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Assessment of the Clean Power Plan

Prepared for:

The Arizona Utility Group

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EXHIBITS

1. Executive Summary

Several of the prominent utilities operating in Arizona including Tucson Electric Power Company (TEP), Arizona Public Service Company (APS), Salt River Project (SRP), Unisource Energy Services (UES), and Arizona Electric Power Cooperative (AEPCO), collectively referred to as the Arizona Utility Group or (AUG), retained Pace Global to perform an assessment of the impacts to the state that could result from the implementation of the EPA's proposed Clean Power Plan (also referred to herein as the "CPP") and to provide comments and recommendations to the EPA on its proposed rule.

Under the EPA's proposed Clean Power Plan, Arizona would be required to reduce the carbon dioxide (CO_2) intensity of its power generation fleet by approximately 47% by 2020 and approximately 52% by 2030 in order to meet its goals. Arizona undoubtedly faces one of the most aggressive reduction requirements of all states, driven by the application of the EPA's proposed building block approach to determining state-level emission goals. Pace Global's analysis of Arizona's compliance implications finds that the rule is neither flexible nor achievable and that implementation of this plan without modifications would result in severe impacts to the reliability of electric supply in the state and excessive cost implications for Arizona customers. The CPP is projected to increase fuel and purchased power costs by 40% and generation capital expenditures by 30% when compared to more reasonable alternatives

Pace Global conducted the following analyses:

- Analyzed the reasonableness of key assumptions in the building block approach for Arizona;
- Assessed the potential costs to Arizona customers associated with implementing the Clean Power Plan as proposed by the EPA.
- Analyzed an alternative path for the state to reduce the carbon intensity of its generation on a realistic and achievable timeframe.

Pace Global's major conclusions are:

1. The interim targets resulting from EPA's building blocks are unreasonable, are inequitable for Arizona, and cannot be achieved without major reliability concerns.
2. The infrastructure needs and costs associated with implementing the Clean Power Plan as it currently stands are very significant over a relatively brief period of time.
3. Alternative interim and final goals that fully consider the remaining useful life of existing plants would achieve significant carbon reductions without jeopardizing grid reliability and result in a lower cost to ratepayers.

Each conclusion is discussed in more detail below and in the remainder of this report.

1.1. EPA's Interim Goals Resulting from Building Blocks are Unreasonable, Inequitable and Unachievable

- **Building block 1 cannot be technically achieved:** EPA's assumption of a six percent efficiency improvement for operating coal plants is highly speculative and technically impossible, especially noting that the rule, as proposed, would not account for efficiency improvements made to date.

- **Building block 2 should account for plant useful life and result in reasonable timeline for compliance:** In the computation of the goal, the application of building block 2 accounts for 73% of Arizona's total reduction requirement. Reductions from this building block would be required by 2020, as the EPA assumes that increased utilization of existing natural gas combined cycle units and proportional reduction in coal generation is an immediate measure to reduce CO_2 emissions from electric generation. In Arizona, this would result in the elimination of all affected coal capacity in the state without considering the significant remaining useful life that some of these units have. This assumption ignores many realities of how the electric power system operates and how long it takes to add required infrastructure, the fact that transmission in the state would need to be reconfigured (expanded) to operate gas units at the levels that would be required, and the fact that massive amounts of new gas capacity and pipeline infrastructure would have to be built to maintain operating reserve margins in Arizona. Pace Global's analyses show that all coal plants would have to retire due to this building block by 2020 using realistic assumptions of plant operation.

  – Pace Global recommends that the EPA consider the remaining useful life of existing plants as well as applying a phase-in of the re-dispatch assumed by building block 2 over the 2020 to 2030 time period rather than assuming that this re-dispatch could occur by 2020.

- **Building block 3 needs clarification:** Although building block 3 accounts for a smaller portion of Arizona's overall reduction requirement, renewable generation can be an important compliance strategy for Arizona in meeting its goals under the Clean Power Plan.
  – Consistent with the treatment of renewables under virtually all state renewable energy standards, the EPA should clarify that renewable generation should be accounted for at the point of delivery and not the source of generation for use in compliance purposes under building block 3.

- **Building block 4 is not reasonably achievable:** The application of building block 4 drives 15% of Arizona's reduction requirements. This building block was apparently developed by considering what aggressive states have achieved over the past few years in energy efficiency reductions. There is no evidence that achieving levels of 1.5% per year can be maintained over a period of 10 or more years. The EPA's approach selects far too aggressive efficiency levels for goal calculation and does not consider what Arizona has already achieved nor factor in the ability of states to meet the 1.5% annual reduction continuously for more than a decade.
  – Pace Global recommends that the EPA adjust building block 4 to consider a 0.6% annual efficiency improvement rather than 1.5% when establishing overall target levels. This benchmark would be more in line with studies of achievable efficiency penetration levels.

The CPP is Inequitable for Arizona

The goals are particularly severe for Arizona and would require all affected coal in the state to be eliminated by 2020.

- The state of Arizona must reduce its carbon levels by 47% by 2020 and 52% by 2030 from current levels, which is one of the highest reductions in the country, with all but 10 states having less than a 40% reduction by 2030. The fact that the vast majority of the reductions are required for the interim goal means that the plan must effectively be implemented by 2020, a virtually impossible task.

EPA's Interim Targets Imply Major Reliability Concerns in Arizona

- Pace Global's analyses of the CPP Building Block application indicate that all of the non-tribal coal in the state would be retired by 2020. This would drive reserve margins in the state negative by 2020 without the addition of significant new capacity in the state. To maintain reserve margins, Pace Global estimates that by 2020, at least 2.4 GW of incremental natural gas generation capacity costing around $2 billion[1] (over baseline expected needs to meet load growth and account for planned retirements) would be needed within a period of three years. This is virtually impossible to plan, permit and construct in Arizona.

- The direct application of the four building blocks would require momentous changes to Arizona's coal fleet by 2020. Approximately 3,316MW of coal fired generation would have to be retired by 2020, on top of already planned retirements and re-powerings, implying a stranded investment of over $3 billion (2013$) in 2020.
- Most coal generation is in the eastern part of Arizona, while most of the existing natural gas generation is in western Arizona. Transmission capacity has been built out to serve load from the existing capacity sites. Without additional transmission infrastructure investment, which can take five to ten years to develop and construct, electric reliability and deliverability could be severely compromised.
- There are two main natural gas pipelines serving Arizona, and one is already near capacity throughout the year, with both near capacity during peak periods. The CPP building blocks imply that a more than 3-fold increase in natural gas demand by the power sector alone would be expected by the early 2020s, driving the need for pipeline upgrades. Without additional pipeline infrastructure that can take four or more years to develop and construct, current pipeline capacity would be overwhelmed, and electric, as well as consumer natural gas, reliability and deliverability could be severely compromised.

[1] This is generation cost only. Cost for additional transmission and gas pipeline infrastructure have not been specifically estimated in this analysis, but would be significant.

1.2. There are Reasonable Alternatives Available to the EPA

The significant cost, reliability and timing constraints that would impact Arizona's ability to comply with the proposed goals of the Clean Power Plan can be mitigated by the application of several changes to the building blocks, which would result in a more gradual, but ultimately significant reduction in the CO_2 intensity of generation. These specific recommendations and justification are summarized in Exhibit 1.

Exhibit 1: Recommended Adjustments to the CPP Building Blocks and Justification

	Recommended Change for the EPA	Rationale
Building Block 2	(1) Exclude coal plants from NGCC re-dispatch if they are 40 or less years old as of 2030. (2) Evenly phase in the re-dispatch assumed by building block 2 over the 2020 to 2030 time period rather than assuming that this re-dispatch could occur by 2020	This would both account for the useful life of plants and result in a more feasible timeline to address infrastructure issues and costs (including stranded) associated with the required significant generation switching required.
Building Block 3	Clarify that all renewable generation should be accounted for at the point of delivery and not the source of generation.	This would enable states to rely on regional resources for compliance and is consistent with virtually all existing state renewable energy standard legislation.
Building Block 4	Adjust building block 4 to assume a 0.6% annual efficiency improvement rather than 1.5%.	This penetration level is more consistent with a reasonable achievable level for purposes of target setting and would allow states to rely on efficiency as a compliance mechanism, providing flexibility.

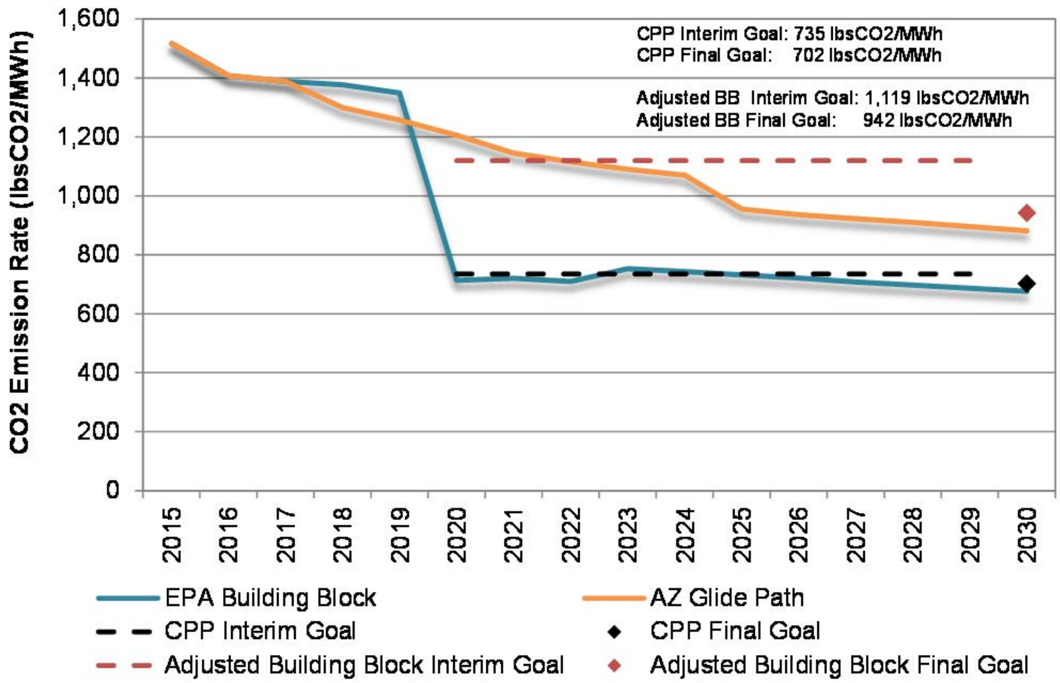
Source: Pace Global.

In applying these recommended changes to the EPA's building block approach, Pace Global determined recommended goals for Arizona that would:

- Reduce the carbon emission intensity of generation in Arizona by around 35% by 2030, with an adjusted final 2030 goal of 942 $lbCO_2/MWh$ versus the EPA's goal of 702 $lbCO_2/MWh$ proposed;
- Account for the useful life of coal plants;
- Provide adequate time to develop the transmission infrastructure to ensure grid reliability;
- Provide adequate time to develop the gas pipeline infrastructure to ensure gas supply reliability;
- Achieve these reductions at a much lower cost to the customer and avoid near-term rate shocks (as depicted in Exhibit 3).

Exhibit 2 presents emission rates by year between now and 2030 for the EPA Building Block scenario and the Arizona Glide Path scenario based on Pace Global's analysis. Both scenarios achieve significant reductions in carbon emissions. However, the Arizona Glide Path scenario offers a much more gradual path to meeting these reductions, without the cost and reliability concerns that would result from implementing the interim and 2030 targets for Arizona as currently proposed.

Exhibit 2: Emission Rates by Scenario v. CPP Proposed and Adjusted Goals



Source: Pace Global.

1.3. The Costs of Compliance under the EPA Building Block Scenario are Very Significant

Pace Global assessed the cost implications of the Clean Power Plan assuming the literal application of the building blocks as well as an alternative scenario to reducing emissions in a more reasonable and cost effective manner. Costs of the EPA building block analysis were compared to the alternative Arizona Glide Path scenario that accounts for the useful life of coal plants in the state to assess costs directly attributed to meeting Clean Power Plan compliance. This comparison is summarized in Exhibit 3 and includes the following key findings:

- The fuel and purchased power component of costs for Arizona electric ratepayers are estimated to increase by 40% (with risk of higher impacts, depending on the impact of the plan on U.S. natural gas markets and pricing) under the EPA Building Block scenario versus the Arizona Glide Path scenario. This is due to fuel switching from lower-cost coal to higher-cost natural gas, as well as increases in the expected cost of natural gas over time as a result of substantially higher gas demand in the EPA Building Block scenario.
- New capital expenditures associated with building gas plants are likely to be 30% higher in the Building Block scenario between 2020 and 2030 than the Arizona Glide Path scenario's plan to phase coal out more gradually.
- In addition, the EPA Building Block scenario would result in $3 billion in utility stranded costs in 2020, resulting in ratepayers paying twice for the same service.

Exhibit 3: Summary of Cost Impacts of the Clean Power Plan (2013$)

	AZ Glide Path Scenario	EPA Building Block Scenario	Delta (EPA BB – AZ Glide Path)	Percent Change
2020-2030 Average Fuel + PP Costs ***($/MWh)***	$37.9/MWh	$52.7/MWh	$15/MWh	40%
2020-2030 Total Fuel + PP Costs ***($Billion)***	$44.5B	$62.2B	$17.7B	40%
2020 – 2030 Gas Capacity (MW)	7,825MW	10,125MW	2,300MW	29%
2020-2030 Capital Cost Investment ***($Billion)***	$6.2B	$8.1B	$1.9B	31%
Stranded Cost in 2020 Due to Early Coal Closures ***($Billion)***	n/a	$3.04B	n/a	n/a

Note that the additional cost associated with new and upgraded electric transmission and natural gas pipeline infrastructure required to meet Clean Power Plan goals are not included in this summary.

Source: Pace Global.

This analysis shows that customers would benefit greatly from a more moderate and gradual reduction in coal generation that accounts for the useful life of coal plants while still achieving significant reductions in carbon intensity.

2. Assessment Overview

Pace Global performed an assessment of the Clean Power Plan's impacts on Arizona to analyze the following:

- Analyzed the reasonableness of key assumptions in the building block approach for Arizona;
- Assessed the potential costs to Arizona customers associated with implementing the Clean Power Plan as proposed by the EPA.
- Analyzed an alternative path for the state to reduce the carbon intensity of its generation on a realistic and achievable timeframe.

In performing the assessment, Pace Global reviewed the impacts of the Clean Power Plan on Arizona's natural gas and electric power systems by assessing the implications of the prescribed draft rule and by comparing the plan with a more plausible alternative. Scenarios considered in this analysis include:

- EPA Building Block scenario – literal application of EPA's four building blocks resulting in 0 MW of affected coal capacity remaining in the state by 2020
- Arizona Glide Path scenario – ~2,500MW remaining coal capacity in the state by 2030

Pace Global performed electric market dispatch analysis and fuel market analysis under these different scenarios to quantitatively assess the consumption, generation, cost, and infrastructure impacts specific to Arizona. To support the quantitative analysis, Pace Global deployed an hourly chronological dispatch model to simulate the economic dispatch of power plants within a competitive framework with the AuroraXMP platform. In its fuel market analysis, Pace Global utilized the Gas Pipeline Competition Model ("GPCM") to conduct analysis of natural gas economics in North America. An overview of the modeling approach and assumptions used in the analysis are included as appendices to this report.

The remainder of the report is organized into three major chapters as follows:

- EPA's Building Block Approach and Implications for Arizona
- Assessment of Alternative Scenario
- Cost Implications of the Clean Power Plan

3. EPA's Building Block Approach and Implications for Arizona

The EPA defines the Best System of Emission Reduction (BSER) as four building blocks which are uniformly applied to actual 2012 baseline state generation profiles to determine individual state-level, rate based carbon dioxide goals ($lbCO_2$ / MWh) under the Clean Power Plan. These building blocks, which the EPA characterizes as "reasonably achievable," aim to account for individual states' baseline generation mix. The resulting state goals, however, vary widely among different states in terms of the magnitude of reduction in emission rates required to comply and the expected cost and changes to generation mix that would be required to achieve them. As proposed, Arizona would be required to decrease its emission rate 52%, from 1,453 $lbCO_2$/MWh in 2012 to 702 $lbCO_2$/MWh by 2030, making it one of the most aggressive of all state goals in the proposed plan.

Exhibit 4 presents the calculation of the state's goal by building block and the relative reduction applicable to each one.

Exhibit 4: Application of the Building Blocks to Arizona

- Arizona's final goal: 702 lbs of CO_2 / MWh by 2030
  - Interim Goal: 735 lbs of CO_2 / MWh average over 2020-2029
- Final Target Calculation:
  - 2012 Baseline: 1,453 lbs CO_2 / MWh
  - Block 1 HR: 1,453 lbs CO_2 / MWh → 1,394 lbs CO_2 / MWh → 8% of total reduction
  - Block 2 Disp.: 1,394 lbs CO_2 / MWh → 843 lbs CO_2 / MWh → 73% of total reduction
  - Block 3 Ren.: 843 lbs CO_2 / MWh → 814 lbs CO_2 / MWh → 4% of total reduction
  - Block 4 EE: 814 lbs CO_2 / MWh → 702 lbs CO_2 / MWh → 15% of total reduction
- Total Reductions:
  - 1,453 lbs CO_2 / MWh → 702 lbs CO_2 / MWh → 52% reduction over baseline

Source: EPA.

3.1. Assessment of Reasonableness of Building Block Assumptions

Building block 1: Make Fossil Fuel Plants More Efficient – Building block 1 assumes that the average heat rate of affected fossil units[2] decreases 6%. However, EPA's basis for concluding that a 6% efficiency improvement for all affected units is possible, much less reasonably achievable, is not supported by the facts. The application of building block 1 would not account for efficiency gains made before 2012, and in effect would further disadvantage units that have already made efficiency improvements before this time. Interestingly, in the application of the building block approach under the proposed rule, Arizona would have to retire or otherwise eliminate all coal by 2020 to meet interim goals (pursuant to building block 2), which would essentially eliminate this building block as a compliance option for Arizona.

Building block 2: Use Low-Emitting Power Sources More – Building block 2 assumes that affected existing and under construction NGCC units could increase dispatch up to a 70% capacity factor while proportionally backing down coal to reduce the emission intensity of the state's generation mix. The application of this building block in determining state goals assumes that this occurs by 2020. Due to the large amount of NGCC capacity in Arizona, this building block has a significant impact on its state goal computation and would require significant and sudden shifts in the state's generation mix to meet the resulting emission rate reductions. In fact, as applied in the EPA's building block approach, the increased use of NGCC units in the state would displace all coal fired generation in the state, in effect forcing the retirement of all of the approximately 3,316 MW of coal capacity operating[3] as of the 2012 baseline net already planned retirements and units slated for conversion to natural gas.

There are several issues with the prescription of building block 2 for Arizona:

(1) ***Existing NGCC Resources are Inadequate to Replace AZ Coal Retirements*** - Today, all Arizona utilities rely on the existing coal-fired and natural gas resources within in the state, including the existing natural gas merchant plants, to meet their summer peaking demand requirements. In addition to serving a portion of Arizona loads, Arizona's merchant gas resources are also committed to meet summer peak demands in adjacent states. As a result, the early retirement of Arizona's existing coal-fired resources by 2020 will necessitate the construction of new natural gas plants in order to maintain system reliability for 2020 and beyond.

(2) ***Useful life of Fossil Generation is Not Considered*** – Arizona is home to some of the newest coal fired units in the country with the most recent units commencing operation as recently as 2009. These investments assume a long and useful life of 40 years or more. The application of building block 2 would require the retirement of virtually all if not all coal generation in the state by 2020, with no consideration to the useful life of the existing coal fleet. Retiring these units far earlier than a reasonable planned useful life would result in excessive stranded costs and ratepayers essentially paying twice for this generation capacity.

(3) ***Transmission Infrastructure Would Not Support a Wholesale Change in the Generation Mix*** - The lack of transmission import capacity limits load serving entities from displacing all the retired coal units with the existing NGCC units, as shown in Exhibit 5. The majority of coal units and associated

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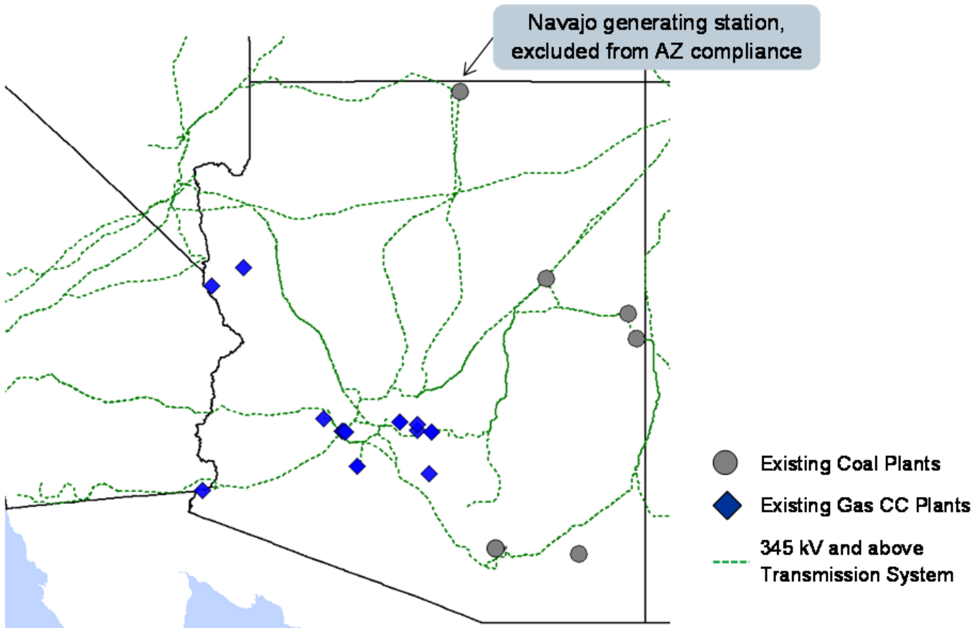
[2] Affected electric generating units are generally defined as currently operational or under construction in 2012, over 25MW and designed to operate more than one third of the time.

[3] Arizona's state goal only includes affected generating units on non-tribal land and therefore the Navajo generating station is not accounted for in the discussion of state goal computation and compliance implications.

transmission from which generation would shift is located in the far eastern and southern parts of the state while the existing NGCC units are located in and to the west of the Phoenix area. The transmission system works well for current operations, but the changes proposed by the EPA may well demand significant modifications.

Exhibit 5: Arizona's Existing Coal and NGCC Units and Transmission Infrastructure



Source: Pace Global, Ventyx.

(4) ***Increased Natural Gas Demand Would Strain Pipeline Infrastructure*** - Incremental natural gas demand resulting from the increased utilization of natural gas fired generation and the required new natural gas capacity needed to backfill the retired coal units to meet load would exceed the capacity of Arizona's existing, but already heavily utilized natural gas pipeline network. Pace Global's analysis indicates that compliance with Arizona's interim goals would result in increased use of the El Paso system, as the alternate pipeline, Transwestern, is already 98% to 100% utilized. Both the El Paso and Transwestern systems would require expansion by the mid-2020s to maintain adequate supply capacity. Pipelines require a minimum of four years lead time from need determination to in service date. The timing of the CPP goals would require these expansion projects to begin soon to meet demand.

Building block 2 accounts for over 70% of Arizona's reduction required from baseline to its 2030 goal. The assumption that this generation switching could occur by 2020 is not feasible for Arizona due to in large part to the magnitude of investments in generation, transmission and pipeline infrastructure simultaneously, which require substantial commitments, permitting and construction lead times. Significant new infrastructure in the form of new electric transmission infrastructure, natural gas pipeline expansions, and generation infrastructure to maintain reliability would be needed. Further it would leave stranded investments in the state's existing coal fleet that would impact electric rates.

(5) ***EPA IPM Modeling Found to be Inconsistent with Economic Utility Practices*** - The EPA's analysis of the Clean Power Plan using the Integrated Planning Model (IPM) assesses several compliance scenarios. The Option 1 compliance for Arizona individually as a state is the most relevant comparison, considering that Arizona has no firm plans for regional compliance at this time. This modeling reflects 1,497 MW of coal-fired generation remaining online through 2030 and beyond while Arizona still meets interim and final proposed goals. The EPA modeling achieves this 2030 result through a decade of sub-optimal dispatch at the four units located at the Springerville Generating Station, the newest and generally most efficient of the coal-fired units currently operating in Arizona.

As shown in Exhibit 6, the four existing units at the Springerville Generating Station maintain an annual capacity factor of 83% in 2016 and 2018. Starting in 2020, the output on Springerville Unit 3 drops to a 0% annual capacity factor with a maximum annual capacity factor of 26% in 2025 and 2030. Springerville Units 1 and 2 show annual capacity factors declining to 33% in 2020 and 36% in 2025 before returning to a 61% capacity factor in 2030. EPA's modeling results in much smaller curtailments at the newest Springerville Unit, 4, with operation at an annual capacity factor of 66% in 2020 and a 72% annual capacity factor in 2025 and 2030.

Pace Global finds the EPA analysis to be inconsistent with economic utility practice in its assumption that coal units, specifically Springervlle Units 1, 2 and 3, would operate for such an extended period of time at sub-optimal dispatch. This large reduction in the overall plant utilization at the Springerville Generating would result in an economic outcome that would favor shut down over operating the plant at average annual capacity factor of 40% over a 10 year period. Pace Global does not find this analysis to support Arizona's ability to maintain any more than a very minimum capacity of the existing coal fleet online beyond 2019 while complying with EPA's goals, particularly the interim goal.

Exhibit 6: Arizona Affected Coal Unit Capacity Factors (EPA IMP Analysis of CPP)

Unit Capacity Factors	2016	2018	2020	2025	2030
Apache Unit 2	85%				
Apache Unit 3	85%				
Cholla Unit 1	84%	85%			
Cholla Unit 2	83%				
Cholla Unit 3	83%				
Cholla Unit 4	84%				
Coronado Unit 1	84%	84%			
Coronado Unit 2	84%	84%			
Navajo Unit 1-3*	83%	83%	83%	83%	83%
Springerville Unit 1	84%	84%	33%	36%	61%
Springerville Unit 2	84%	84%	33%	36%	61%
Springerville Unit 3	82%	82%		26%	26%
Springerville Unit 4	82%	82%	66%	72%	72%

*Note that Navajo units located on tribal land are not affected units under the proposed Clean Power Plan and therefore do not impact Arizona's compliance.

Source: EPA Analysis of the Clean Power Plan, Option 1 – State

Finally, the modeling does not take into account region-specific technical issues. In particular, given the remote location of Arizona's existing coal units, it is anticipated that shutdown of these units may result in issues surrounding voltage and system stability. In the absence of a detailed transmission analysis, given Arizona's demonstrated lack of flexibility, EPA would be unable to assess what units are necessary for the reliability of the electric grid.

Pace Global recommends that the EPA adjust the building block approach to exclude remaining useful life units from the re-dispatch calculation and phase in the application of building block 2 evenly over the 2020 to 2030 time period, similar to the application of building blocks 3 and 4. The additional timing will enable more cost effective decision making and reduce the cost and reliability impacts associated with stranded coal investments and simply defaulting to natural gas for compliance.

Building block 3: Use More Zero- and Low-emitting Power Sources – Building block 3 assumes that renewable generation meets a progressive state-assigned target based on regional build out trends by 2030 and that under construction nuclear units come online and at risk nuclear units stay online through 2030.

The proposed rule is unclear as to whether or not renewable generation must be physically located in a state or delivered into a state, accounting for the fact that virtually all states that have renewable mandates implemented rely on out of state generation for compliance. Consistent with many legislated state renewable energy standards, the EPA should clarify that the renewable generation is accounted for at the final point of delivery and not the point of generation. Enforceability[4] is one of the key criteria by which the EPA will assess state compliance under the Clean Power Plan. Noting this, it is very likely that most states will have to enact legislation of some type to align oversight agencies and generation owners and operators (and independent system operators where applicable) to ensure that responsible parties can be held to requirements under the state implementation plan. State renewable energy standards almost universally recognize delivered renewable energy from out of state sources for compliance. Legislation could only include the state RPS if the EPA were to accept that renewable energy delivered to a state from outside state borders could be recognized for compliance purposes under the Clean Power Plan.

The nuclear portion of building block 3 defines certain new and "at risk" nuclear generation units that, should they not be online in the compliance timeframe, would very likely result in higher overall emission rates in select states, as the alternative generation would likely not all come from zero-emitting sources. The expected generation from these units was calculated to be on average approximately 6% of U.S. nuclear generation, which was uniformly applied to all states' nuclear generation in developing proposed goals. This creates a significant inequity for states with nuclear generation that is not at risk.

The EPA should amend this part of building block 3 to account for at risk units specifically and not apply a blanket average to all states that have nuclear generation. This would impact the application of building block 3 in determining state goals as well as the use of nuclear generation for compliance under the Clean Power Plan. The Palo Verde nuclear generating station in Arizona is not viewed as at risk, as it has several owners that rely on the plant to meet native load. However, through the application of building block 3, Arizona's state goal is downwardly adjusted based on the national average of nuclear generation

[4] The four general criteria by which the EPA proposes to evaluate SIPs are enforceability, achievement of state goals, verifiable emission reductions, and the process for regular reporting progress towards goal attainment.

deemed to be at risk. The EPA should clarify the ability of the state to document and count this unit for use in compliance towards its goals.

Building block 4: Use Electricity More Efficiently – Building block 4 assumes that demand-side energy efficiency increases 1.5% annually from 2017 to 2030. This building block has the second largest impact on Arizona's state goal derivation, driving a reduction of 15% of the rate reduction by 2030 versus the 2012 baseline.

The EPA selected a 1.5% annual reduction based on a review of the top tier states' efficiency performance in the 2012 baseline year, noting that three states actually achieved this level in one year and that nine other states had mandates to achieve this level for at least one year by 2020. Achieving a 1.5% efficiency improvement has been demonstrated in top tier states in a single year. However, the EPA's assumption in building block 4 is that this high level is achieved by all states for the years 2017 to 2029. In the EPA's Clean Power Plan technical support document on GHG Abatement Measures, only one source, the American Council for an Energy Efficient Economy (ACEEE), reported efficiency potential of 1.5% per year. The next highest efficiency potential was reported from the Electric Power Research Institute (EPRI), a non-partial source, in a 2014 study to be 0.6%, representing the high end of achievable efficiency penetration levels.[5] Thus, even the EPA's scientific support is not fairly supporting the fact that 1.5% efficiency penetration in all states is feasible, much less the achievement of this level consistently for more than a decade.

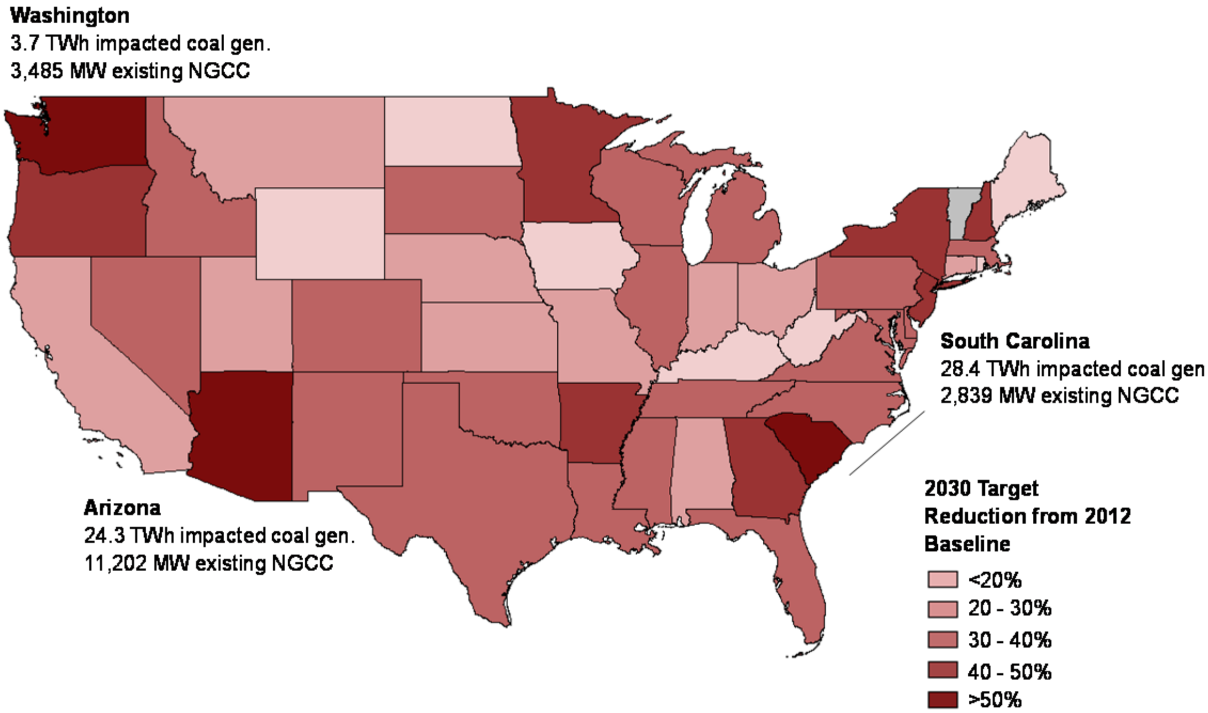
Although a full legal analysis was not performed for this scope, Pace Global anticipates that this building block will be heavily scrutinized in the comment process and either reduced or eliminated from the building block approach in the final rule or challenged in the courts following the release of the final rule. For the purpose of goal setting, the EPA should lower the efficiency reduction level to 0.6% per year, in line with the EPRI efficiency potential study. Although Arizona does have strong efficiency standards adopted at the state level, the application of this building block just further lowers the state target and increases their already aggressive compliance burden. The EPA should ensure that goal setting does not become a compliance obligation, but rather enables entities to have flexibility to choose between renewable energy and energy efficiency to achieve compliance. Arizona's existing efficiency program should be viewed as a compliance mechanism to manage its significant reduction requirements under the Clean Power Plan and particularly building block 2.

3.2. The CPP's Proposed Goal Levels are Inequitable for Arizona

Implications for Arizona to comply with the proposed rule are disproportionately higher than nearly any other state. Arizona has one of the most severe reduction targets of all states covered under the Clean Power Plan, with a reduction below its 2012 baseline of 52%, while most states' requirements are well below 50% with some less than 20% (Exhibit 7). Other states like Washington and South Carolina also have a large percentage reduction, although the drivers are different. Washington State has only a small amount of coal, so relatively minor generation switching measures can achieve compliance. South Carolina is impacted not by building block 2, as it has limited existing NGCC capacity, but rather by building block 3, due to the proposed new nuclear generation capacity in the state. Arizona stands out as the state most impacted by building block 2, due to its high coal generation and significant existing NGCC capacity.

[5] EPA Technical Support Document "GHG Abatement Measures," Table 5-7 "Summary of National EE Potential Studies"

Exhibit 7: Reduction of 2012 Emission Required by Final Clean Power Plan Goals (%)



Source: EPA, Pace Global.

3.3. Interim Goals

Interim state goals as proposed in the Clean Power Plan, which would need to be met on average over the 2020 to 2029 time period, are very close to the final goals and would require near-term generation changes including replacing most if not all of the coal capacity in the state, enhancements to the gas transportation infrastructure, and transmission infrastructure development. Arizona's interim goal of 735 $lbCO_2$ / MWh is 47% below its 2012 baseline emission rate. Because Arizona's interim and final goals proposed are below the emission rate of even the most efficient natural gas generation, incremental renewable generation and energy efficiency over levels prescribed in the building blocks would be required to comply.

3.4. Implications of Building Blocks on Arizona's Electric System

Pace Global assessed the implications of the CPP building block's on Arizona's electric system by quantitatively assessing compliance through an approximation of a literal application of the Clean Power Plan building blocks (generally following the EPA's goal setting calculation). While this modeling approach shows Arizona complying with EPA's interim and final goals, the results shown in this analysis are not achievable given the real world timeframes needed to construct new generation, transmission and gas pipeline infrastructure. The purpose of this Building Block scenario analysis is to highlight the potential reliability impacts for Arizona that are likely to result under the implementation of the Clean Power Plan. Exhibit 8 below summarizes the building blocks and modeling assumptions.

Exhibit 8: Building Block Scenario Assumptions

Building Blocks	Modeling Assumptions	Commentary on Modeling
1. Fossil plant efficiency improvements	Increase efficiency of existing coal plants by ~6%	Because of Arizona's significant peaking natural gas capacity as of the CPP baseline in 2012, no coal operates in 2020 or beyond in order to meet building block 2
2. Coal-to-natural gas combined cycle (NGCC)	Increase utilization of all existing and new NGCCs up to 70% while proportionally reducing coal-fired generation	Existing combined cycle units are necessary to meet Arizona peak summer capacity requirements, not operate at a specific capacity factor value
3. Coal-to-low- or no-emitting sources	Increase renewables to Arizona state target of 4%, and assume no nuclear retirements	Renewable energy levels were assumed to meet EPA goal values; Palo Verde continues to operate
4. End-use energy efficiency	Reduce demand-side energy use 1.5% annually through 2030	For Arizona this equates to ~12% by 2030

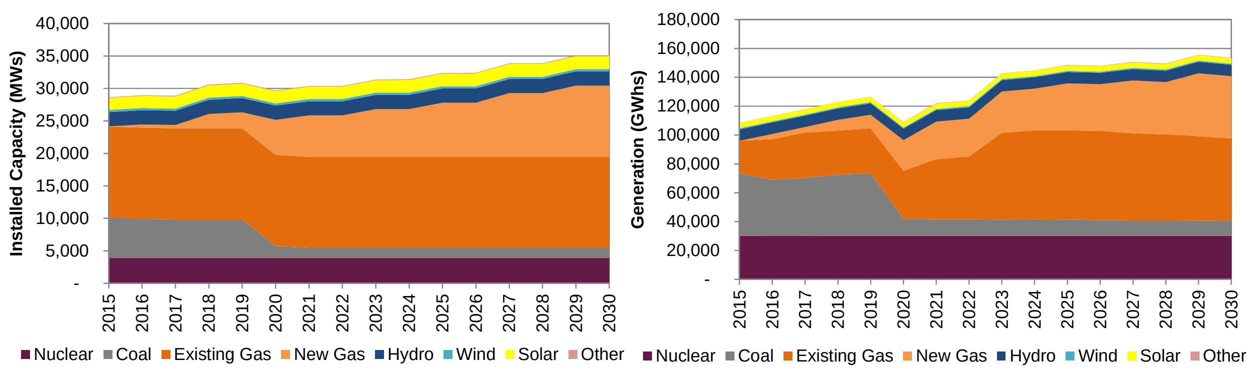
The study of the building block scenario focused on the generation supply and demand implications of the rule as well as the impacts to natural gas consumption and infrastructure utilization. An economic analysis of these impacts was performed as well to quantify costs associated with the implementation of the Clean Power Plan versus some of the alternative scenarios assessed. It is important to note that the study does not incorporate plant decommissioning expenses, specific transmission infrastructure or upgrade requirements, contractual take-or-pay provisions, or specific change in operating and maintenance costs at facilities.

Source: EPA, Pace Global.

3.4.1. Arizona Generation Mix and Installed Capacity under the CPP Building Block Scenario

Exhibit 9 shows the annual generation and installed capacity for Arizona from 2015 through 2030. Under the literal application of the Clean Power Plan building blocks, Arizona would be required to retire all of its existing coal-fired generation in 2020 to comply with EPA's goals (except for tribal coal). The total elimination of coal-fired generation in Arizona required to meet the CPP interim targets would require an estimated 10 GW of new resource capacity from 2020 to 2030 to meet future reserve margins for Arizona's peak summer season, with about 2.3GW directly attributed to CPP impacts and not load growth. The only coal-fired generation included beyond 2020 is sourced from the Navajo Generation Station that is on tribal land and not subject to Arizona interim and final goals.

Exhibit 9: Arizona Generation and Installed Capacity (2015-2030)



Note that in-state generation dips slightly in 2020 as the new gas capacity including NGCC and peaking units does not completely replace baseload coal retirements and some economic imported purchased power is assumed to meet reserve margins in this period. Over time, new NGCCs do end up replacing most of the lost coal generation and the in-state generation rises.

Source: Pace Global.

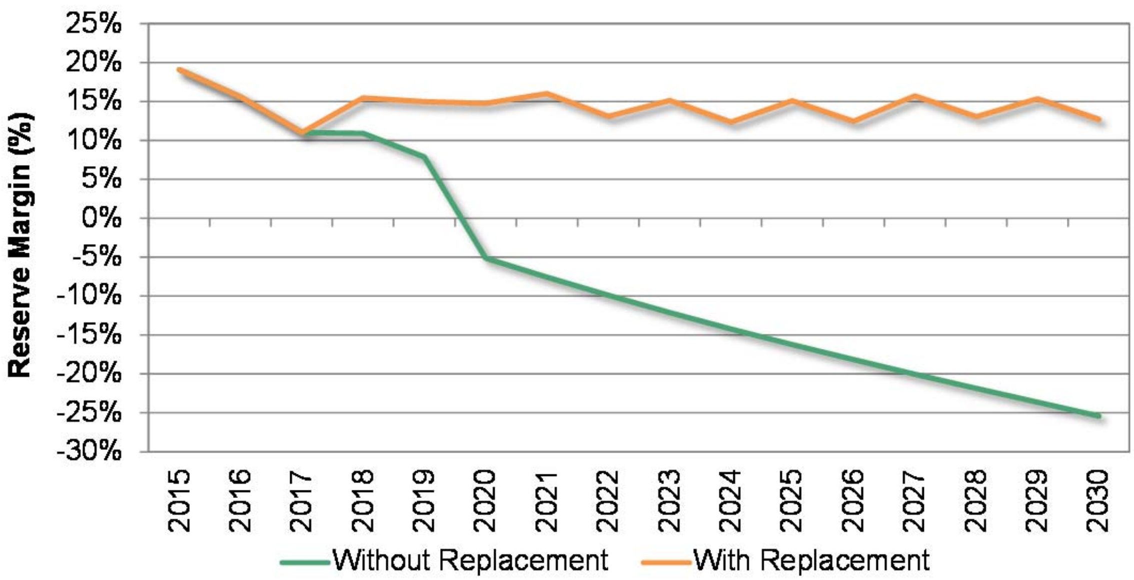
3.5. Risks to Electric Reliability

The electric reliability issues from the Clean Power Plan are associated with both supply and deliverability. The elimination of existing coal-fired generation reduces overall electric supply. The assumption that incremental, lower-emitting generation resources can be permitted and brought online in a two to three year period from state plan development to compliance is not possible and would drive lower reserve margins. Even accounting for planned new builds between now and 2020, reserve margins would be right around 15%, meaning that the loss of most or all of Arizona's coal fired generation would require virtually a MW for MW replacement of this generation to maintain safe reserve margins.

An estimated 3.5 GW of new natural gas capacity by 2020 and over 10 GW by 2030 would be needed to meet reserve margin requirements in Arizona by 2030 following the retirement of all affected coal capacity within the state. This analysis assumes that Arizona utilities would not be able to rely on power imports from out of state to cover large shortfalls in generation capacity, meaning that new local natural gas builds would be needed in state to maintain system reliability. This assumption is based on the fact that the

Arizona Corporation Commission's (ACC) Integrated Resource Planning (IRP) rules state that utilities cannot rely on capacity that is not sourced from known generation for reserve margin requirements.[6] Therefore, absent specific knowledge of generation resource and transmission infrastructure changes in neighboring states, out of state generation cannot be relied upon. Exhibit 10 shows the impact to Arizona's reserve margins under compliance with state Clean Power Plan goals both with and without incremental new natural gas capacity.

Exhibit 10: Arizona Reserve Margins with and without Incremental Natural Gas Builds



Source: Pace Global.

The assumption that coal generation can be one-for-one diverted to existing NGCC units is inaccurate, and the magnitude and timing which Arizona specifically would need to switch generation would make the state's electric supply unreliable. The lead time for new transmission infrastructure is five to ten or more years. The recent North American Electric Reliability Corporation's (NERC) report[7] on the Clean Power Plan cites the need for a 10 to 15 year outlook for planning transmission development due to the time required for engineering, contracting, siting and permitting, as well as the various federal, state, provincial, and municipal approvals required. The CPP interim goals would allow for less than a 5 year outlook from state planning finalization until when the new transmission capacity would absolutely be needed.

Since the CPP requirements will not be finalized until mid-2015 and state implementation plans will not be approved by EPA until mid-2017 or later, timing of the final state plan approval and the typical five-year

[6] Arizona Corporation Commission Resource Planning and Procurement for 2011-2012, Docket No. E-00000A-11-0113, Decision No. 73884

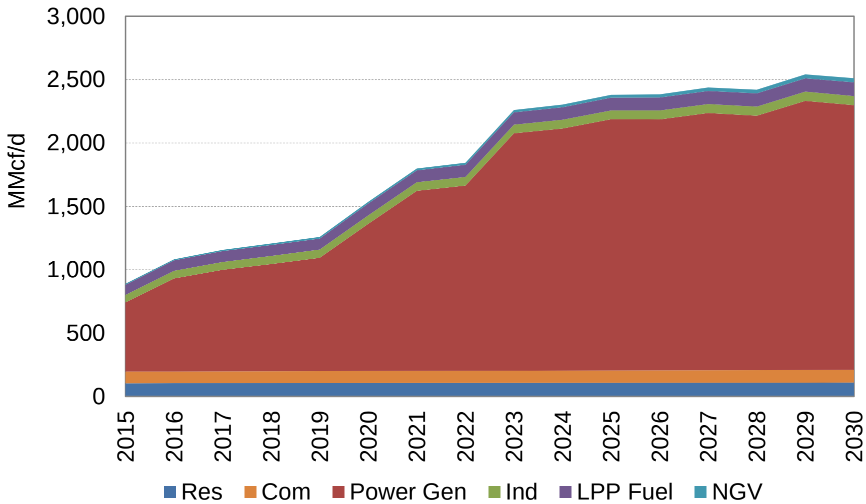
[7] Potential Reliability Impacts of EPA's Proposed Clean Power Plan, Initial Reliability Review November 2014

timeframe to site and construct new power plants would result in real reserve margin declines, noting the sharp decrease in coal generation required under Pace Global's analysis of the CPP Building Block scenario. Given these real world constraints, Arizona will need to seek relief from the CPP's interim goals in order to maintain grid reliability and security. The EPA should include a reliability safety valve mechanism in the final rule. Even if the interim goals are delayed or state goals reduced, there is still a risk to reliability. Consistent with impacts, the EPA should include in its final rule circumstances under which compliance can be delayed to manage real time issues that will compromise electric reliability.

3.5.1. Arizona Natural Gas Demand under the EPA Building Block Scenario

Pace Global projects power sector natural gas demand in Arizona in the building block case to increase from 546 MMcf/d in 2015 to 2,088 MMcf/d by 2030, an almost four-fold increase from the power sector alone. This growth is driven by the increased utilization of existing NGCC units and incremental natural gas capacity additions to meet reserve margins. Growth in non-power sectors is expected as well, although as illustrated in Exhibit 11, these increases are dwarfed by the growth for power sector end use.

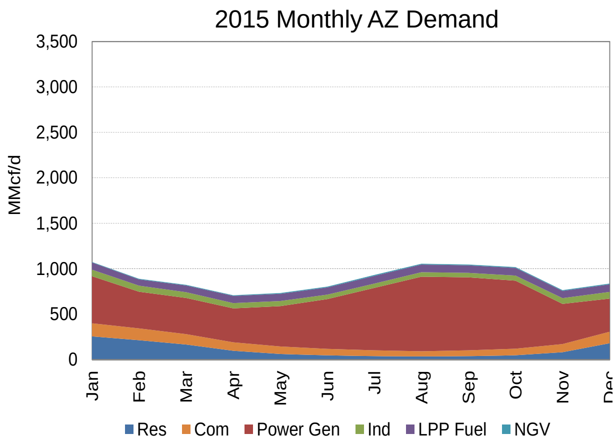
Exhibit 11: Projected Annual Arizona Natural Gas Need in EPA Building Block Scenario

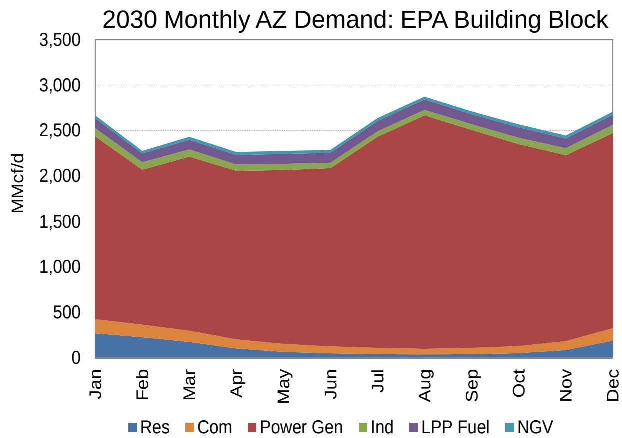


Source: Pace Global

Arizona currently is a winter peaking market, but also exhibits a peak close to winter levels in the summer months as well. Although the increase in power sector consumption under the Building Block scenario is not anticipated to alter Arizona's seasonal peaking profile, the peaks both in the winter and summer would increase dramatically as evidenced in the graphics in Exhibit 12.

Exhibit 12: Monthly Arizona Natural Gas Need 2015 v. Projected 2030 Building Block Scenario





Source: Pace Global

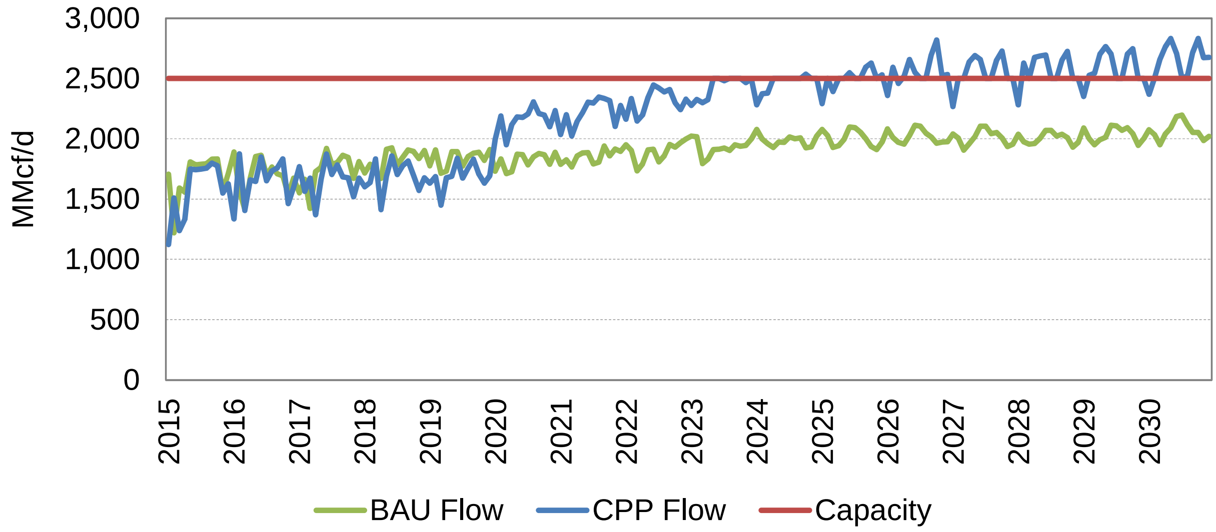
3.5.2. Arizona's Natural Gas Transportation Requirements under the EPA Building Block Scenario

Arizona benefits primarily, though not exclusively, from two long-haul pipelines, Transwestern and El Paso Natural Gas pipelines. Both of these pipelines are expected to remain highly utilized, as they currently are, to serve demand in New Mexico, Arizona and California and also to serve rising exports to Mexico. Given the current high capacity factor of pipeline usage in this region, the addition of Clean Power Plan induced natural gas demand for power needs in the southwest leads to concerns that the current pipeline system is inadequate to serve all demand during periods of peak usage. Pace Global's pipeline flow model analysis indicates that under the Clean Power Plan, expansions would be needed to meet consumption needs and maintain reliability on both the northern and southern legs of the El Paso pipeline and on the Transwestern pipeline, as illustrated in Exhibit 13 through Exhibit 15.

Pace Global's pipeline flow model analysis indicates that under the Clean Power Plan, the following expansions would be needed to meet consumption needs and maintain reliability:

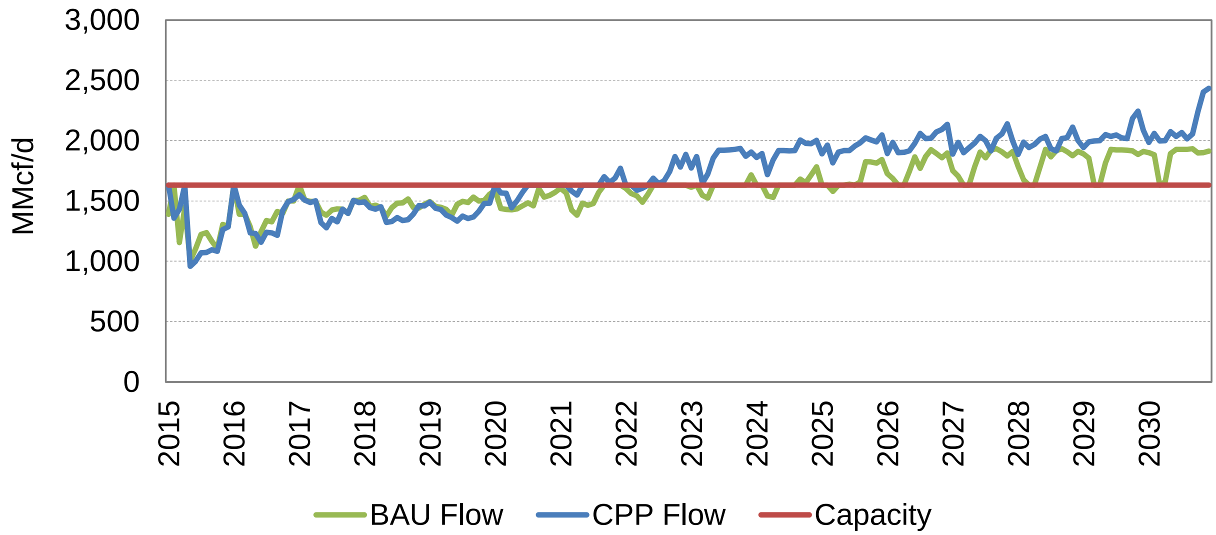
- El Paso Southern leg would require expansion by the early 2020s if not sooner, as it is expected to exceed design flow by 2022 based on average flows.
- El Paso Northern leg would require expansion by 2025.
- Transwestern pipeline, which is already over 95% utilized, would benefit from expansion, although most of the incremental flows will impact the El Paso pipeline system.

Exhibit 13: El Paso North Projected Monthly Pipeline Flow v. Pipeline Capacity



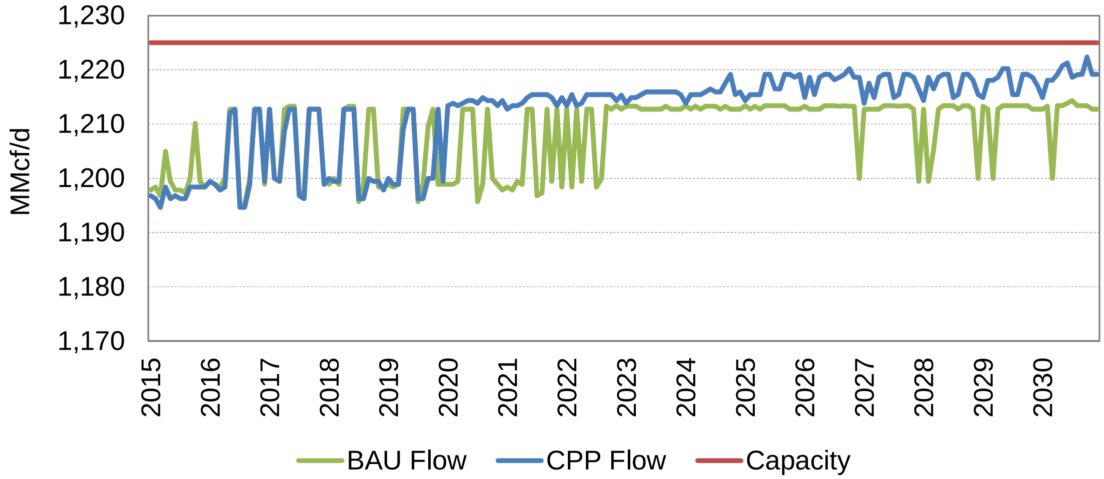
Source: Pace Global, RBAC

Exhibit 14: El Paso South Projected Monthly Pipeline Flow v. Pipeline Capacity



Source: Pace Global, RBAC

Exhibit 15: Transwestern Projected Monthly Pipeline Flow v. Pipeline Capacity



Source: Pace Global, RBAC

Generators will need to secure existing pipeline capacity in order to ensure readily available supply. Even so, generators who are in the money and could generate, but who rely on interruptible pipeline capacity, may find themselves unable to dispatch during periods of high demand due to pipeline constraints. The pipeline constrained Northeastern U.S. experienced just such a situation during the 2013-2014 winter months. The gas-fired capacity expected to be built by 2020 will be contending with several large new sources of demand (e.g., LNG and pipeline exports, industrial projects), which will put upward price pressure on natural gas. This significant increase in natural gas demand coupled with inadequate natural gas storage and transportation infrastructure will ultimately lead to higher natural gas and power price volatility in the Desert Southwest.

3.6. Risks to Natural Gas Supply Reliability

The dramatic projected increases in natural gas demand pose risks with regard to pipeline capacity able to deliver sufficient supply. In terms of whether there is sufficient time and incentive to build the pipeline that is needed, it is not likely. Pipeline is generally built on the basis of demonstrated firm demand resulting from an open season. Historically power generators have been hesitant to sign up for long term firm transportation capacity that is required to gain the needed investment in a timely manner. This results in a slower build-out of gas transmission, such as we see in the Northeast, where incremental pipeline capacity is not growing fast enough to mitigate periods of very high gas prices. As power generators' share of gas consumption in Arizona and surrounding states grows, a similar situation to the Northeast region may develop in the Southwest, in which new pipeline capacity is hindered by hesitation for firm capacity commitments.

Time to develop new pipeline infrastructure is at a minimum four years from the determination of need. The permitting stage can often significantly extend the process to five years or much longer. An extension of this timeline is very possible in Arizona and the greater Western U.S. as the amount of land owned by the military, federal government, state governments, and tribal nations is large. In Arizona, approximately 41% of land is owned by the federal government, almost 13% by the state, and about 27% belongs to tribal nations. All of this adds to the complexity of siting and constructing new capacity. Incremental expansions through compression upgrades can be realized in a two-year timeframe, but this only provides for small incremental capacity expansions. In fact, NERC[8] specifically identifies Arizona as one state whereby the existing pipeline capacity is not adequate to handle incremental gas needs of the state under the CPP, consistent with Pace Global's findings.

Additionally, the natural gas supply situation in combination with literal application of the CPP building blocks appears to place Arizona in a precarious position. Given that Arizona is reliant on the supply of natural gas from 3 major pipelines, the prolonged disruption of service to one of these pipelines could prove devastating to Arizona residents in the absence of backup coal capacity."

Finally, grid reliability issues associated with increased renewable resources are not directly addressed as part of the EPA's proposed building block approach. Based on recent industry studies[9] and prior NERC reliability assessments, as the penetration of variable generation resources increases, maintaining system reliability will become more challenging. Given that Arizona would be required to retire all of its existing coal-fired generation in 2020 to comply with EPA's goals, additional assessments, including interconnection-wide studies, will be needed as state implementation plans are developed to further understand potential reliability challenges that may indirectly result from the proposed CPP.

[8] Potential Reliability Impacts of EPA's Proposed Clean Power Plan, Initial Reliability Review November 2014

[9] NERC-CAISO Joint Report: Maintaining Bulk Power System Reliability While Integrating Variable Energy Resources – CAISO Approach; other industry reports include those developed by the Integration of Variable Generation Task Force (IVGTF)

4. Alternative Scenario Assessment

Pace Global assessed the Arizona electric system under an alternative scenario that offers a more gradual reduction of coal generation in the state to reduce emissions. The purpose of this analysis was to identify the impacts to Arizona's Clean Power Plan compliance and overall emission rate, while maintaining some of the most efficient coal generating stations in the state to reduce cost and reliability impacts.

Exhibit 16 presents a summary of the alternative scenario modeled.

Exhibit 16: Summary of Alternative Scenario Modeled

Scenario	Remaining Coal Capacity 2030 (MW)	Percentage of Coal Online in 2030 (%)*	Rationale for Scenario
Arizona Glide Path scenario	2,542	77%	Scenario maintaining useful life of coal units

*Note, percentage based on the total affected coal capacity in Arizona excluding planned retirements and repowerings, including 3,316MW of the total 3,861MW operating today.

Source: AUG

A summary of the affected coal capacity and generation in the state is summarized in Exhibit 17.

Exhibit 17: Affected Coal Assumptions by Scenario

	Capacity (MW)	Generation (MWh)	% Coal Capacity v. 2014	% Coal Generation v. 2014
Total Coal (2014)	3,861	24,801,925	100%	100%
Planned Retirements / Conversions by 2020	545	2,967,068	14%	12%
Planned Remaining Coal by 2020	3,316	21,834,857	86%	88%
EPA Building Block Scenario - Remaining Coal 2020	0	0	0%	0%
Arizona Glide Path scenario - Remaining Coal 2030	2,542	16,662,479	66%	67%

Note that only affected coal units in the state are included in these values.

Source: AUG and Pace Global

In comparison to EPA's renewable target setting for Arizona under building block 3, the alternative scenario assumes significantly higher levels of installed renewable capacity from 2020 through 2030. Under this scenario, the assumed installed renewable capacity reflects a level more in line with the Arizona renewable energy standard which assumes 15% of a load serving entity retail load is sourced from renewable resources. Incremental renewable capacity additions assume approximately 85% solar and 15% wind.

The higher levels of renewable generation, in combination with the reduction in retired coal fired capacity, reduce the amount of new natural gas fired generation needed to meet future load and reserve margins requirements in Arizona. Of course some new natural gas capacity would be expected to come online in Arizona, regardless of actions taken to reduce emissions, just to meet load growth. Exhibit 18 presents new capacity by technology for both scenarios.

Exhibit 18: Arizona New Capacity by Technology by Scenario (MW)

	Natural Gas				Renewables	
	Total 2020	**Cumulative Total 2020 - 2030**	**2020 Capacity Attributed to CPP**	**Cumulative 2020-2030 Capacity Attributed to CPP**	**2020**	**Cumulative 2020 - 2030**
EPA Building Block	3,525	10,125	2,400	2,300	0	0
Arizona Glide Path scenario	1,125	7,825	0	0	1,000	3,462

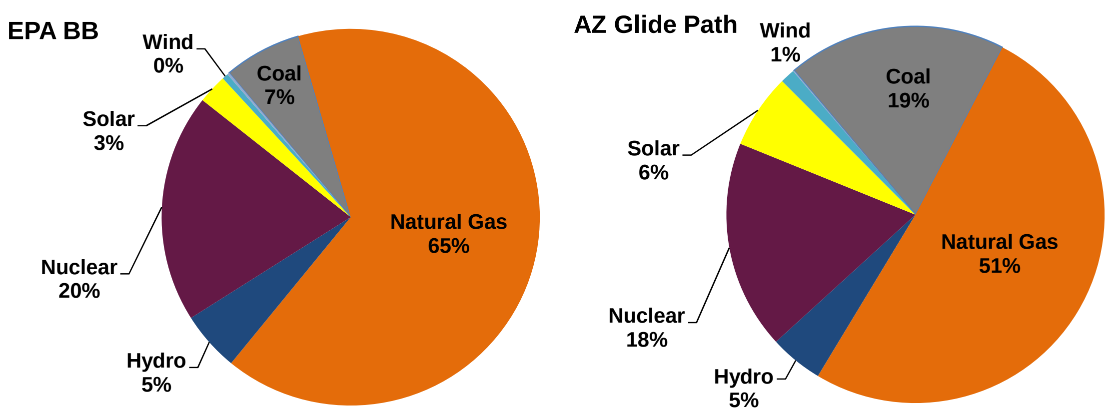
Note: Arizona Glide Path scenario assumed as baseline case for comparison purposes to determine capacity additions attributed to the Clean Power Plan. Also, per the EPA's building block approach, the renewable generation target would be met before 2020 and therefore no incremental additions are assumed over the 2020 to 2030 time period assuming the literal application of the building blocks.

Source: Pace Global

4.1. Generation Mix and Capacity Needs by Scenario

Exhibit 19 presents Arizona's generation mix for both scenarios. To properly represent the generation mix of the state, the Navajo coal plant, which is not an affected unit for Arizona CPP compliance, is reflected as ~7% of the coal generation in the state that remains through 2030. Navajo represents the only coal remaining in the EPA Building Block scenario. The Arizona Glide Path scenario shows a declining relative share of coal generation through 2030, maintaining coal at 19% of generation by 2030.

Exhibit 19: Total Arizona Generation Mix in 2030 by Scenario (MWh)



Source: Pace Global

4.2. Proposed Modifications to EPA Building Blocks to Address Interim Goal Issues

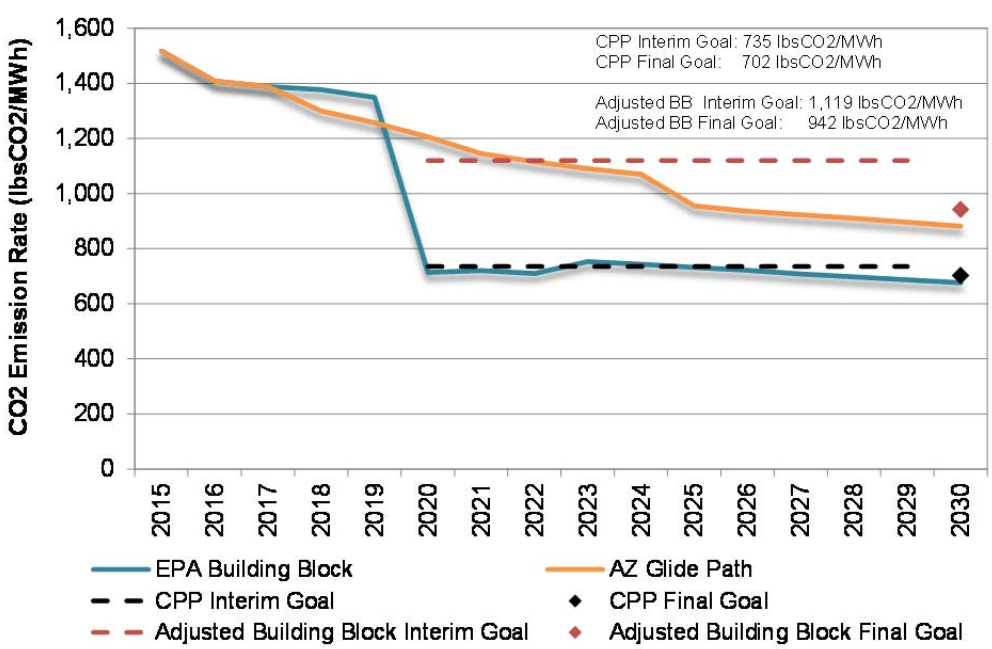
Pace Global's suggested modifications to the EPA's building block approach include specific adjustments to building blocks 2 and 4 that would impact the level of Arizona's goals. As referenced earlier in the report, these adjustments include:

– Pace Global recommends that the EPA consider the remaining useful life of existing plants as well as applying a phase-in of the re-dispatch assumed by building block 2 over the 2020 to 2030 time period rather than assuming that this re-dispatch could occur by 2020.

– Pace Global recommends that the EPA adjust building block 4 to consider a 0.6% annual efficiency improvement rather than 1.5% when establishing overall target levels. This benchmark would be more in line with studies of achievable efficiency penetration levels.

These building block adjustments would make compliance feasible under more extended timelines and would be more consistent with the emission trajectory of the Arizona Glide Path scenario. Exhibit 20 presents the annual emission rates for scenarios modeled and proposed and adjusted goals. The adjusted goals would result in a reduction of the interim goal for Arizona from the unachievable 735 lbCO_2/MWh to 1,119 lbCO_2/MWh. The final adjusted goal would be slightly higher than that proposed in the CPP at 942 lbCO_2/MWh versus the proposed 702 lbCO_2/MWh.

Exhibit 20: Emission Rates by Scenario v. CPP Proposed and Adjusted Goals



Source: Pace Global.

5. Cost Implications of the Clean Power Plan

There are significant cost impacts from new infrastructure investments, including power and natural gas infrastructure, operational changes to the generation fleet, and the recovery of stranded investments. Natural gas pricing would likely increase as well, noting the increased reliance on natural gas to meet power demand nationally. All costs are presented in this section in real 2013 dollars unless otherwise noted.

5.1. Cost of New Generation Infrastructure

The cost of new NGCC capacity is likely to be in the range of $1,000/kW, noting that installed costs will vary depending on the size of the project, technology selected, interconnection retirements, etc. Significant associated transmission investment could also be required depending on the location of the new capacity versus the load centers in the state. Capital cost assumptions are detailed in Appendix A.

Pace Global estimates capital costs for new natural gas generation to meet CPP compliance, net of the expected required investment to meet load growth through 2030, to be $1.9 billion. This represents an approximately 31% increase in costs on average from 2020 to 2030 between the EPA Building Block scenario and Arizona Glide Path scenario, that would otherwise be borne by ratepayers under the Arizona Glide Path scenario gradual emission reduction plan.

Exhibit 21: Capital Costs for New Natural Gas Generation by Scenario (2013$M)

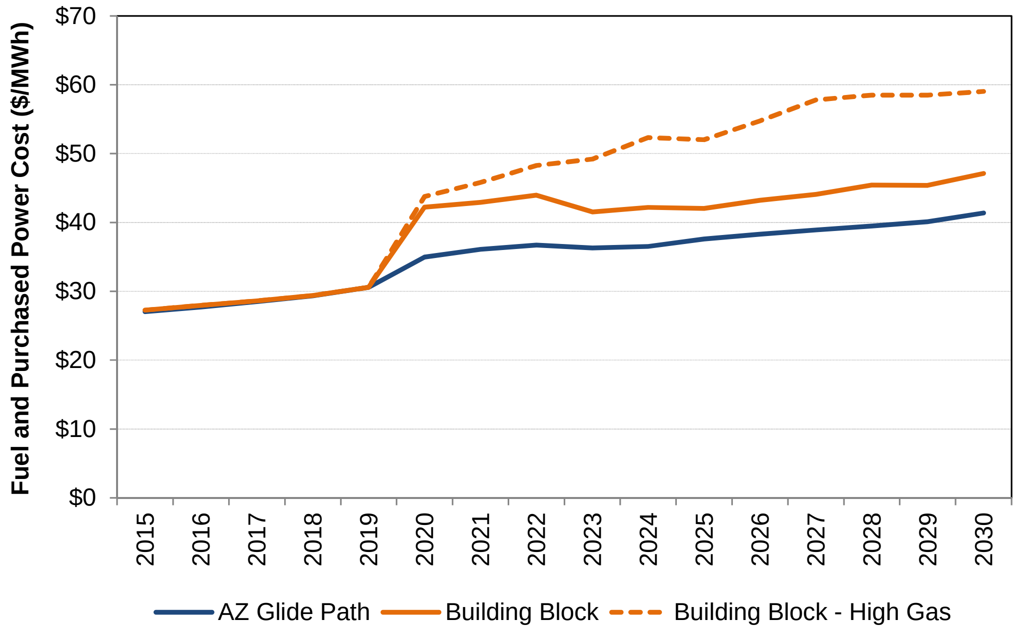
	Total 2020	Cumulative Total 2020 - 2030	2020 Cost Attributed to CPP	Cumulative 2020-2030 Cost Attributed to CPP
EPA Building Block	$3,000	$8,067	$1,991	$1,900
Arizona Glide Path	$1,009	$6,167	$0	$0

Source: EPA, Pace Global.

5.2. Cost of Fuel and Purchased Power

The EPA Building Block scenario would require a wholesale retirement of the coal capacity in Arizona, shifting the cost of fuel for ratepayers from coal to more expensive natural gas. Pace Global estimated costs of both fuel and purchased power for electric ratepayers in Arizona Glide Path scenario and the EPA Building Block scenario. Noting the uncertainty associated with the long-term impacts to natural gas pricing associated with the incremental demand under a Clean Power Plan compliance scenario, these costs were assessed both with and without the impacts of potential higher gas pricing (as described next). Exhibit 22 compares these costs estimated for the EPA Building Block scenario versus Arizona Glide Path scenario. This shows that the current building block plan would cost electric ratepayers up to 40% more in fuel and purchased power costs between 2020 and 2030 as a result of fuel switching and expected increases in natural gas prices over time.

Exhibit 22: Fuel and Purchased Power Costs, EPA Building Block vs. Arizona Glide Path

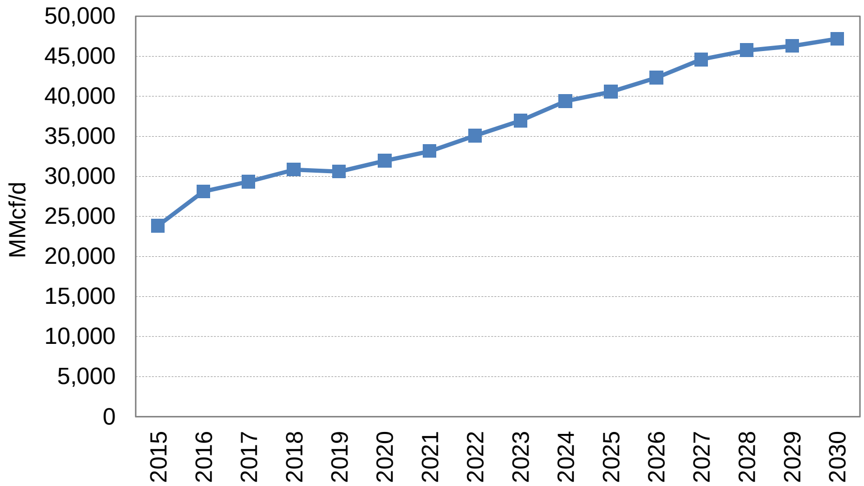


Source: Pace Global.

5.3. Cost of Natural Gas

Increases in natural gas demand resulting from implementation of the Clean Power Plan are likely to raise gas prices and overall consumer prices nationally and in Arizona. The impact of an additional gas demand required for compliance would come at a time when exports (liquefied natural gas and pipeline exports to Mexico) are also growing rapidly. Pace Global estimates that all other things constant, power sector consumption could increase from approximately 24 Bcf/d in 2015 to 47 Bcf/d by 2030 under the EPA Building Block scenario. This is shown in Exhibit 23.

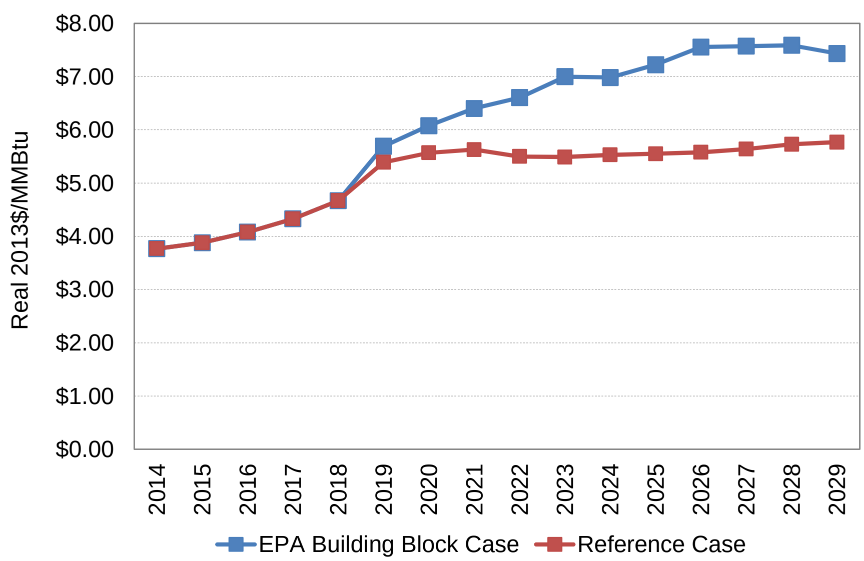
Exhibit 23: Projected National Natural Gas Power Sector Demand (EPA Building Block)



Source: Pace Global.

Pace Global estimates that this incremental increase in national consumption levels would result in price increases nationally at the Henry Hub pricing point. When compared to a reference case outlook of Henry Hub pricing, the price increase under the Clean Power Plan is around $1.35 on average between 2020 and 2030, with deltas in the $1.50-2.00/MMBtu range by the end of the 2020s. Henry Hub pricing projections for the reference case and the EPA Building Bock scenarios are presented in Exhibit 24.

Exhibit 24: Projected Henry Hub Natural Gas Pricing, EPA Building Block v. Reference



Source: Pace Global.

In addition, the market has recently seen a sharp increase in the volatility of market prices in regions where shale gas development has outstripped the infrastructure capability to deliver to markets where the gas is needed. Price spikes in the northeast last winter, for example, exceeded $123.50/MMBtu. As demand increases rapidly, this issue could become a much wider problem than in just the northeast. Volatility could be very significant with growth in power sector natural gas demand projected under the Clean Power Plan.

5.4. Other Cost Implications

5.4.1. Cost of Stranded Assets

The retirement of some or all coal-fired generating capacity in Arizona that would be necessary to meet the interim and final goals of the CPP would result in significant stranded asset value for utilities in Arizona. This stranded value is only exacerbated by recent investments in control technology and plant upgrades in recent years. Depending on the treatment, these costs would be recovered through higher rates for Arizona customers. The stranded asset value under the building block scenario is estimated to be $3.8 billion in 2020 ($3.0 billion in 2013$), resulting from the retirement of all coal generation in the state. Again, the ultimate treatment of these stranded costs could result in severe rate impacts for Arizona customers in or around 2020.

5.4.2. Cost of New Natural Gas Infrastructure

Generally speaking, new gas pipeline construction costs have averaged $155,000 per inch-mile, according to a 2013 U.S. pipeline economics study conducted by *Oil and Gas Journal*. For smaller pipes, less than 12 inches in diameter, costs are assumed to range from $20,000 to $70,000 per inch-mile. Adding capacity potentially can cost less if the design capacity of the pipeline allows for the addition of incremental compression.

The northern leg of El Paso Natural Gas pipeline is likely to become highly constrained by 2020 and in need of expansion. At a minimum, the 330 mile length of El Paso in Northern Arizona, which varies between a 30 and 36 inch diameter and averages approximately 2.5 Bcf/d in throughput capacity, would need to be expanded by 500 MMcf/d no later than 2023 at a likely maximum cost of $335 million.[10] If a 12 inch or smaller diameter pipeline can be used (which has a median $45k/mile cost, according to the same Oil and Gas Journal study), then at a minimum the additional infrastructure cost would be $97 million. The range for a gas pipeline infrastructure upgrade on the most affected portion of pipeline (El Paso Arizona North) is between $97 and $335 million dollars. This estimate is illustrative of one expansion required for major a major pipeline and not exhaustive of all other upgrades that would be required for both major pipelines and smaller distribution systems.

5.5. Cost of Changing Coal Plant Operational Behavior

In addition to coal plant retirements, compliance with the Clean Power Plan could include the operation of coal plants at less than economic dispatch. This could include startup/ shutdown cycles and load following cycles. For coal-fired units, cold starts are often defined as when a unit is offline over 40 hours. Warm starts are commonly defined to include starts occurring after the unit has been offline from five to forty hours. Hot starts are generally those occurring within five hours of a unit going offline. While each of these cycles causes some measure of wear and tear in excess of steady state operation, cold starts are generally the most damaging and load following the least damaging.

As mentioned above, cycling any unit results in increase equipment wear and therefore cost. These impacts generally manifest themselves in some combination of the following measurable effects:

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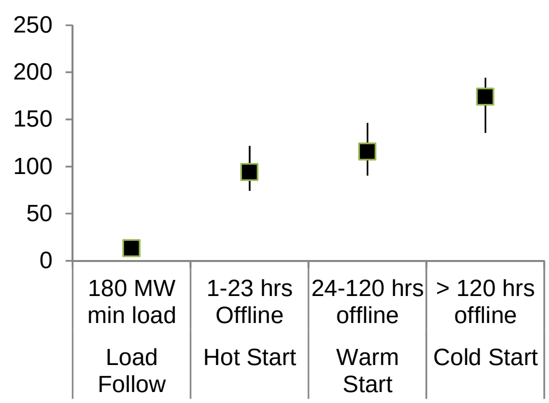
[10] These figures are derived from the following: ($155,000 $/inch-mile) * (330 miles) * (6.5 inch-equivalent of additional pipeline capacity needed).

- Decreased reliability evidenced by increased equivalent forced outage rate (EFOR) and increased cost of replacement energy;
- Derating resulting from damage;
- Increased capital and maintenance costs to repair increasingly worn parts;
- Increased fuel consumption, either from increased startups and/or higher heat rates resulting from part load operations;
- Other startup costs i.e. chemicals, auxiliary power, manpower;
- Shorter unit economic life.

Depending upon the cycling type, from 49-62% of the cycling cost results from increased capital and maintenance costs associated with increased maintenance frequency, inspections, and repairs. Moreover, 23-29% of the cost increase results from forced outages requiring not only repairs (parts and labor), but also purchase of replacement power.

Arizona's coal-fired units were designed for baseload service and therefore do not cycle well. As a result, load cycles requiring startups and shutdowns will mostly be met with combustion turbine-based power plants, either combined cycle or peaking units. A limited amount of load cycling while the unit is online can be feasible and has relatively low operating costs. As evidenced in Exhibit 25, not only are expected load cycling costs much lower than the startup / shutdown cycles, the range of expected costs, and therefore the certainty around those costs, is higher than load following operations. The amount of load cycling that is possible is, however, constrained by minimum load requirements, O&M cost impacts, and emissions issues associated with running coal plants at low loads.

Exhibit 25: Coal-Fired Power Plant Cycling Cost Range, $000 per Cycle



Note: Typical 500 MW conventional coal-fired power plant. Values in 2008$

Source: Coal Power Magazine, Intertek-Aptech, Pace Global.

6. Conclusions

6.1. Summary of Key Recommendations

Arizona's interim goals proposed in the Clean Power Plan, which require a shutdown of the entire, non-tribal coal fleet in Arizona by 2020, cannot be met. A state plan for compliance and associated regulation that likely will be likely be needed for enforcement will not be in place before June 2017, and three years is inadequate to plan, coordinate, permit, construct and operate the natural gas plants necessary to maintain statewide reserve margin requirements, the transmission infrastructure required to deliver the gas fired generation to customers and the natural gas pipeline capability to supply the generating facilities.

Arizona is one of the hardest hit states in the country by the Clean Power largely because of inappropriate assumptions about the ability to redispatch from coal to gas by 2020 that does not account for the major transmission and infrastructure required to do so. Further, the EPA's energy efficiency assumptions used in goal setting are well above levels that have been maintained to date for any significant length of time. This creates a high bar for compliance rather than a reasonably achievable efficiency benchmark for goal determination. Even the EPA's own analysis of Arizona's ability to comply with the proposed goals has coal capacity running below operating minimums.

These inequities and impossible to meet targets can be best dealt with through a number of measures:

- Amend building block 2 to set a balanced more gradual reduction target for coal fired generation between 2020 and 2030 and account for the useful life of coal units that will give time to develop the needed infrastructure to build needed gas generation in the state and reduce stranded cost impacts to ratepayers.
- Amend Building Block 3 to ensure that renewable generation is counted at the point of delivery.
- Recalculate Building Block 4 to include energy efficiency measures of 0.6% per year rather than 1.5% per year.
- Reset the interim and 2030 targets for Arizona consistent with these measures.

Making these adjustments would still achieve dramatic reductions in Arizona's carbon footprint by 2030, but would do so in a way that would not jeopardize reliability of power and natural gas supply in the state and would avoid the likelihood of severe customer rate shock by 2020.

Appendix A: Scenario Assumptions

Pace Global performed power and natural gas market modeling for the EPA Building Block scenario and the alternative Arizona Glide Path scenario. Assumptions underlying these analyses are presented in this section.

EPA Building Block Scenario Assumptions

The EPA Building Block Scenario assumes the following assumptions to literally model the EPA's building blocks for Arizona.

Exhibit 26: EPA Building Block Scenario Assumptions

Building Blocks	Modeling Assumptions	Commentary
1. Fossil plant efficiency improvements	Increase efficiency of existing coal plants by ~6%.	Because of Arizona's significant peaking natural gas capacity as of the CPP baseline in 2012, no coal operates in 2020 or beyond in order to meet building block 2.
2. Coal-to-natural gas combined cycle (NGCC)	Increase utilization of all existing and new NGCCs up to 70% while proportionally reducing coal-fired generation.	Existing combined cycle units are necessary to meet Arizona peak summer capacity requirements, not operate at a specific capacity factor value.
3. Coal-to-low- or no-emitting sources	Increase renewables to Arizona state target of 4%, and assume no nuclear retirements.	With under construction renewables, Arizona already exceeds 4%; therefore current levels of ~5% are assumed; Palo Verde continues to operate.
4. End-use energy efficiency	Reduce demand-side energy use 1.5% annually through 2030.	For Arizona this equates to ~12% by 2030.

The following tables present key assumptions underlying the analysis.

Exhibit 27: Natural Gas Price and Regional Basis (2013$/MMBtu)

Year	Henry Hub	N. Arizona Basis	S. Arizona Basis
2015	3.77	0.05	0.15
2016	3.88	0.02	0.14
2017	4.08	0.05	0.18
2018	4.33	0.06	0.23
2019	4.67	0.03	0.18
2020	5.39	0.11	0.30
2021	5.57	0.09	0.24
2022	5.63	0.12	0.25
2023	5.50	0.15	0.24
2024	5.49	0.16	0.23
2025	5.53	0.17	0.21
2026	5.55	0.27	0.30
2027	5.58	0.34	0.35
2028	5.64	0.38	0.38
2029	5.73	0.42	0.40
2030	5.77	0.57	0.53
2031	5.84	0.60	0.53
2032	5.93	0.65	0.57
2033	6.01	0.67	0.57
2034	6.05	0.68	0.57
2035	6.09	0.71	0.59

Source: Pace Global

Exhibit 28: Average Arizona Delivered Coal Prices (2013$/MWh)

Year	Coal Price ($/MWh)
2015	23.2
2016	23.4
2017	23.7
2018	23.6
2019	23.6
2020	23.5
2021	23.3
2022	23.3
2023	23.2
2024	23.2
2025	22.7
2026	22.7
2027	22.6
2028	22.6
2029	22.5
2030	23.4

Note: Delivered coal prices to individual plants in Arizona range from approximately $21.5/MWh to $27.5/MWh.

Source: Pace Global

Exhibit 29: Arizona Load Forecast Before Efficiency (MW) and Efficiency Assumed (%)

Year	Average	Peak	Building Block 4 Efficiency %
2015	10,469	20,055	
2016	10,788	20,669	
2017	11,106	21,283	1.5%
2018	11,425	21,896	1.5%
2019	11,743	22,509	1.5%
2020	12,062	23,121	1.5%
2021	12,380	23,734	1.5%
2022	12,698	24,346	1.5%
2023	13,017	24,960	1.5%
2024	13,336	25,574	1.5%
2025	13,654	26,187	1.5%
2026	13,973	26,800	1.5%
2027	14,298	27,427	1.5%
2028	14,631	28,069	1.5%
2029	14,972	28,726	1.5%
2030	15,321	29,398	
2031	15,678	30,086	
2032	16,043	30,790	
2033	16,417	31,511	
2034	16,800	32,248	
2035	17,191	33,003	

Note: Load forecast is gross economic demand and does not include any efficiency or demand side program assumptions. All scenarios assume that the building block 4 efficiency annual percentages are applied resulting in a cumulative efficiency savings of 11.4% by 2030.

Source: Pace Global and EPA

Exhibit 30: Capital New Resource Technology Parameters for Market Expansion

Technology	Early Capital Cost	Mid Capital Cost	Late Capital Cost	Early Levelized	Mid Levelized	Late Levelized
	(2014-2016)	(2017-2024)	(2025-2030)	(2014-2016)	(2017-2024)	(2025-2030)
	$/kW	*$/kW*	*$/kW*	*$/kW-yr*	*$/kW-yr*	*$/kW-yr*
CC (7FA)	1046	974	890	148	139	127
CT (FA)	735	685	624	115	109	100
Advanced CT (LMS 100)	1099	996	880	160	147	131
Solar PV*	2392	2012	1616	161	200	165
Wind 1.5 MW*	1909	1779	1632	183	212	197

*Wind and Solar Costs increase during the "mid levelized" period as tax benefits such as PTC is assumed to phase out and ITC reduces.

Source: Pace Global

Exhibit 31: New Units Additions

Owner Name	Plant Name	NERC Sub Region	Unit Status	Online Date	Primary Fuel	Prime Mover	Winter Capacity (MW)
PacifiCorp	Lake Side Power Plant	BASIN	Operating	May-14	Gas	CC	647.4
Kennecott Utah Copper Corp	KUCC	BASIN	Under Const	Aug-15	Gas	GT	5.9
Gerlach Geothermal LLC	San Emidio Project	BASIN	Under Const	Jun-15	Geo	GE	8.6
Durbin Creek Windfarm LLC	Durbin Creek Windfarm	BASIN	Site Prep	Sep-14	Wind	WT	20.0
Willow Spring Windfarm LLC	Willow Spring Windfarm	BASIN	Site Prep	Sep-14	Wind	WT	30.0
Hanford Peaker LLC	GWF Hanford Combined Cycle	CAL N	Site Prep	Sep-16	Gas	CC	120.0
Henrietta Peaker LLC	Henrietta Peaker***	CAL N	Site Prep	Sep-16	Gas	CC	123.0
Contra Costa Generating Station LLC	Oakley Generating Station **	CAL N	Under Const	Dec-16	Gas	CC	624.0
Xeres Ventures LLC	Santa Clara SC1 Data Center	CAL N	Operating	Jun-14	LOil	IC	9.0
Westlands Solar Farms LLC	Westlands Solar Farm	CAL N	Operating	Apr-14	Solar	PV	23.0
Topaz Solar Farms LLC	Topaz Solar Farm	CAL N	Under Const	Jan-15	Solar	PV	151.9
Topaz Solar Farms LLC	Topaz Solar Farm	CAL N	Under Const	Mar-15	Solar	PV	92.0
Lax Arpt	Central Utilities Plant LAX	CAL S	Under Const	Dec-14	Gas	CC	8.8
Lax Arpt	Central Utilities Plant LAX	CAL S	Under Const	Dec-14	Gas	CT	6.6
Los Angeles Dept of Water & Power	Scattergood	CAL S	Under Const	Dec-15	Gas	CC	309.0
Los Angeles Dept of Water & Power	Scattergood	CAL S	Under Const	Dec-15	Gas	GT	190.0
Lax Arpt	Central Utilities Plant LAX	CAL S	Under Const	Dec-14	Other	CA	2.2
Genesis Solar LLC	Genesis Solar Energy Project	CAL S	Operating	Mar-14	Solar	SS	125.0
Desert Sunlight 300 LLC	Desert Sunlight Solar	CAL S	Under Const	Jun-14	Solar	PV	25.2
Desert Sunlight 300 LLC	Desert Sunlight Solar	CAL S	Under Const	Jul-14	Solar	PV	20.2
Desert Sunlight 300 LLC	Desert Sunlight Solar	CAL S	Under Const	Aug-14	Solar	PV	18.9
Desert Sunlight 300 LLC	Desert Sunlight Solar	CAL S	Under Const	Oct-14	Solar	PV	22.7
Desert Sunlight 250 LLC	Desert Sunlight Solar	CAL S	Under Const	Nov-14	Solar	PV	25.2
SG2 Imperial Valley LLC	Solar Gen 2	CAL S	Under Const	Dec-14	Solar	PV	50.0
SG2 Imperial Valley LLC	Solar Gen 2	CAL S	Under Const	Dec-14	Solar	PV	100.0

Owner Name	Plant Name	NERC Sub Region	Unit Status	Online Date	Primary Fuel	Prime Mover	Winter Capacity (MW)
Imperial Valley Solar 3 LLC	Imperial Valley Solar	CAL S	Under Const	Dec-14	Solar	PV	400.0
AES Solar LLC	Mount Signal Solar Farm	CAL S	Under Const	Dec-14	Solar	PV	109.0
Solar Star California XIX LLC	Antelope Valley I Solar Project	CAL S	Under Const	Oct-15	Solar	PV	310.0
Solar Star California XX LLC	Antelope Valley II Solar Project	CAL S	Under Const	Oct-15	Solar	PV	276.0
Rice Solar Energy LLC	Rice Solar Energy Project	CAL S	Site Prep	Jun-16	Solar	SS	150.0
Los Angeles Dept of Water & Power	Headworks Reservoir	CAL S	Under Const	Dec-17	Water	HY	4.0
Jawbone Wind Energy LLC	Jawbone Wind Energy Project	CAL S	Site Prep	Mar-15	Wind	WT	39.0
Geolectric Power Co NM LLC	Lightning Dock Geothermal	DESERT SW	Site Prep	May-15	Geo	GE	6.0
Sexton Energy LLC	Tangerine LFG Project	DESERT SW	Under Const	Jan-15	Renew	IC	1.4
Copper Mountain Solar 2 LLC	Copper Mountain Solar	DESERT SW	Under Const	Oct-14	Solar	PV	30.0
Copper Mountain Solar 2 LLC	Copper Mountain Solar	DESERT SW	Under Const	Dec-14	Solar	PV	30.0
Tucson Electric Power Co	H Wilson Sundt Generating Station	DESERT SW	Under Const	Dec-14	Solar	PV	5.0
Sempra Generation	Copper Mountain Solar	DESERT SW	Under Const	Mar-15	Solar	PV	250.0
American Capital Energy	Searchlight Solar	DESERT SW	Under Const	Jun-15	Solar	PV	20.0
First Solar Inc	Moapa Solar Project	DESERT SW	Under Const	Jun-15	Solar	PV	150.0
First Solar Inc	Moapa Solar Project	DESERT SW	Under Const	Dec-15	Solar	PV	100.0
Torch Renewable Energy	Red Horse 2 Wind	DESERT SW	Under Const	Jun-15	Wind/Solar	WT	70.0
Iberdrola Renewables Inc	El Cabo Wind	DESERT SW	Under Const	Dec-15	Wind	WT	298.0
Moapa Solar LLC	Moapa Solar Energy Center	DESERT SW	App Pending	Sep-15	Solar	PV	100
Moapa Solar LLC	Moapa Solar Energy Center	DESERT SW	App Pending	Sep-16	Solar	SS	100
Silver State Solar Power South LLC	Silver State South Solar Project	DESERT SW	App Pending	Dec-16	Solar	PV	250
Arlington Valley Solar Energy I LLC	Arlington Valley Solar Energy Project	DESERT SW	Proposed	Dec-15	Solar	SS	125
Arizona Public Service	Ocotillo	DESERT SW	Proposed	Apr-18	Gas	CT	525
Silver State Solar Power South LLC	Silver State South Solar Project	DESERT SW	Proposed	Dec-18	Solar	PV	100
Pacific Hydro Inc	Kingman Wind	DESERT SW	Proposed	Dec-17	Wind	WT	10.2
Portland General Electric Co	Carty Generating Station	NWPP	Under Const	Jul-16	Gas	CC	440.0
Dorena Hydro LLC	Dorena Dam	NWPP	Under Const	Oct-14	Water	HY	5.2
Fairfield Wind LLC	Fairfield Wind	NWPP	Operating	May-14	Wind	WT	10.0
Portland General Electric Co	Lower Snake River Wind Energy Project	NWPP	Under Const	Jun-15	Wind	WT	267.0
Two Elk Generation Partners LP	Two Elk Energy Park	RMPA	Site Prep	Dec-16	Coal	ST	290.0
Black Hills Corp	Cheyenne Power Plant	RMPA	Under Const	Oct-14	Gas	CC	55.0
Cheyenne Light Fuel & Power Co	Cheyenne Power Plant	RMPA	Under Const	Oct-14	Gas	CC	40.0
Cheyenne Light Fuel & Power Co	Cheyenne Power Plant	RMPA	Under Const	Oct-14	Gas	CS	37.0
Public Service Co of Colorado	Cherokee (CO)	RMPA	Under Const	Sep-15	Gas	CC	633.2
Haxtun Wind LLC	Haxtun Wind Farm	RMPA	Site Prep	Dec-14	Wind	WT	28.8

Source: Pace Global and the AUG

Alternative Scenario Assumptions

Pace Global modeled an alternative scenario for reducing emissions statewide but also maintaining some coal generation in the state. The treatment of affected coal units in this scenarios is detailed Exhibit 32

Exhibit 32: Affected Coal Unit Assumptions by Scenario

	Capacity (MW)	Generation (MWh)	% Coal Capacity v. 2014	% Coal Generation v. 2014
Total Coal (2014)	3,861	24,801,925	100%	100%
Planned Retirements / Conversions by 2020	545	2,967,068	14%	12%
Planned Remaining Coal by 2020	3,316	21,834,857	86%	88%
EPA Building Block Scenario - Remaining Coal 2020	0	0	0%	0%
Arizona Glide Path scenario - Remaining Coal 2030	2,542	16,662,479	66%	67%

Source: Pace Global and the AUG

The Arizona Glide Path scenario did not prescriptively model the EPA's building blocks with the exception of building block 4 to ensure consistency in load across all analyses. The prominent assumptions presented in the tables above were also assumed for this scenario. No improvements in coal plant heat rates are assumed. NGCC units operated at economic dispatch levels. The renewable build out in Arizona was based on aggregate estimates by utility.

Appendix B: Power Market Analysis Methodology

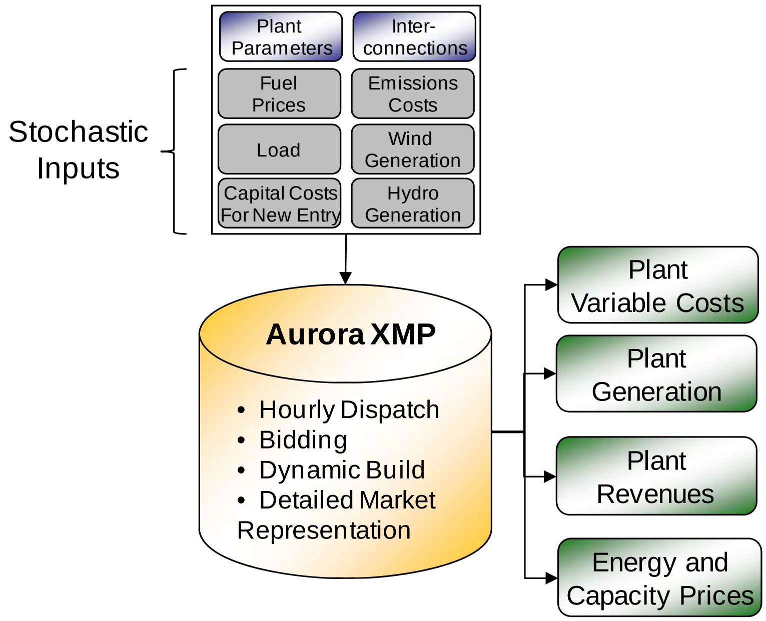
Power Market Modeling

Pace Global deploys an hourly chronological dispatch model to simulate the economic dispatch of power plants within a competitive framework. Representations of hourly regional demand profiles and plant-level supply characteristics are included, as well as detailed assessments on the fundamental drivers of power plant dispatch within each relevant market area. Key components of our methodology include:

- **Load Forecast:** Pace Global independently develops regional load forecasts (with stochastic uncertainty bands) based on the historic relationship between economic drivers, weather, and load.
- **Regional Fuel/Emission Projections:** Pace Global develops independent projections of fuel and emission pricing inputs (with stochastic uncertainty bands) based on the fundamental drivers of each market and a comprehensive review of regulatory environments.
- **Renewable Generation Profiles:** Pace Global analyzes the historic generation of renewable technologies throughout its modeling regions in order to characterize renewable generation profiles.
- **Bidding Function:** Pace Global's market simulations incorporate bidding behavior and scarcity premiums in our dispatch algorithm. Each region's bidding function is based on hourly analyses of the historic relationship between prices and reserve margins
- **Dynamic Capacity Expansion:** Gas-fired, wind, and solar capacity expansions are built dynamically when observed margins reach a specified threshold.
  - Creates boom/bust cycles that capture observed market behavior

A summary of the methodology with key inputs, algorithms, and outputs is shown in Exhibit 33.

Exhibit 33: Pace Global Market Analysis Methodology



Source: Pace Global.

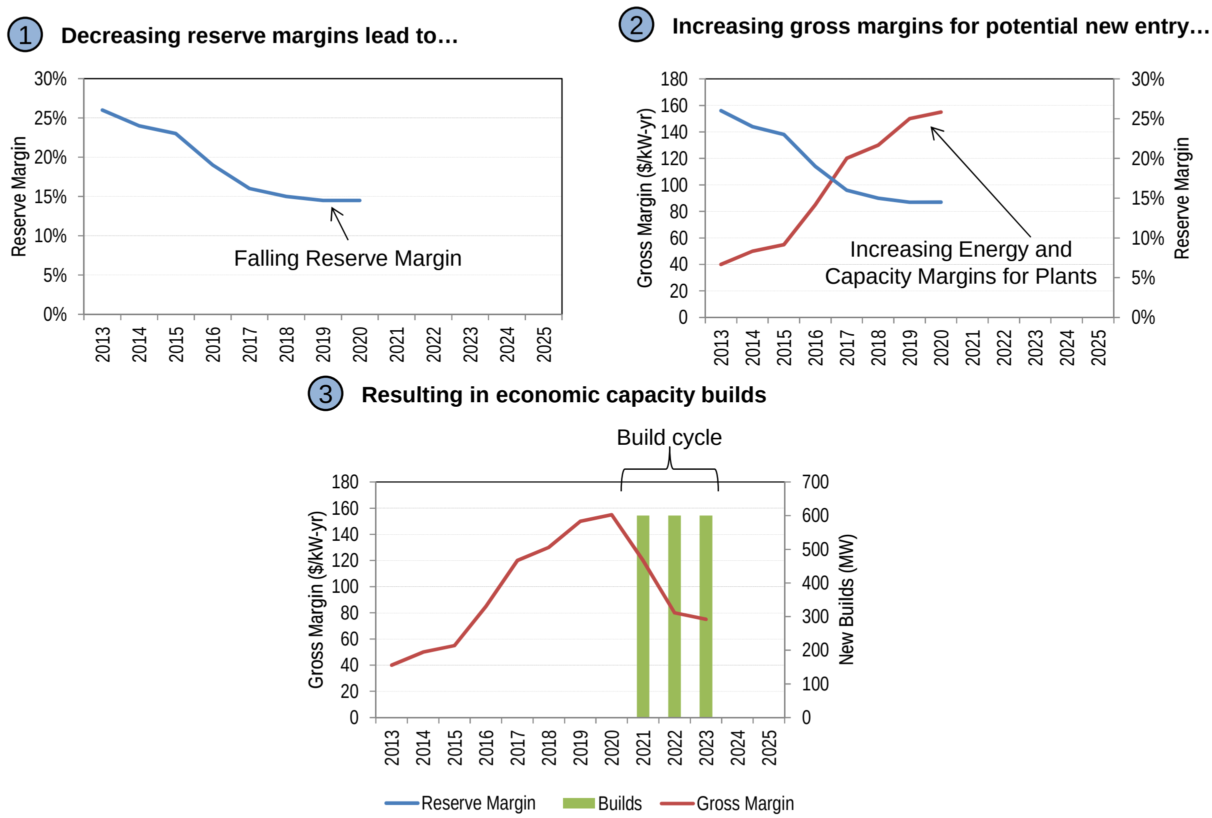
Dynamic Build Capacity Expansion

Pace Global incorporates the dynamic simulation of additional economic capacity in our long term analyses. With this approach, incremental expansion is expected when economic conditions provide a sufficient rate of return for new units. Where net energy and capacity revenues together justify build of a new unit on the basis of a historic trend, a new unit is built. Sustained positive returns, generally stimulated by falling reserve margins and rising prices are expected to lead to capacity additions. The magnitude of the capacity expansion depends on the achieved Return on Investment ("ROI") specific to the type of generating plant.

Pace Global's dynamic build logic is illustrated in Exhibit 34. This graphic illustrates how new capacity enters the market according to economic signals – these units are shown under the legend "Economic Expansion" (the units labeled "Additional Expansion" reflect announced units or units built on the basis of RPS or reliability requirements). For example, following an expected widening in system reserve margins over the period to 2009-2011, the system is expected to tighten during the 2011-2014 timeframe. In this example, we project that rising margins in the period 2011-2014 will send a signal causing a new plant to come online around the 2015 time frame.

Following a temporary capacity glut, rising plant margins during the 2015-2018 period are unlikely enough to provide an unequivocal signal to new plant developers. In this case, a full build phase is not supported until the period from 2023-2026. From 2021, declining plant margins set in, reflecting the overbuild cycle. The dynamic expansion methodology is currently applied to incremental natural gas-fired combined cycles, natural gas-fired peakers, wind, and solar builds in the region, and is employed across all iterations of analysis. This allows all market simulations to incorporate the reactive behavior observed in the market to periods of sustained margins.

Exhibit 34: Dynamic Build Simulation Logic



Source: Pace Global.

Escalation Rate

Exhibit 35 shows Pace Global's annual deflator series. Pace develops its market projections in real terms and converts prices to nominal values using the market rate implied by the yield on treasury bonds and similar maturity Treasury Inflation Protected Securities ("TIPS"). The yield quoted on treasury bonds is equal to the real yield plus inflation, while the yield quoted for TIPS is the real yield. Subtracting the yield of TIPS from the yield of Treasury bonds arrives at the market's forward implied inflation rate.

Exhibit 35: Pace Global's Annual Deflator Series

Year	Deflator Series
2014	1.0164
2015	1.0331
2016	1.0500
2017	1.0672
2018	1.0863
2019	1.1058
2020	1.1256
2021	1.1494
2022	1.1738
2023	1.1987
2024	1.2260
2025	1.2540
2026	1.2826
2027	1.3118
2028	1.3417
2029	1.3723
2030	1.4036
2031	1.4356
2032	1.4683
2033	1.5018
2034	1.5356
2035	1.5701

Source: Pace Global and U.S. Treasury Department.

Appendix C: Fuel Market Analysis Methodology

GPCM-Based Natural Gas Market Modeling

In its fuel market analysis, Pace Global utilizes the Gas Pipeline Competition Model (GPCM) to conduct analysis of natural gas economics in North America. GPCM, developed and updated by RBAC, Inc., is a combination software-database system that allows Pace Global to quantitatively analyze the complex interactions among producers, pipelines, storage facilities, gas marketers, and consumers in the highly integrated North American natural gas industry. The primary output of GPCM is natural gas price forecasts and gas trading hub basis differentials to the Henry Hub, but has a range of other outputs including pipeline usage, transportation zone pricing customer receipts, storage balances, etc.

Model Structure and Capabilities

Mathematically, GPCM is a network model that can be diagrammed as a set of "nodes" and "arcs". Nodes represent production regions, pipeline zones, interconnects, storage facilities, delivery points, and customers or customer groups. The connections between these nodes are called arcs, which represent transactions and flows. Some of these are supplier deliveries to pipelines, transportation across zones and from one zone to another, transfers of gas by one pipeline to another, delivery of gas into storage, storage of gas from one period to another, withdrawal of gas from storage, and pipeline deliveries of gas to customers.

GPCM dynamically solves for economic rents, allowing cheaper supplies to be used before more expensive supplies and enabling customers willing to pay more to be served before those willing to pay less. By including the entire system of North American gas production, transmission, storage, consumption, and imports/exports, GPCM optimizes gas flows in an economically sensible order to produce an economically efficient, market-clearing solution. GPCM contains more than 200 existing and proposed pipelines, 400 storage areas, 85 production areas, 15 liquefied natural gas (LNG) import/export terminals, and nearly 500 demand centers.

GPCM can be adapted to model different scenarios based upon varying assumptions for projected gas supply and demand growth, among other variables. The model provides a “Base Case” scenario using existing pipeline tariffs, capacities, and normal weather for demand regions. This Base Case can be adapted to model the following factors:

- Increases or decreases of projected demand by sector
- Increases or decreases of production capacity in traditional and unconventional areas
- Proposed pipeline projects or expansions
- Proposed LNG export terminals and capacity expansions
- New storage fields or increases in existing storage capacity

The output from GPCM consists of the following types of items, which can be exported to an Excel spreadsheet for further analysis and reporting:

- Production and spot market prices by region
- Pipeline receipts from producers by zone
- Pipeline flows from zone to zone
- Transportation prices and discounting by pipeline and zone
- Transfers between pipelines at interconnects
- Injections into and withdrawals from storage
- Deliveries by pipelines to customers
- Gas supply available to each customer in each region
- Market clearing prices in each region

Dynamic Build Capacity Expansion

Pace Global has the capability to incorporate the dynamic simulation of additional pipeline capacity in our long term analyses. To the extent that the scenario under consideration requires that only "pre-programmed builds" come online (i.e., announced and under construction new pipeline or expansions that increase capacity), Pace Global has the ability to turn off the dynamic simulation switch. With this approach, incremental expansion is expected when economic conditions provide a sufficient rate of return for new pipeline capacity. Where utilization rates approach the capacity ceiling and there are economic opportunities to expand service, existing pipeline capacity can be expanded to increase revenue and reduce deadweight loss. Sustained positive returns are expected to lead to capacity additions. The magnitude of the capacity expansion depends on the rents that could be generated under an expansion scenario.

Geography and Granularity

GPCM covers the North American natural gas market, including Alaska, Canada, the continental United States, and Mexico. GPCM also contains a graphical display system to visually analyze interconnections, flows, and other output from the model. Demand forecasts can be manipulated by sector and by state. Supply sources can be manipulated by basin or play. Output data is provided on a monthly basis but can be aggregated up to annual averages. The forecasting horizon extends out to December 2035.

Exhibit 36 below provides a list of natural gas market points reported out by GPCM (note that additional market points can be built into the model, as needed).

Exhibit 36: GPCM Reported Natural Gas Market Points (Gas Hubs)

Agua Dulce Hub	Florida Gas, zone 3	SoCal Gas
Algonquin, city-gates	GTN, Kingsgate	Southern Natural, La.
Algonquin, receipts	Henry Hub	Southern Star, Tx.-Okla.-Kan.
Alliance, into interstates	Houston Ship Channel	Stanfield, Ore.
ANR, La.	Iroquois, receipts	TCPL Alberta, AECO-C
ANR, ML 7	Iroquois, zone 2	Tennessee, La., 500 Leg
ANR, Okla.	Iroquois-Z1	Tennessee, La., 800 Leg
Carthage Hub	Katy	Tennessee, zone 0
CEGT-South	Kern River, delivered	Tennessee, zone 6 delivered
CEGT-West	Kern River, Opal plant	Texas Eastern, ELA
CenterPoint, East	Lebanon Hub-Ohio	Texas Eastern, ETX
Cheyenne Hub	Leidy Hub	Texas Eastern, M-1 (Kosi)
Chicago city-gates	Mich Con city-gate	Texas Eastern, M-3
CIG, Rocky Mountains	NGPL, Amarillo receipt	Texas Eastern, STX
Columbia Gas, Appalachia	NGPL, La.	Texas Eastern, WLA
Columbia Gulf, La.	NGPL, Midcontinent	Texas Gas, zone 1
Columbia Gulf, mainline	NGPL, STX	Texas Gas, zone SL
Consumers Energy city-gate	NGPL, Texok zone	TGP-Z1 100L
Dawn, Ontario	Niagara	Transco, zone 1
Dominion, North Point	Northern, demarc	Transco, zone 2
Dominion, South Point	Northern, Ventura	Transco, zone 3
Dracut, Mass.	Northwest, Can. bdr (Sumas)	Transco, zone 4
El Paso, Bondad	Northwest, s. of Green River	Transco, zone 5 delivered
El Paso, Permian Basin	Northwest, Wyo. Pool	Transco, zone 6 N.Y.
El Paso, San Juan Basin	Oneok, Okla.	Transco, zone 6 non-N.Y.
El Paso, South Mainline	Panhandle, Tx.-Okla.	Transwestern, Permian Basin
Emerson, Viking GL	PG&E city-gate	Trunkline, ELA
Florida city-gates	PG&E, Malin	Trunkline, WLA
Florida Gas, zone 1	PG&E, south	Waha
Florida Gas, zone 2	Questar, Rocky Mountains	Westcoast, station

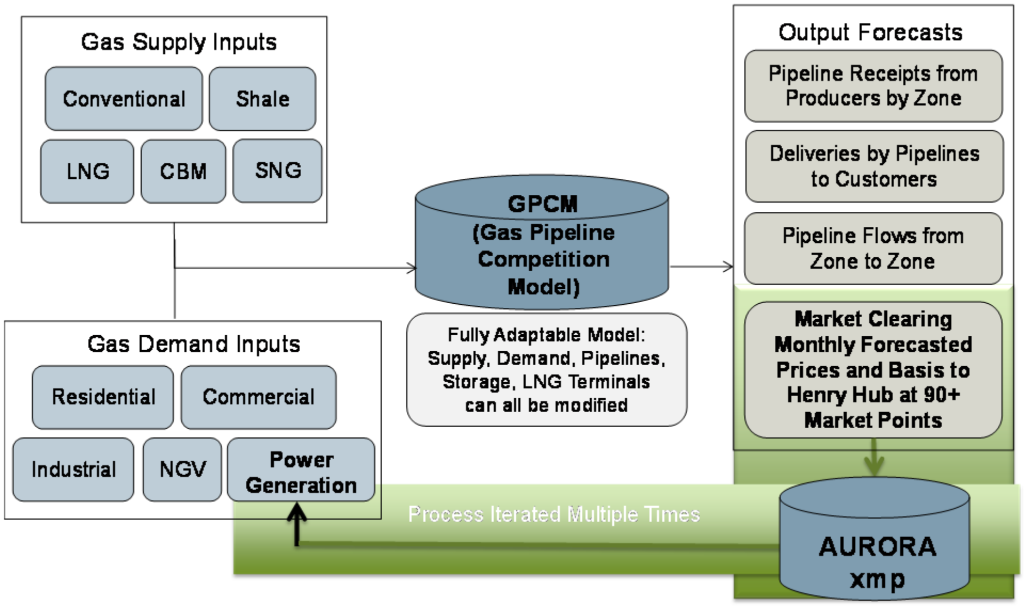
Source: Pace Global

Additional information on GPCM can be found at www.rbac.com.

Natural Gas and Power Analysis Integration

Pace Global integrates its power and natural gas market analyses to account for the impacts of power sector consumption on natural gas infrastructure and pricing. Resulting natural gas demand from the power market analysis is run through GPCM to recalibrate pricing associated with the given consumption levels. This iterative process is performed until the resulting demand and pricing balance. Exhibit 37 presents the GPCM model parameters as well as the iterative process with the power market analysis used by Pace Global.

Exhibit 37: Natural Gas Model Overview and Power Market Integration Scenatic



Source: Pace Global