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PENNSYLVANIA'S ELECTRIC POWER SYSTEM AND THE CLEAN POWER PLAN

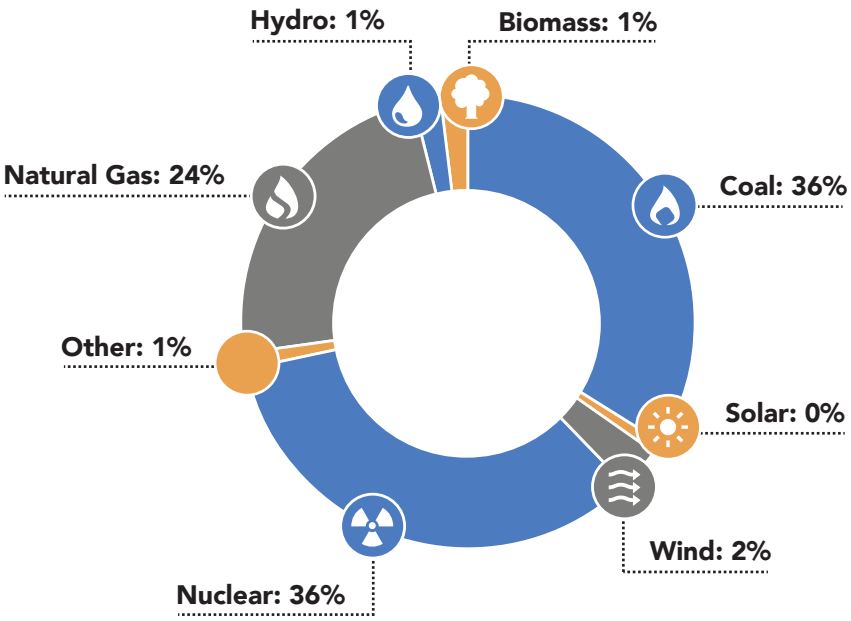
The U.S. Environmental Protection Agency (EPA) will soon release the final rule for carbon emissions from existing power plants, called the Clean Power Plan (CPP). The rule represents the next step in the process of carbon regulation that began with the Supreme Court's determination in 2007 that carbon dioxide (CO_2) qualifies as an air pollutant subject to regulation by EPA under the Clean Air Act.[1]

Under Section 111(d) of the Clean Air Act, EPA will set air pollutant standards for each state based on what EPA determines to be the "best system of emission reduction" (BSER). In its proposal, EPA determined the BSER based on state specific potentials for emission reductions from four "Building Blocks" that include both traditional smokestack controls as well as "beyond the fence line" measures, namely improving the efficiency of coal plants, increasing dispatch of existing natural gas plants, deploying renewable and nuclear power generation, and reducing demand by means of energy efficiency.[2]

In 1997, Pennsylvania's electricity system was partially deregulated and split into two markets: a competitive market of electric generation suppliers (EGSs) and a regulated market of electric distribution companies (EDCs) in charge of transmission and distribution.[3]

PJM Interconnection (PJM) is the Regional Transmission Organization (RTO) responsible for transmission services and maintaining reliable electricity in the state.[4]

Pennsylvania's Generation Mix (2014)



Source: AEE PowerSuite

Although Pennsylvania's emission rate target is set by the Building Blocks, there is no requirement that the state use those specific measures for compliance. Rather, in developing a compliance plan to achieve the interim (2020-2029) and final (2030-2032) targets, the state is free to use other technologies and policy tools. This gives Pennsylvania an opportunity to design a plan that is best suited to the resources and needs of its unique power system.

A Strong Foundation

Pennsylvania has a strong foundation for a compliance plan. The state has a diverse generation mix that includes nuclear, natural gas, coal and some renewable energy, mostly wind. As the price of natural gas has fallen, Pennsylvania has increased its reliance on natural gas-fired generation. Accounting for just 5% of total generation in 2005, natural gas rose to 24% of total generation in 2014.[5] Ranking among the top five states for proven natural gas reserves, Pennsylvania also stands to benefit as states boost their natural gas consumption under the CPP.[6]

The state has started to invest in more renewables and energy efficiency as well. Carbon emissions in the state have gone down 14% from 2005 to 2012, and at an average retail price of 10.45 cents/kWh in 2014, electricity in Pennsylvania is cheaper than the national average.[7,8] Pennsylvania also produces more electricity than it needs, exporting over 200,000 GWh of electricity in 2012.[9]

Still, the state's power system faces significant challenges. Pennsylvania had the fourth-highest reported outages of any state in both 2014 and 2013. In 2014, a total of 148 outages affected over 1.6 million Pennsylvanians. Such outages are not only disruptive but also expensive, with an annual estimated cost to the U.S. economy of $150 billion.[10]

To maintain the steady improvements in the reliability, affordability, and resilience of Pennsylvania's electricity system, the state must continue to invest in 21st century electricity generation and grid technologies. Luckily, these same technologies will also lower the state's carbon emissions. With a flexible design that allows states to select the technologies and services for compliance to suit the needs of the state, the Clean Power Plan presents Pennsylvania with an opportunity to modernize its electric grid for the benefit of consumers and the economy. In designing its compliance plan, Pennsylvania can further reduce emissions, maintain affordability, and increase reliability.

Proposed Targets for Pennsylvania (from draft Clean Power Plan)			
Adjusted Starting Rate[11]	**Interim Target (average 2020 – 2029)**	**Final Target (2030 – 2032)**	**Total Reduction Required (2032)**
1,531 lbs CO_2/MWh	1,179 lbs CO_2/MWh	1,052 lbs CO_2/MWh	479 lbs CO_2/MWh (31%)

The interim and final emission rate targets for Pennsylvania may change in the final rule, but the options for compliance will largely stay the same. Many of the things that the state is already doing will help it meet the finalized target emission rates set by EPA.

On Track to Achieve 23% of Final Proposed Reductions

Pennsylvania is on track to achieve 23% of total proposed reductions simply by what it is already doing.

Pennsylvania has already made changes to its power system that will reduce its emissions from the 2012 baseline used by EPA. Coal plant retirements already planned in the state will achieve 3% of Pennsylvania's proposed reductions.[12] In 2013, Pennsylvania generated nearly 1,300 GWh more electricity from renewable energy than in 2012.[13] Merely adding this generation to the 2012 baseline will achieve 3% of the state's proposed reductions. If the state's existing renewable energy requirements are maintained, it will add enough renewables by 2021 to meet an additional 11% of its required reductions.[14] Energy efficiency measures already implemented in the state will contribute another 6% of the state's proposed requirement.[15] All of these planned changes already under way would get the state 23% of the way towards meeting its goal in the draft plan, so whatever the final target, Pennsylvania will have a good start.

Impact of Planned Changes on Pennsylvania's Emission Rate		
Planned Activity	**Impact on Emission Rate (lbs CO_2/MWh)**	**% of Required Reduction Achieved[16]**
Planned Coal Retirements	16	3%
Existing 2013 Renewables	13	3%
Additional RE from 2021 RPS Requirement	50	10.5%
Energy Savings Already Achieved	29	6%
Total	**108**	**23%**

How Advanced Energy Can Help

As Pennsylvania develops its compliance plan, it can consider a host of options provided by advanced energy technologies and services to reduce its carbon emissions and help the state achieve other electric system and economic objectives. Many of these strategies are already being successfully implemented in Pennsylvania, and could be scaled up to achieve further emission reductions.

Pennsylvania has both an Alternative Energy Portfolio Standard (AEPS) and an Energy Efficiency and Conservation (EE&C) requirement.[17,18] The AEPS contains two tiers. If current trends continue, approximately 91% of electricity used for Tier I compliance could also be used for compliance with the Clean Power Plan.[19] Phase II of the EE&C (also referred to by its legislative authorization, Act 129) will end May 31, 2016. The Pennsylvania Public Utility Commission is currently designing Phase III.[20]

Some Grid Modernization Technologies		
Advanced Metering Infrastructure (AMI)	The legislature mandated that electric distribution companies install smart meters to all customers by 2023.[21,22] These meters will improve reliability and reduce operating costs for utilities, and allow utilities and consumers to better manage energy use, which can reduce emissions.	**Grid Modernization Projects** **Four Seasons Produce in Ephrata, Pennsylvania spends approximately $700,000 annually on electricity. In 2007, Four Seasons partnered with EnerNOC for demand response and now receives estimated annual payments of approximately $25,000 from PJM by reducing energy consumption when called upon.[27]**
Demand Response	Pennsylvania's EE&C requirements include peak demand reduction. Demand response brings down peak load, which can directly reduce emissions by over 1% nationally, and moderates energy prices for everyone.[23,24]	
Distribution Automation	Distribution automation helps optimize voltage conservation and reactive power (needed for motors and transformers to start up) and increases energy efficiency throughout the system without action on the part of customers, all of which helps to reduce emissions and improve reliability of the grid.[25]	
Energy Storage	Hydro pumped storage made up nearly 60% of all Tier II compliance credits under the AEPS in 2013.[26] Energy storage allows higher penetration of variable renewables, offsets emissions from older, dirtier plants for meeting peak demand, and relieves grid congestion when demand is high and transmission and distribution equipment losses are highest.	
Energy Efficiency		
Utility Energy Efficiency	A recent report estimates that ramping up energy efficiency programs in Pennsylvania would result in over 16,000 jobs and $8.3 billion in net energy savings by 2030 while also reducing electricity use by 23% relative to 2012.[28] Pennsylvania can encourage even more utility energy efficiency through decoupling and removing cost caps on utility programs.	**Energy Efficiency Policies** **Pennsylvania's EE&C requirement has proven an effective tool for saving energy. However, with annual savings of less than 1% of electricity sales, Pennsylvania lags behind its neighbors in the northeast, some of which achieve over 2% annually now.[37]** **Energy Efficiency Projects** **The Central Bucks School District north of Philadelphia signed a contract with Johnson Controls that carries projected savings of $24 million over 15 years from reduced energy use, utility rebates and demand response.[38]**
Energy Service Company (ESCO) Services	Pennsylvania has the nation's most successful program for harnessing private capital for efficiency upgrades of public buildings - over $590 million in efficiency retrofits in state buildings from 2000 to 2010 at no up-front cost to taxpayers.[29] The non-utility sponsored efficiency savings from the ESCO market, which are nearly equal in size to utility programs nationally, are not included in BSER.[30] Continued growth in the ESCO market in Pennsylvania could help the state achieve as much as 8% of its emission reductions while saving local governments, schools, and hospitals $2.7 billion.[31]	
Building Codes	Pennsylvania has recently undertaken efforts to update its building code, moving the state towards adoption of 2009 IECC and IRC codes for greater energy efficiency, and the state leads by example with higher requirements for public buildings.[32,33] The state also has a number of incentive programs for encouraging building efficiency.[34] Expanding these efforts, the state could save 2,500 GWh by 2030 through consistent adoption of the most modern codes.[35]	
Behavioral Efficiency	Using AMI combined with behavioral efficiency services has been shown to reduce energy usage and drive down costs for everyone. Behavioral efficiency in Pennsylvania can result in energy savings of 8,100 GWh (1% of the proposed rule's reductions) and cost savings to consumers of $974 million by 2030.[36]	

Renewable Energy		
Solar	The solar carve-out in the AEPS is expected to bolster Pennsylvania's nascent solar PV industry. PV prices have dropped nearly 50% since 2010 and the state already ranks 12th nationally in installed capacity with 245 MW, enough to power 30,000 homes.[39] Even this amount of solar capacity supports 471 solar companies, 2,800 jobs, and $27 million in investment.[40] Pennsylvania's technical potential is over 400 GW, or 632,00 GWh annually, meaning the state could surpass the renewable portion of EPA's calculation 18 times over from solar alone.[41]	**Renewable Energy Policies** **Pennsylvania enacted its Alternative Energy Portfolio Standard (AEPS) in 2004, setting a target of 18% alternative energy generation by 2020, including requirements for Tier I and Tier II resources. This standard also has a 0.5% solar PV requirement.** **After adding 1,400 MW of clean energy capacity in just five years from 2009 to 2013, Pennsylvania in 2013 had 2,231 MW of non-hydro renewable energy capacity. The state is also a leader in private clean energy investment, ranking 6th nationally with $841 million in private investment rolling into the state in 2013.[46]**
Wind	With 28 active facilities in the state, Pennsylvania is a national leader in wind manufacturing.[42] The state also ranks 16th nationally in installed wind capacity with 1.3 GW, producing enough electricity to provide 329,000 homes. The wind industry supports 2,000 Pennsylvania jobs throughout the value chain, and brought $2.7 billion in capital investments and $4 million in lease payments to the state last year. Yet the state has reached less than half its potential: wind supplies less than 2% of the state's electricity generation. With a technical potential of 3 GW the state could meet 40% of the renewable target in EPA's calculation from wind alone.[43]	
Waste to Energy	The AEPS Tiers allow for certain waste-to-energy technologies to be used for compliance. These technologies reduce emissions overall by offsetting dirtier fossil units. Pennsylvania is the largest importer of municipal solid waste in the country and there are six waste-to-energy facilities in the states.[44,45]	

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ENDNOTES

1. In the landmark 2007 case Massachusetts vs. EPA, the Supreme Court ruled that carbon dioxide is an air pollutant subject to regulation under the Clean Air Act, and EPA is therefore required to administer guidelines for emission reduction, http://www.supremecourt.gov/opinions/06pdf/05-1120.pdf. Since that ruling, the Supreme Court has upheld EPA's authority to regulate carbon emissions on two separate occasions: American Electric Power Company vs. Connecticut and in Utility Air Regulatory Group vs. EPA, which upheld EPA's authority to regulate emissions from stationary sources, http://www.supreme-court.gov/opinions/13pdf/12-1146_4g18.pdf and http://www.nytimes.com/2014/04/30/us/politics/supreme-court-backs-epa-coal-pollution-rules.html.
2. For a more in depth look at how the Building Blocks were established and applied to individual states in the Proposed Rule, see EPA TSD: GHG Abatement Measures. http://www2.epa.gov/sites/production/files/2014-06/documents/20140602tsd-ghg-abatement-measures.pdf
3. http://extension.psu.edu/natural-resources/energy/energy-use/resources/deregulation
4. http://www.ferc.gov/market-oversight/mkt-electric/overview.asp
5. http://powersuite.aee.net/portal/states/PA/energy_data
6. http://www.eia.gov/naturalgas/crudeoilreserves/pdf/uscrudeoil.pdf
7. U.S. Electric Power Industry Estimated Emissions by State (EIA-767, EIA-906, EIA-920, and EIA-923) http://www.eia.gov/electricity/data/state/
8. http://powersuite.aee.net/portal/states/PA/energy_data
9. http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_1.html&sid=US
10. http://images.electricalsector.eaton.com/Web/EatonElectrical/%7Baa0d93cf-362a-4bd9-9005-bb723dd40d97%7D_USBlackoutTracker2014ReportFinal.pdf
11. Includes 5.8% of existing nuclear generation that EPA deems to be at-risk of retirement, and existing 2012 renewable generation.
12. Planned unit-level coal plant retirements are taken from EIA Monthly, http://www.eia.gov/electricity/monthly/pdf/epm.pdf. The capacity factor for each unit was assumed to be the same as the capacity factor for the entire plant in 2012, the baseline year used by EPA. The average emission rate for the state's coal fleet was recalculated without these units and substituted for the starting average coal emission rate in EPA's formula for BSER. Retired coal plant capacity was assumed to be replaced by a combination of energy efficiency and zero-emission resources.
13. http://powersuite.aee.net/portal/states/PA/energy_data
14. The 2013 Annual AEPS Report shows the shares of each resource type in Tier 1 in 2013. The estimated emission reductions described here assume that the percentage of each resource type remains the same in subsequent years. This includes wind (57.6%), Wood/Wood Waste Solids (7.6%), Solar (<0.1%), landfill gas (25.9%), and other biogas (0.1%). By 2021, the Tier 1 generation requirement will by 12,131 GWh, of which approximately 91.% would be eligible for compliance. http://www.puc.pa.gov/electric/pdf/AEPS/AEPS_Ann_Rpt_2013.pdf
15. Includes cumulative savings from Phase II of Pennsylvania's EE&C requirement which totaled over 3,300 GWh. Phase III of the EE&C goals are currently being considered by the Pennsylvania PUC.
16. The required reductions referenced here are from the starting adjusted emission rate minus the proposed final target under the proposed Clean Power Plan. The targets are likely to change when the rule is finalized, but percent contributions depicted here are still a good indicator of how big of a contribution the state's already planned activities are likely to make.
17. Pennsylvania's AEPS contains a requirement of 8% of electricity sales from Tier I technologies and 10% from Tier II technologies which are defined as follows: Tier I: Solar, Wind, Biomass, Low-Impact Hydroelectric, Geothermal, Methane Gas, Fuel Cells, Coal Mine Methane; Tier II: Municipal Solid Waste, Integrated Gasification Combined Cycle Coal, Waste Coal, Coal Gasification, Anaerobic Digestion, Fuel Cells, Demand Side Management, Large Scale Hydroelectric, Solar Water Heat, Other Distributed Generation Technologies. There is also a specific requirement for solar PV. http://www.puc.pa.gov/PcDocs/534798.doc
18. http://powersuite.aee.net/portal/states/PA/energy_policies
19. The 2013 Annual Report shows the shares of each resource type in Tier 1 in 2013. The estimated emission reductions described here assume that the percentage of each resource type remains the same in subsequent years. This includes wind (57.6%), Wood/Wood Waste Solids (7.6%), Solar (<0.1%), landfill gas (25.9%), and other biogas (0.1%). By 2021, the Tier 1 generation requirement will by 12,131 GWh, (91.3%) http://www.puc.pa.gov/electric/pdf/AEPS/AEPS_Ann_Rpt_2013.pdf
20. http://www.puc.state.pa.us/consumer_info/natural_gas/energy_efficiency_conservation_saving_information.aspx
21. http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information.aspx
22. http://powersuite.aee.net/portal/states/PA/utilities
23. http://www.coned.com/energyefficiency/PDF/DemandResponseProgramsDetails.pdf
24. Navigant Consulting, Carbon Dioxide Reductions from Demand Response (Nov. 25, 2014), prepared for the Advanced Energy Management Alliance (AEMA) and included in AEMA's comments to EPA on the Clean Power Plan. http://aem-alliance.org/study-finds-significant-greenhouse-gas-savings-demand-response-group-urges-epa-incorporate-clean-power-plan/
25. https://www.smartgrid.gov/sites/default/files/doc/files/Distribution Reliability Report - Final.pdf
26. http://www.puc.pa.gov/electric/pdf/AEPS/AEPS_Ann_Rpt_2013.pdf
27. http://www.enernoc.com/our-resources/case-studies/four-seasons-produce-turns-to-enernoc-for-fresh-ideas-in-reducing-energy-use
28. http://aceee.org/sites/default/files/publications/researchreports/e1401.pdf

29. http://media.law.stanford.edu/organizations/programs-and-centers/steyer-taylor/State-Policy-Report-low-res.pdf
30. Up 10% from 2013, the U.S. ESCO market produced approximately $611.2 million in revenue in 2014, not including HVAC equipment ($4 billion nationally). The entire ESCO market is expected to continue growing at a rapid pace, reaching $10.6-$15.3 billion in total revenue by 2020. See Advanced Energy Now 2014 Market Report, http://info.aee.net/advanced-energy-now-2014-market-report
31. ACEEE State and Utility Pollution Reduction (SUPR) Calculator http://aceee.org/state-and-utility-pollution-reduction-supr
32. http://energycodesocean.org/state-country/pennsylvania
33. http://www.portal.state.pa.us/portal/server.pt/gateway/PTARGS_0_2_785_708_0_43/http%3B/pubcontent.state.pa.us/publishedcontent/publish/global/files/executive_orders/2000___2009/2004_12.pdf
34. http://www.newpa.com/find-and-apply-for-funding/funding-and-program-finder/high-performance-building-program-hpb
35. Based on adoption of recent model codes – IECC 2015 and ASHRAE 90.1 2013 – and updates every three years. Also assumes improved compliance with current building codes. ICF International, Clean Power Plan Energy Code Emissions Calculator http://energyefficientcodes.com/energy-codes-make-sense-with-or-without-the-clean-power-plan/
36. ACEEE State and Utility Pollution Reduction (SUPR) Calculator http://aceee.org/state-and-utility-pollution-reduction-supr
37. http://aceee.org/files/pdf/state-sheet/pennsylvania.pdf
38. http://www.johnsoncontrols.com/content/us/en/products/building_efficiency/case_studies2/building-management-systems/central-bucks.html
39. http://www.seia.org/state-solar-policy/pennsylvania
40. http://www.seia.org/state-solar-policy/pennsylvania
41. Pennsylvania's expected renewable generation from Building Block 4 of BSER is approximately 35,000 GWh in 2029, according to the proposed rule. Technical potential is from http://www.nrel.gov/gis/re_potential.html
42. http://awea.files.cms-plus.com/FileDownloads/pdfs/Pennsylvania.pdf
43. http://www.nrel.gov/gis/re_potential.html
44. http://www.portal.state.pa.us/portal/server.pt/community/solid_waste/14077
45. http://swana.org/portals/Press_Releases/Economic_Benefits_WTE_WP.pdf
46. http://www.pewtrusts.org/en/about/news-room/news/2014/12/05/keystone-state-emerges-as-rising-clean-energy-leader