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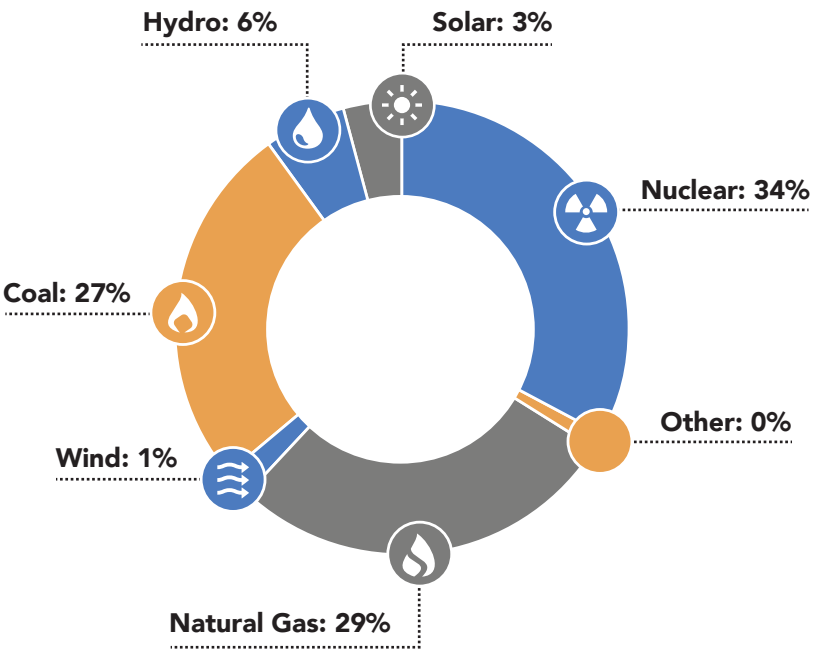
Arizona's Electric Power System and the Clean Power Plan

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 final 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]

Arizona's electricity market is vertically integrated. Two of its three largest utilities, Arizona Public Service (APS) and Tucson Electric Power (TEP), are regulated by the Arizona Corporation Commission (ACC), which is led by 5 elected commissioners and regulates 59% of the state's electricity load.[3] The state's second largest utility, Salt River Project (SRP), is unregulated and governed by a board of directors, functioning much like a municipal entity. Together, these three utilities account for 87% of the state's residential customers.[4]

Arizona's Electric Generation Mix in MWh (2014)[5]



Source: AEE PowerSuite

Although Arizona'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 Arizona an opportunity to design a plan that is best suited to the resources and needs of its unique power system.

A Strong Foundation

Arizona has a strong foundation for a compliance plan. The state has a diverse generation mix dominated by baseload nuclear and coal units and peaking natural gas units. The Palo Verde Nuclear Generating Station is the largest nuclear power plant in the country. The state has also invested in increasing its renewables and energy efficiency. In 2013, the state had approximately 2,100 MW of non-hydro renewable energy capacity, dominated by solar PV (1,563 MW) and solar thermal (284 MW).[6] The state ranks second nationally in installed solar PV capacity. However, growth is starting to lag relative to other states. With 247 MW installed in 2014, Arizona ranked fifth nationally in new solar capacity additions.[7]

The rate of carbon emissions from electricity generation in the state has gone down nearly 6% from 2005 to 2012, and at an average retail price of 10.10 cents/kWh in 2014, electricity in Arizona is below the national average.[8,9] Arizona also produces more electricity than it needs, exporting nearly 90,000 GWh of electricity in 2012, including 77% of the electricity produced by solar power.[10,11]

Still, the state's power system faces significant challenges. In September 2011, a cascading series of failures in APS's territory left more than five million people in Arizona, California, and Mexico without power for nearly 12 hours, causing an estimated $100 million in economic damages.[13] This event highlights the ongoing need for more grid modernization. In 2014 alone, a total of 50 individual outage events lasted a total of over 22 hours and affected over 250,000 people.[14] Such outages are not only disruptive in Arizona but also expensive nationally with an annual estimated cost to the U.S. economy of $150 billion.[15]

Improvements already made to Arizona's electricity system have helped to lower the state's carbon emissions. With a flexible design that allows states to select technologies and services for compliance that best suit the needs of the state, the Clean Power Plan will allow Arizona to continue to modernize its electric power system for the benefit of consumers and the economy. In this way, Arizona can further reduce emissions, maintain affordability, and increase reliability.

The interim and final emission rate targets for Arizona 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 target emission rates set by EPA.

Starting in October of 2016, APS will participate in the Energy Imbalance Market (EIM) operated by the California Independent System Operator (CAISO). The EIM makes use of CAISO's 5-minute real-time market capabilities, and enables participating balancing areas to buy and sell resources, improve reliability, reduce reserve requirements while minimizing wind and solar curtailments. The move is expected to result in savings of $7 million to $18 million annually by 2020, not including savings due to improved reliability.[12]

Proposed Targets for Arizona (from draft Clean Power Plan)			
Adjusted Starting Rate[16]	**Interim Target (average 2020 – 2029)**	**Final Target (2030 – 2032)**	**Total Reduction Required (2032)**
1,453 lbs CO_2/MWh	735 lbs CO_2/MWh	702 lbs CO_2/MWh	751 lbs CO_2/MWh (52%)

On Track to Achieve 23% of Final Proposed Reductions

Arizona 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 7% of Arizona's proposed reductions.[17] In 2013, Arizona generated over 1,100 GWh more electricity from renewable energy than in 2012.[18] Merely adding this generation to the 2012 baseline will achieve 4% of the state's proposed reductions. If the state's existing renewable energy requirement, the Renewable Energy Standard and Tariff (REST) is maintained, Arizona utilities will add enough renewable energy by 2025 to meet an additional 13% of the state's required reductions in the proposed rule.[19] Whatever the final target, Arizona will have a head start. Indeed, planned changes already under way would get the state 23% of the way towards meeting its goals in the draft plan.

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

Impact of Planned Changes on Arizona's Emission Rate		
Planned Activity	**New Emission Rate (lbs CO_2/MWh)**	**Incremental % of Total Required Reduction Achieved[20]**
Planned Coal Retirements	50	7%
Existing 2013 Additional Renewables	26	3%
Additional Renewable Energy Requirement (15% by 2025)	97	13%
Total	**173**	**23%**

How Advanced Energy Can Help

As Arizona 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 Arizona, and could be scaled up to achieve further emission reductions.

Arizona's hot summers present a challenge for grid operators. A full 25% of residential energy use comes from air conditioning, compared to just 6% on average in other states.[21] Efficiency and innovative pricing techniques are helping utilities meet peak demand during the hottest days of the year. The state leads the nation in Time-of-Use (TOU) pricing and has a robust Energy Efficiency Resource Standard (EERS).[22]

Arizona has both a REST and an EERS, for regulated IOUs, and SRP has its own Sustainable Portfolio Principle Goal. These policies are helping drive growth in the state's advanced energy industry, bringing considerable economic benefits to the state and saving money for consumers.[23,24]

Grid Modernization Technologies		
Advanced Metering Infrastructure (AMI)	APS and several smaller utilities have achieved nearly 100% penetration of smart meters in their service territory. SRP has 86% penetration.[25] The ACC recently approved an opt-out fee for customers who choose not to have smart meters.[26] These meters will improve reliability and reduce operating costs for utilities. The data and control provided by AMI enables utilities and consumers to better manage energy use, which can reduce emissions.	**Grid Modernization Projects** **Johnson Controls installed an enhanced central utility plant at the Phoenix Children's Hospital, which includes advanced automation, heat pump technology, and thermal storage. The plant is expected to deliver energy and water savings of $570,000 annually, in addition to saving enough water to meet the needs of 120 homes.[27]**
Demand Response	Arizona's EERS allows demand response, load management, and peak demand reduction to count towards energy efficiency savings.[28] Peak demand reduction lowers emissions from costly peaking plants. Demand response brings down peak load, which can directly reduce emissions by over 1% nationally, and moderates energy prices for everyone.[29]	
Distribution Automation	Distribution automation helps optimize voltage conservation and reactive power (needed for motors and transformers to start up), integrate more distributed generation, and increase energy efficiency throughout the system without action on the part of customers, all of which helps to reduce emissions. This has the added benefit of improving grid reliability[30]	
Energy Storage	Energy storage allows higher penetration of variable renewable generation, 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

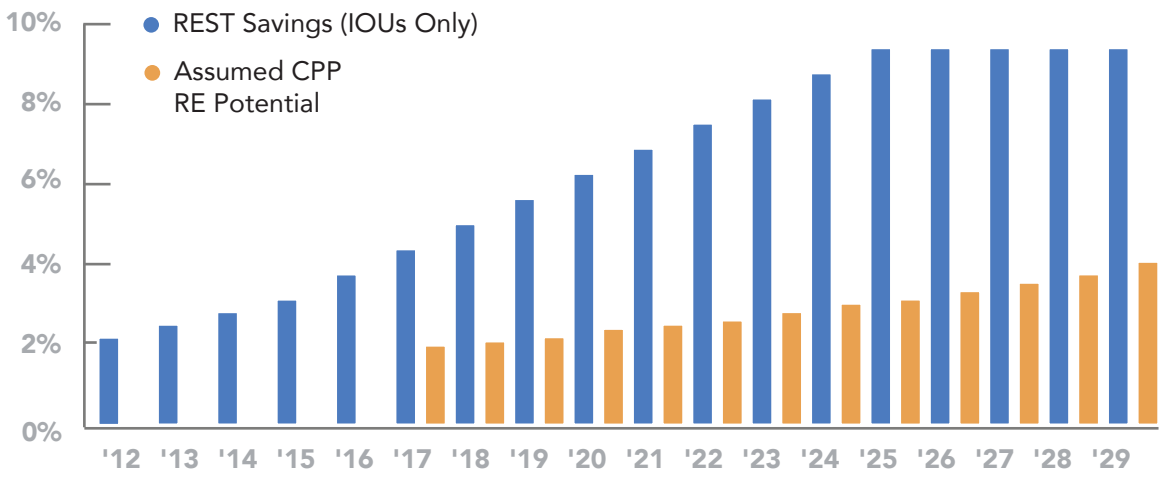
Utility Energy Efficiency	Arizona utilities are on track to achieve the final target in the state's EERS.[31] The graph below shows that if Arizona maintains its current EERS, savings from utility programs alone will surpass in 2020 what EPA deemed achievable across the entire state by 2030.
Energy Service Company (ESCO) services	The non-utility sponsored efficiency savings from the ESCO market, which is nearly equal in size to the market for utility programs nationally, are not included in the calculation of Arizona's emissions target but can be used as a compliance mechanism.[35] Continued growth in the ESCO market in Arizona could help the state achieve as much as 7% of its proposed emission reductions while saving local governments, schools, and hospitals $1.4 billion.[36]
Building Codes	Arizona is a "home rule" state, meaning that building codes are set by local governments and vary throughout the state. The cities of Scottsdale, Chandler, and Phoenix have green building codes for city buildings, and all state-funded buildings must achieve Leadership in Energy and Environmental Design (LEED) Silver certification.[37] Expanding these efforts through consistent adoption of the most modern codes, the state could achieve 25% of its proposed emission reductions and save consumers $7 billion.[38]
Behavioral Efficiency	Using AMI combined with behavioral efficiency services has been shown to reduce energy usage and drive down costs for everyone. Working with leading behavioral efficiency company Opower, APS achieved 41 GWh of total savings from 2011 to 2013, with limited income households achieving above-average savings.[39] Expanded statewide, behavioral efficiency in Arizona could achieve 2% of proposed reductions and save consumers $1.1 billion by 2030.[40]

Energy Efficiency Policies

Arizona's EERS requirement has proven an effective tool for saving energy, and Arizona has emerged as a leader in energy efficiency. The standard requires 22% cumulative savings from the previous year in 2020.[32] for investor owned utilities (IOUs) and less for electric cooperatives. The EERS allows peak demand reduction to count towards part of the energy savings target. Compliance options include demand response, energy efficiency, load shifting, building codes, and CHP. SRP also has its own, voluntary energy efficiency goal.

APS and SRP offer voluntary TOU rates with some of the highest participation rates in the country—half and one-third, respectively.[33] SRP customers have reduced energy use and achieved monthly bill savings of 6% through TOU pricing.[34]

Arizona's Existing Energy Efficiency Policy Exceeds CPP Requirements



Source: EPA GHG Abatement Measures TSD and AEE PowerSuite

Renewable Energy

Solar	Sunny Arizona is a national leader in solar, ranking second nationally with a total of 1.6 GW of installed solar PV capacity in 2013.[41] The state's leadership comes with significant economic benefits – new solar installations in 2014 alone brought in $624 million in investments, and the sector employs 9,200 people at 394 companies across the supply chain.[42] However, Arizona has barely tapped its technical potential of over 5,200 GW, enough to produce nearly 12 million GWh annually, or three times as much electricity as the entire country produced from all sources in 2013.[43]
Wind	Arizona has 238 MW of installed wind capacity from four wind farms, supplying less than 0.5% of the state's electricity generation.[50] This nascent industry supports as many as 500 Arizona jobs throughout the value chain, and brought $490 million in capital investments and $710,000 in lease payments to the state in 2014.[51] New low wind speed turbine technology now available dramatically improves the capacity factor of wind and reduce the cost of wind in Arizona.[52] With a technical potential of 11,000 MW, the state's wind industry has plenty of room to grow.[53]

Renewable Energy Policies

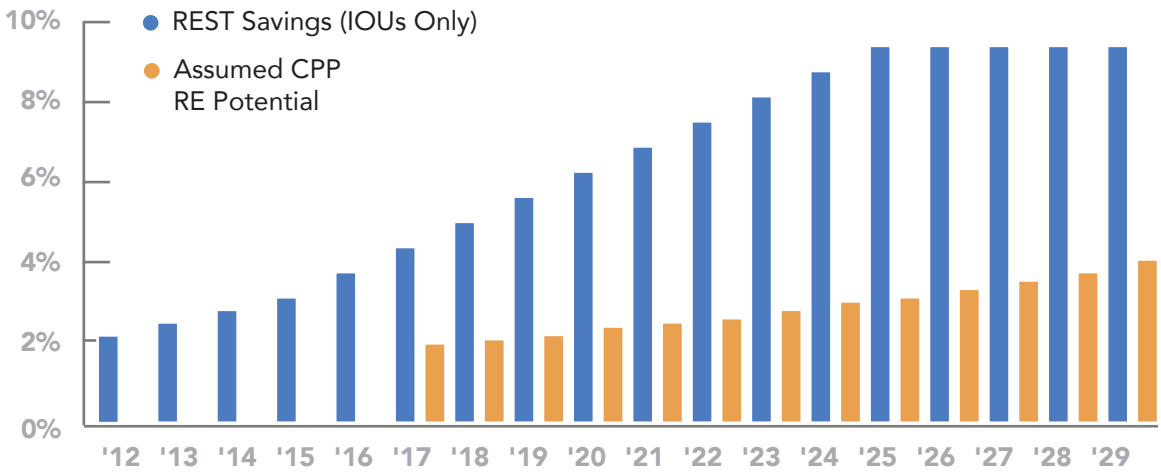
Enacted in 2007, Arizona's REST set a goal for the state's IOUs of 15% renewable energy by 2015. The policy has encouraged a boom in the state's renewable industry. In 2014, 100% of new utility-scale capacity installations in Arizona were solar PV.[44]

The REST also requires 30% of the target to come from customer-sited distributed generation (DG), divided equally between residential and commercial installations.[45,46] The recent addition of a demand charge for net-metered customers in Arizona has discouraged the growth of solar PV.[47]

Renewable Energy Projects

At 290 MW nameplate capacity, the Agua Caliente solar facility in Yuma is the largest PV plant in the world. Developed and operated by First Solar, it sells the entirety of its electricity to California utility Pacific Gas & Electric.[48] Arizona is also home to the largest solar parabolic trough plant in the world. The 280 MW Solana Generating Station in Gila Bend uses a molten salt thermal energy storage system to produce electricity even after the sun goes down. Together, these two plants produce enough electricity to power 140,000 homes.[49]

Arizona's Existing Renewable Energy Policy Exceeds CPP Requirements



Source: EPA GHG Abatement Measures TSD and AEE PowerSuite

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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, including 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.supremecourt.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://www.azcc.gov/divisions/utilities/electric.asp and http://aceee.org/sites/default/files/eers-04072015.pdf
4. http://powersuite.aee.net/portal/states/AZ/utilities
5. The pie chart excludes coal generation from the Navajo Generating Station which is exempt from the Clean Power Plan because it is located on an Indian Reservation. Unit-level generation data is not available for 2014, so annual generation is estimated here based on the plant's historical annual net capacity factor of 86%, yielding 16,950,600 MWh from the 2,250 MW facility.
6. http://www.acore.org/files/pdfs/states/Arizona.pdf
7. http://www.seia.org/state-solar-policy/arizona
8. Carbon intensity (lbs CO2/MWh), rather than absolute emissions ((lbs CO2), is the standard in the proposed Clean Power Plan. While absolute carbon emissions in Arizona rose during this period, electricity production grew at a faster rate, causing carbon intensity in Arizona to decline. This is U.S. Electric Power Industry Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, and EIA-923); and 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/
9. http://powersuite.aee.net/portal/states/AZ/energy_data
10. http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_1.html&sid=US
11. National Renewable Energy Laboratory, "Beyond Renewable Portfolio Standards" (2013), available at http://www.nrel.gov/docs/fy13osti/57830-1.pdf.
12. http://www.caiso.com/Documents/ArizonaPublicService-ISO-EnergyImbalanceMarketEconomicAssessment.pdf
13. Peter Behr, "Danger of a cyber-caused power blackout prompts new insurance strategies," EnergyWire, September 23, 2014, accessed October 27, 2014, http://www.eenews.net/stories/1060006240
14. http://images.electricalsector.eaton.com/Web/EatonElectrical/%7Baa0d93cf-362a-4bd9-9005-bb723dd40d97%7D_USBlackoutTracker2014ReportFinal.pdf
15. http://images.electricalsector.eaton.com/Web/EatonElectrical/%7Baa0d93cf-362a-4bd9-9005-bb723dd40d97%7D_USBlackoutTracker2014ReportFinal.pdf
16. Includes 5.8% of existing nuclear generation that EPA deems to be at-risk of retirement, and existing 2012 renewable generation.
17. 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. In Arizona, this represented 1,797 GWh from the planned retirement of Cholla Unit 2 in 2016.
18. http://powersuite.aee.net/portal/states/AZ/energy_data
19. Arizona's Renewable Energy Standard and Tariff (REST) establishes a requirement that regulated utilities, which constitute approximately 60% of the state's electricity market, procure 15% of the electricity from renewable resources by 2025. http://aceee.org/sites/default/files/eers-04072015.pdf This would result in 7,230 GWh of renewable energy in 2025.
20. 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.
21. http://archive.azcentral.com/home/articles/20131101timeofuse-utility-plans-can-save-money-energy.html
22. http://blog.aee.net/time-varying-rates-an-idea-whose-time-has-come
23. Arizona's REST applies to the state's investor-owned utilities and cooperative utilities. Eligible technologies include solar, wind, biomass, biogas, existing hydropower, new hydropower, fuel cells, geothermal, landfill gas, CHP, solar daylighting, solar space heating & cooling, and solar water heating. Arizona Admin. Code §14-2-1801 et seq. http://apps.azsos.gov/public_services/Title_14/14-02.pdf and http://powersuite.aee.net/portal/states/AZ/energy_policies
24. http://www.srpnet.com/environment/SPPrinciples.aspx
25. EIA Form EIA-861 http://www.eia.gov/electricity/data/eia861/index.html
26. http://www.utilitydive.com/news/arizona-regulators-approve-charges-for-smart-meter-opt-outs/344258/
27. http://www.johnsoncontrols.com/content/dam/WWW/jci/be/case_studies/5683_Phoenix_singles_HighRes.pdf
28. Arizona Admin. Code §14-2401, et seq. http://apps.azsos.gov/public_services/Title_14/14-02.pdf
29. Navigant Consulting, Carbon Dioxide Reductions from Demand Response (Nov. 25, 2014), prepared for the Advanced Energy Management Alliance

(AEMA), available for download at http://aem-alliance.org/download/10680/
30. https://www.smartgrid.gov/sites/default/files/doc/files/Distribution Reliability Report - Final.pdf
31. http://powersuite.aee.net/dockets/az-e-01345a-15-0095 The state's EERS only applies to 60% of the market. http://aceee.org/research-report/u1408
32. Arizona Admin. Code §14-2401, et seq. http://apps.azsos.gov/public_services/Title_14/14-02.pdf
33. http://archive.azcentral.com/home/articles/20131101timeofuse-utility-plans-can-save-money-energy.html
34. http://www.srpnet.com/prices/home/tou.aspx
35. 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
36. ACEEE State and Utility Pollution Reduction (SUPR) Calculator http://aceee.org/state-and-utility-pollution-reduction-supr
37. https://www.energycodes.gov/adoption/states/arizona
38. 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/
39. http://blog.opower.com/2013/10/in-webinar-arizona-public-service-explains-how-to-bring-energy-savings-opportunities-to-all-customers/
40. ACEEE State and Utility Pollution Reduction (SUPR) Calculator http://aceee.org/state-and-utility-pollution-reduction-supr
41. http://www.acore.org/files/pdfs/states/Arizona.pdf
42. http://www.seia.org/state-solar-policy/arizona
43. http://www.nrel.gov/gis/re_potential.html Total U.S. net generation in 2013 was 4,066,000 GWh. http://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3
44. http://www.seia.org/state-solar-policy/arizona
45. http://powersuite.aee.net/portal/states/AZ/energy_policies
46. http://www.fierceenergy.com/story/no-simple-fixes-fixed-charge-debate/2015-06-17 The Energy Information Administration (EIA) does not track distributed generation (DG) and, consequently, EPA did not include it in BSER. However DG can be used for compliance with the proposed rule.
47. http://www.azcentral.com/story/money/business/2015/06/23/arizona-judge-voids-hundreds-solar-leases/29145723/
48. http://www.firstsolar.com/en/about-us/projects/agua-caliente-solar-project
49. http://www.acore.org/files/pdfs/states/Arizona.pdf
50. Arizona Admin. Code §14-2-1801. Eligible Renewable Energy Resources; http://awea.files.cms-plus.com/FileDownloads/pdfs/Arizona.pdf
51. http://awea.files.cms-plus.com/FileDownloads/pdfs/Arizona.pdf
52. http://www.nrel.gov/docs/fy14osti/60979.pdf
53. http://www.nrel.gov/gis/re_potential.html