW of coal capacity in PJM, 55,443.3 MW of capacity, 68.6 percent, has some form of FGD (flue-gas desulfurization) technology to reduce SO₂ emissions. Table 8-12 shows SO₂ emission controls by fossil fuel units in PJM.⁷¹

Table 8-12 SO₂ emission controls (FGD) by fuel type (MW), as of March 31, 2014

	SO ₂ Controlled	No SO ₂ Controls	Total	Percent Controlled
Coal	49,788.0	20,365.8	70,153.8	71.0%
Diesel Oil	0.0	6,093.8	6,093.8	0.0%
Natural Gas	0.0	50,892.8	50,892.8	0.0%
Other	325.0	7,412.5	7,737.5	4.2%
Total	50,113.0	84,764.9	134,877.9	37.2%

NO_x emission control technology is used by nearly all fossil fuel unit types. Coal steam, combined cycle, combustion turbine, and non-coal steam units in PJM have NO_x controls. Of current fossil fuel units in PJM, 123,728.1 MW, 91.7 percent, of 134,877.9 MW of capacity in PJM, have emission controls for NO_x. Table 8-13 shows NO_x emission controls by unit type in PJM. While most units in PJM have NO_x emission controls, many of these controls will likely need to be upgraded in order to meet each state's emission compliance standards. Future NO_x compliance standards will require SCRs or SCNRs for coal steam units, as well as SCRs or water injection technology for HEDD combustion turbine units.

⁷¹ See EPA, "Air Market Programs Data," <<http://ampd.epa.gov/ampd/>>. (Accessed April 8, 2014)

Table 8-13 NO_x emission controls by fuel type (MW), as of March 31, 2014

	NO _x Controlled	No NO _x Controls	Total	Percent Controlled
Coal	68,739.2	1,414.6	70,153.8	98.0%
Diesel Oil	1,456.8	4,637.0	6,093.8	23.9%
Natural Gas	49,333.4	1,559.4	50,892.8	96.9%
Other	4,198.7	3,538.8	7,737.5	54.3%
Total	123,728.1	11,149.8	134,877.9	91.7%

Most coal units in PJM have particulate controls. Typically, technologies such as electrostatic precipitators (ESP) or baghouses are used to reduce particulate matter from coal steam units. In PJM, 69,219.8 MW, 98.7 percent, of all coal steam unit MW, have some type of particulate emissions control technology. Table 8-14 shows particulate emission controls by unit type in PJM. Most coal steam units in PJM have particulate emission controls in the form of ESPs, but many of these controls will need to be upgraded in order to meet each state's emission compliance standards. Future particulate compliance standards will require baghouse technology or a combination of an FGD and SCR to meet EPA regulations, which 177 of 229 coal steam units have not installed.

Table 8-14 Particulate emission controls by fuel type (MW), as of March 31, 2014

	Particulate Controlled	No Particulate Controls	Total	Percent Controlled
Coal	69,219.8	934.0	70,153.8	98.7%
Diesel Oil	0.0	6,093.8	6,093.8	0.0%
Natural Gas	174.0	50,718.8	50,892.8	0.3%
Other	3,159.0	4,578.5	7,737.5	40.8%
Total	72,552.8	62,325.1	134,877.9	53.8%

Fossil fuel fired units in PJM emit multiple pollutants, including CO₂, SO₂, and NO_x. Table 8-15 shows the estimated emissions from units in PJM in the first three months of 2014. It is estimated that over 166 million metric tons of CO₂, 368 thousand metric tons of SO₂, and 293 thousand tons of NO_x were emitted in the first three months of 2014 by PJM units.

Table 8-15 CO₂, SO₂ and NO_x emissions by month (metric tons), by PJM units, January through March, 2014

	Tons of CO ₂	Tons of SO ₂	Tons of NO _x
January	59,789,898.3	132,134.4	105,954.6
February	53,607,987.6	119,625.8	94,816.6
March	52,912,695.5	116,233.8	92,092.4
Total	166,310,581.3	367,994.0	292,863.6

Wind Units

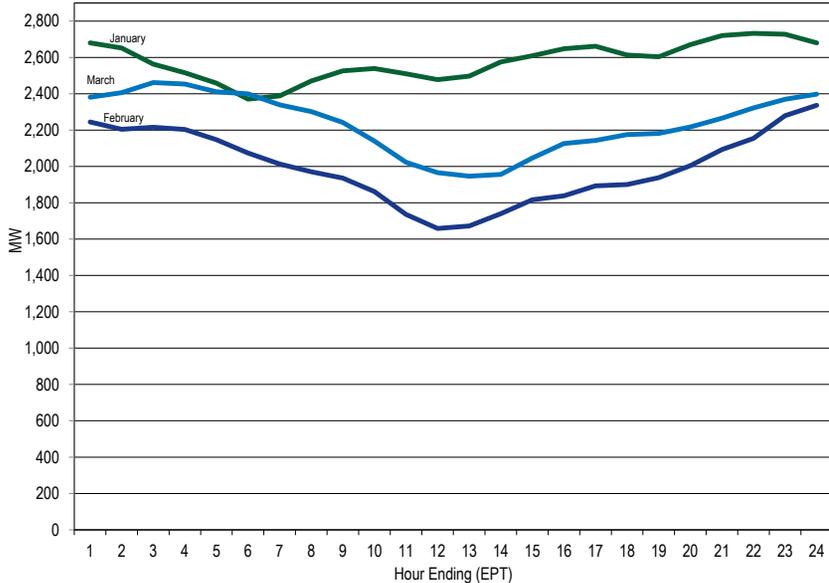
Table 8-16 shows the capacity factor of wind units in PJM. In the first three months of 2014, the capacity factor of wind units in PJM was 38.0 percent. Wind units that were capacity resources had a capacity factor of 38.8 percent and an installed capacity of 4,888 MW. Wind units that were classified as energy only had a capacity factor of 35.4 percent and an installed capacity of 1,476 MW. Wind capacity in RPM is derated to 13 percent of nameplate capacity for the capacity market, and energy only resources are not included in the capacity market.⁷²

Table 8-16 Capacity factor of wind units in PJM: January through March 2014⁷³

Type of Resource	Capacity Factor	Capacity Factor by Cleared MW	Installed Capacity (MW)
Energy-Only Resource	35.4%	NA	1,476
Capacity Resource	38.8%	245.7%	4,888
All Units	38.0%	245.7%	6,364

Figure 8-2 shows the average hourly real time generation of wind units in PJM, by month. The highest average hour, 2,732.2 MW, occurred in January, and the lowest average hour, 1,658.7 MW, occurred in February. Wind output in PJM is generally higher in off-peak hours and lower in on-peak hours.

Figure 8-2 Average hourly real-time generation of wind units in PJM: January through March, 2014



⁷² Wind resources are derated to 13 percent unless demonstrating higher availability during peak periods.
⁷³ Capacity factor does not include external resources which only offer in the Day - Ahead Market. Capacity factor is calculated based on online date of the resource. Capacity factor by cleared MW is calculated during peak periods (peak hours during January, February, June, July and August) and includes only MW cleared in RPM.

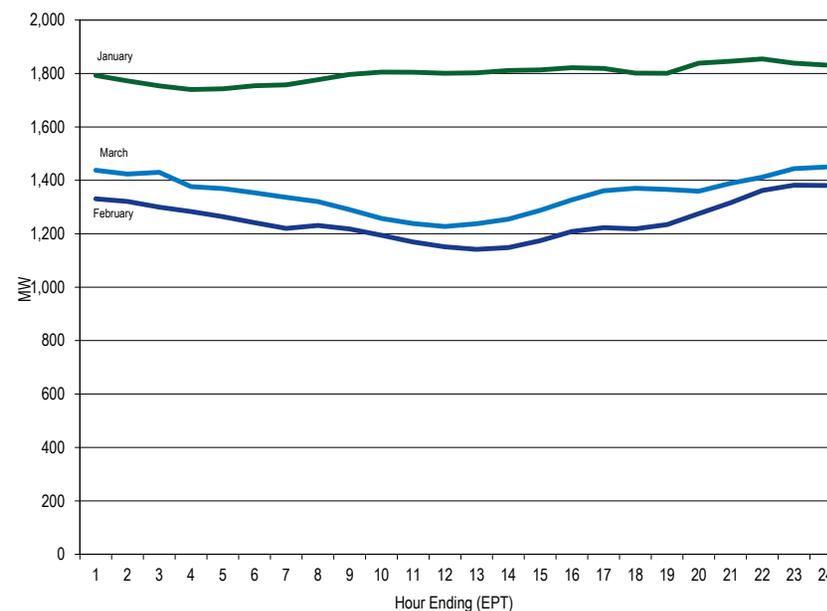
Table 8-17 shows the generation and capacity factor of wind units in each month of the first three months of 2013 and the first three months of 2014.

Table 8-17 Capacity factor of wind units in PJM by month, 2013 and January through March 2014

Month	2013		2014	
	Generation (MWh)	Capacity Factor	Generation (MWh)	Capacity Factor
January	1,784,359.3	40.3%	1,918,441.4	42.7%
February	1,397,468.3	35.4%	1,342,055.5	33.4%
March	1,606,248.3	36.5%	1,661,382.1	37.3%
April	1,639,590.9	37.8%		
May	1,271,272.4	28.5%		
June	862,532.2	19.8%		
July	588,174.8	13.4%		
August	510,448.5	12.0%		
September	719,196.4	16.7%		
October	1,070,829.4	23.5%		
November	1,833,051.6	41.2%		
December	1,543,685.2	34.2%		
Annual	14,826,857.3	28.3%	4,921,878.9	38.0%

Wind units that are capacity resources are required, like all capacity resources except demand resources, to offer the energy associated with their cleared capacity in the Day-Ahead Energy Market. Wind units may offer non-capacity related wind energy at their discretion. Figure 8-3 shows the average hourly day-ahead generation offers of wind units in PJM, by month. The hourly day-ahead generation offers of wind units in PJM may vary.

Figure 8-3 Average hourly day-ahead generation of wind units in PJM: January through March 2014



Output from wind turbines displaces output from other generation types. This displacement affects the output of marginal units in PJM. The magnitude and type of effect on marginal unit output depends on the level of the wind turbine output, its location, time and duration. One measure of this displacement is based on the mix of marginal units when wind is producing output. Figure 8-4 shows the hourly average proportion of marginal units by fuel type mapped to the hourly average MW of real time wind generation through the first three months of 2014. Figure 8-4 shows potentially displaced marginal unit MW by fuel type in the first three months of 2014. This is not an exact measure of displacement because it is not based on a redispatch of the system without wind resources. When wind appears as the displaced fuel at times when wind resources were on the margin this means that there was no displacement for those hours.

Figure 8-4 Marginal fuel at time of wind generation in PJM: January through March 2014

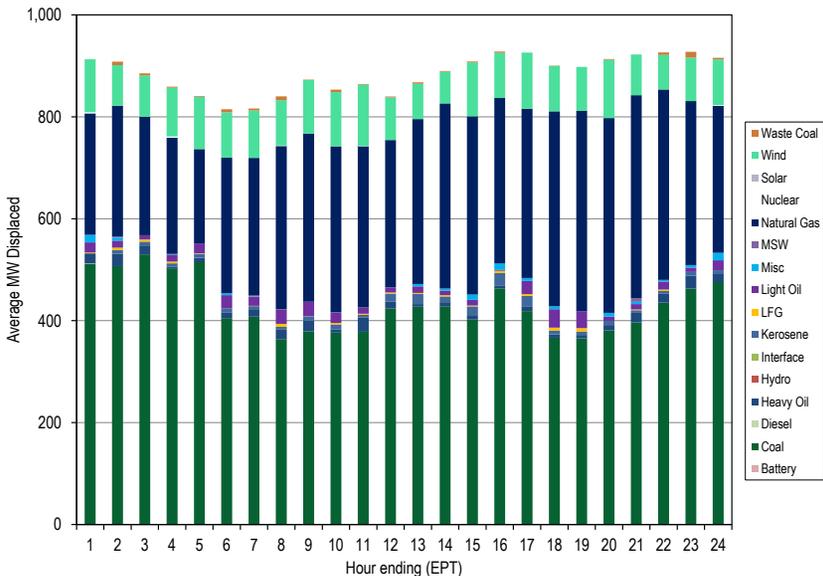
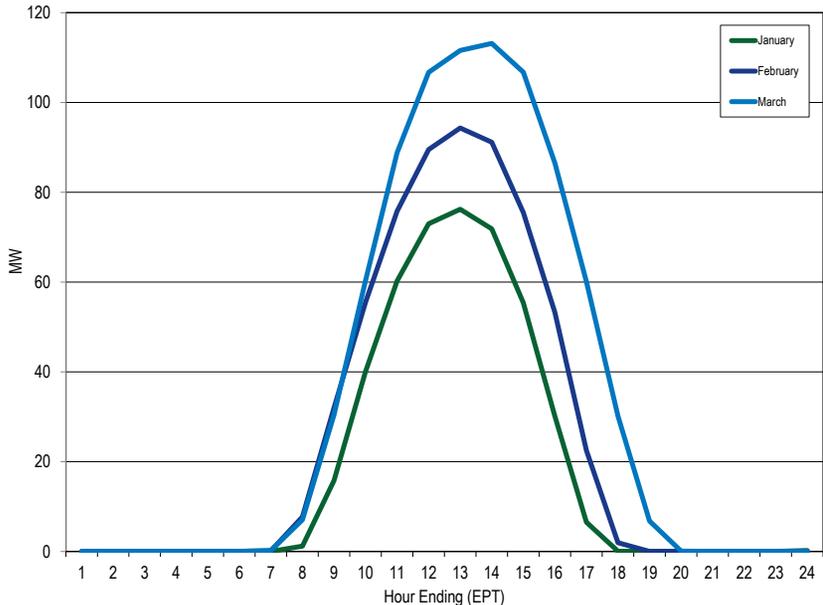


Figure 8-5 Average hourly real-time generation of solar units in PJM: January through March 2014



Solar Units

Solar output differs from month to month, based on seasonal variation and daylight hours during the month. Figure 8-5 shows the average hourly real-time generation of solar units in PJM, by month. Solar generation was highest in March, the month with the highest average hour, 113.14 MW, compared to 238.5 MW of solar installed capacity in PJM. Solar generation in PJM is highest during the hours of 11:00 through 13:00 EPT.

