Best Practices in Planning for Clean Power Plan Compliance

A Guide for Consumer Advocates

Prepared for the National Association of State Utility Consumer Advocates

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Preface

This report has been prepared by Synapse Energy Economics (Synapse), pursuant to a grant from the Energy Foundation, to help prepare members of the National Association of State Utility Consumer Advocates (NASUCA) to participate most effectively in planning to address the U.S. Environmental Protection Agency's (EPA's) Clean Power Plan.

Consumers ultimately shoulder most of the costs of new environmental initiatives. NASUCA's members are designated by the laws of their respective jurisdictions to represent the interests of utility consumers in their states. Preparing NASUCA members to be able to effectively participate in the decision-making processes which inform ultimate compliance with whatever final regulations are promulgated by the EPA is therefore essential. Such preparation can help assure that costs to consumers are not incurred unnecessarily and to assure that consumers receive the best possible value for money spent.

Recognizing that NASUCA members and other stakeholders have a wide range of reactions to the EPA's Clean Power Plan, the intent of this report is not for NASUCA to take positions as to the Plan's substance or to comprehend every conceivable issue consumers in a particular state might face. Nor does the report in any way represent the distilled opinions of NASUCA's membership. Just as individual states will vary in their responses to the Plan, the intent of this report is to be a common resource to help all of NASUCA's members prepare to address Clean Power Plan issues whatever their individual state's positions.

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Executive Summary

Achieving the required carbon dioxide (CO_2) emission reductions under the U.S. Environmental Protection Agency's (EPA's) proposed Clean Power Plan will require complex planning and involve many different stakeholders. The compliance planning process will involve a series of steps, shown in Figure 1, below. While the final rule will not be released until mid-summer, states should already be preparing to develop compliance plans to meet emission targets, and understanding the steps involved in compliance planning is a good way to begin the process (see Figure 1).

Figure 1. Key steps for developing Clean Power Plan compliance plans

Energy and environmental planners already have experience with compliance planning for air pollution reduction via state implementation plans (SIPs) and with electric system planning through utility integrated resource planning (IRP), but certain provisions in the proposed Clean Power Plan suggest that compliance planning will be much more flexible than under either of these two processes:

- First, states are allowed to comply on an individual basis, on a collaborative basis where states with individual plans trade renewable energy certificates or other credits, or jointly as part of a multi-state group, and each state may choose its own best compliance strategy.
- Second, planners have a range of compliance measures from which to choose when developing emission reductions strategies under the Clean Power Plan. These measures include EPA's four building blocks, as well as a number of alternatives, and consist of a combination of supply- and demand-side

resources. This flexibility and number of alternative compliance options present challenges for planners and regulators, but also opportunities to meet emission targets at the least-cost to ratepayers.

As ratepayers' representative in their respective states, consumer advocates have a critical role to play in the Clean Power Plan compliance planning process. This role may be different from state to state depending on the specific responsibilities of consumer advocates, but less active consumer advocates can still influence the planning process in a meaningful way. Using the steps shown in Figure 1 as a guide, specific questions that consumer advocates might ask during the planning process include the following:

1. **Mass- or rate-basis:** Will my state pursue a mass-based or rate-based compliance target, and why is this form of target the best choice?
2. **Solo, trading, or joint:** Will my state choose solo compliance, compliance with interstate trading, or multi-state joint compliance? Which type of compliance planning offers the most benefits for my state?
3. **Correct specifications:** Has my region's electric system been characterized properly? Are generator attributes correct? Have all future environmental regulations and their costs been taken into account, specifically with respect to older generators and the impact this might have on continued operation versus retirement?
4. **Measure availability:** Which of EPA's building blocks are available as compliance options in my state? Are alternative compliance options available? What are the state-specific costs of each of these options? Which options might be categorized as least-cost?
5. **Forecasting assumptions:** Are the electric sector forecasts and assumptions up-to-date? Do sound forecasting methodologies underlie the assumptions? Were the forecasts done by reputable third parties?
6. **Transparency:** Is the electric sector modeling process transparent? What scenarios are being examined? What sensitivity variables are considered? Do these represent reasonable future conditions?
7. **Realistic constraints:** Are any model constraints realistic, or are there artificial constraints within the model that do not represent real-world conditions? Do the outputs from the modeling process indicate that constraints to inputs are realistic?
8. **Supply-side resources:** Do electric sector models treat supply- and demand- side resources on equal footing? Are models allowed to select optimal levels of demand-side resources?
9. **Evaluation criteria:** What are the criteria used to evaluate potential compliance plans? Are candidate plans least-cost? Do they meet other state energy policy goals? Are candidate plans flexible enough to change as technology and economic conditions change? What are the expected rate and bill impacts under candidate resource plans?
10. **Ratepayer interests:** Are ratepayer interests adequately represented in the final compliance plan?

Consumer advocates may be involved in all of the steps in Clean Power Plan compliance planning, or they may be involved in a subset. The goal of this guide is to provide a toolkit for consumer advocates to use in evaluating the planning options for their states regardless of their level of involvement in the process, and to recommend best practices for developing effective, least-cost compliance plans.

1. INTRODUCTION

The Clean Power Plan, released on June 2, 2014, is the U.S. Environmental Protection Agency (EPA) proposed rule for reducing emissions of carbon dioxide (CO_2) from existing fossil fuel power plants under Section 111(d) of the Clean Air Act. As a group, these plants are the largest single source of greenhouse gas emissions in the country. EPA has stated that its rule will reduce emissions from these existing sources by 30 percent below 2005 levels by 2030.

This guide explores best practices for the Clean Power Plan compliance planning process, with an emphasis on the roles and concerns of consumer advocates. Note that there may be planning tools and processes that are not mentioned in this guide, but that may still be useful for Clean Power Plan compliance. Electric system plans for Clean Power Plan compliance will require energy and environmental regulators to create or examine a variety of input forecasts and assumptions, evaluate numerous resource portfolios, and analyze emissions and cost outputs to determine a compliance plan that meets state emission targets at the "least cost." This guide outlines the steps that will be involved in the Clean Power Plan compliance planning process and describes the ways in which consumer advocates can become involved at each stage.

Under the proposed Clean Power Plan, EPA sets state-specific targets for CO_2 from existing sources and states are tasked with developing implementation plans showing how they will meet the standard. The targets were developed by taking each state's power system as it operated in 2012 and then applying pollution-reduction measures identified as "building blocks" to assess how much of a reduction each state could achieve by 2030. These building blocks include: heat rate improvements at existing coal plants; re-dispatch of existing natural gas combined-cycle plants (NGCCs); credits for nuclear generating capacity and increased renewable energy capacity; and an increase in end-use energy efficiency. Together, EPA says, the building blocks represent meaningful reductions in CO_2 at a reasonable cost, and thus make up the set of tools that the agency has determined represents the "best system of emission reduction."

Importantly, the building blocks reflect neither the maximum emission reductions possible from these measures, nor the least-cost approach to achieving those reductions. They represent EPA's determination of what is achievable by the power plant sector at a reasonable cost. Each state's emission target is different, because each state has a unique mix of emissions and power sources, and EPA's building blocks have thus been applied differently in each state. While the final form of the rule has yet to be determined, it will almost certainly require complex, state-specific planning.

Calculation of emission rates and emissions

The Clean Power Plan requires each state to comply with a CO_2 emission rate or a CO_2 total emission target over the 2020-2030 compliance period. Within the Clean Power Plan, there are three "moments" in which emission rates or emissions are calculated (see Figure 2).

Figure 2. "Moments" in which emission rates and emissions are calculated in the Clean Power Plan

The first such moment is in target setting. In June 2014, EPA released preliminary emission rate targets for each state developed using a customized building block approach. These targets are the limits with which each state must comply.

The second moment in which emission rates or total emissions are calculated is in planning for compliance. State planners must develop plans for their states to comply with the targets set out by EPA. Here, states may choose to follow the building blocks described by EPA, or design their own strategies to comply with the targets. The development of compliance plans is the focus of this guide.

The third moment in which emission rates or emissions are calculated is in determining compliance, which occurs both over the interim period (2020-2029) and in the final compliance year (2030). EPA evaluates each state's emission rates and emissions to determine whether the original targets (calculated in the first moment) were achieved. Here, EPA assesses whether states' compliance plans succeeded in achieving the targets set in the Clean Power Plan.

States have a great deal of flexibility in determining how they will meet their Clean Power Plan emission rate targets. None of the building blocks described above are *required* for compliance. They are simply used to establish the emission targets each state must meet. States may employ as much or as little from the building blocks as they see fit, so long as their strategy achieves the required emission performance. For more information on the background and implications of the Clean Power Plan, see the Synapse Energy Economics November 2014 report entitled *Implications of EPA's Proposed "Clean Power Plan": Analyzing consumer impacts of the draft rule* prepared for National Association of State Utility Consumer Advocates (NASUCA).[1]

Under the proposed Clean Power Plan, states have the option to create compliance plans on an individual basis, or to join with other states to create multi-state plans. Once the rule is finalized (this is anticipated in mid-summer, 2015), states choosing a single-state compliance plan to meet the 2030 emission targets will be required to submit their plans by 2016—or one year from the date EPA's guidelines are finalized. They will have to demonstrate interim progress between 2020 and 2029. States that choose to join with other states to develop a multi-state compliance plan will be required to submit an initial plan in 2016 and an update in 2017. The update will describe their progress toward key milestones and toward the development and submission of a complete plan. Submission of final multi-state compliance plans is required by 2018—or two years after the date EPA's guidelines are finalized.

Clean Power Plan compliance plans are likely to result in many changes at the utility level, including building new generating units, upgrading existing generating units, and implementing additional energy efficiency programs. Consumers will ultimately be asked to shoulder most of the costs of new environmental initiatives through rate increases in their service area. NASUCA's members play an essential role in their states in that they represent the interests of utility consumers. Robust participation by NASUCA members in the decision-making processes that design and implement Clean Power Plan compliance strategies is therefore critical to ensure that costs are not incurred unnecessarily and that consumers receive the best possible value for money spent.

While the Clean Power Plan will have implementation costs, it could lead to significant consumer benefits. These benefits not only include reduced health impacts and welfare risks from climate change, but also savings from reduced energy bills due to new end-use energy efficiency programs. To maximize these benefits, it is critical for consumer advocates to be involved in the process early on and to push for appropriate least-cost planning as states develop their compliance strategies.

This guide describes a number of elements necessary to create plans for compliance with Clean Power Plan emission targets. Section 2 describes the entities involved in the planning process, and lays out the steps in formulating a compliance plan. Section 3 looks at the various resources and potential compliance measures that might be tested for inclusion in state or regional plans. Sections 4 and 5 examine best practices in forecasting assumptions that underlie emission reductions plans and potential tools for modeling compliance scenarios, respectively. Section 6 discusses the ways in which states or regions might select a compliance plan for submission to EPA. Finally, Section 7 contains Synapse's

[1] Stanton, E.A. et al. 2014. *Implications of EPA's Proposed "Clean Power Plan": Analyzing consumer impacts of the draft rule.* Prepared by Synapse Energy Economics, Inc. for NASUCA. Available at: http://synapse-energy.com/sites/default/files/Final%20Report%20-%20Implications%20of%20EPAs%20Proposed%20Clean%20Power%20Plan%2014-026.pdf.

conclusions and recommendations for best practices in planning for states' Clean Power Plan compliance.

2. STEPS FOR FORMULATING A COMPLIANCE PLAN

States have been developing plans to comply with Clean Air Act air quality standards for decades. The process is well established and highly regimented. Compliance planning for the proposed Clean Power Plan, however, promises to be far less prescriptive as EPA has proposed to allow unprecedented flexibility in the implementation of compliance options. This flexibility presents both challenges and significant opportunities to optimize least-cost pathways to achieve emission targets.

While the final version of the Clean Power Plan will not be released until this summer, states should be preparing to develop compliance plans now. Understanding the options and steps required for plan development, as well as potential best practices for implementing each of those steps, will help states put together the best possible plans in the timeframe set out by EPA.

As discussed in this section, key steps for developing Clean Power Plan compliance plans include:

Step 1: Identify and engage key agencies and stakeholders

Step 2: Identify planning objectives and criteria for evaluating plans

Step 3: Assess current and future system conditions

Step 4: Formulate a range of potential compliance plans

Step 5: Identify key uncertainties with compliance outcomes

How existing Clean Air Act compliance planning works

In traditional Clean Air Act compliance planning, the state agency responsible for regulating air quality is tasked with developing a comprehensive plan (called a state implementation plan or SIP) for reducing air pollution in order to bring the state into compliance with the air quality standards set by EPA. The air quality agency may work with other relevant government agencies such as state transportation and energy offices to develop this plan, but ultimate authority for the plan rests with the air regulator.

Depending on the pollutant being addressed, states generally have 18 to 36 months from the time they are determined to be out of compliance with an air quality standard to submit a complete SIP to EPA. A complete SIP includes the following:

- Development of emission inventories,
- Information about air quality monitoring networks and data,

- Specific control measures to reduce targeted pollutants, and
- Air quality modeling that demonstrates that the plan will allow the state to meet the air quality standards by a specified date.

The emission control measures in an SIP can cut across all sectors (from transportation to electric generation to agriculture) and when they are submitted to EPA they become federally enforceable by both EPA and the public (through the Citizen Suit provision of the Clean Air Act).

SIPs must be developed through a public "notice and comment" process in which interested stakeholders, including industry representatives, non-governmental organizations, experts, and members of the public, can review elements of the draft SIP and provide feedback on everything from the assumptions used in modeling to the measures proposed to reduce emissions. The public SIP process can take many months and can lead to many iterations of the SIP, depending on whether the agency receives (and incorporates) any significant feedback. Finally, some states require legislative approval before new regulations can be submitted to EPA.

Once the SIP is complete, it is submitted to EPA for review and approval. EPA has 18 months to review and approve or disapprove a state's SIP. If the plan is disapproved, either in whole or in part, the state has an opportunity to correct the problems that led to the disapproval. If the problem is not corrected, EPA is required to promulgate its own plan to reduce emissions in the state, called a Federal Implementation Plan, or FIP.[2]

Compliance planning under the Clean Power Plan

Under the Clean Power Plan, the compliance planning process is significantly more flexible. The focus of this report is to provide guidance on how states should evaluate their planning options and to recommend best practices for developing effective, least-cost compliance plans. Here, Synapse provides a brief overview of how compliance plans are expected to work under the Clean Power Plan, with additional detail on planning options and best practices in the sections that follow.

Once the Clean Power Plan is finalized this summer, states must develop and submit plans describing how they will meet the Clean Power Plan's 2030 emission targets and demonstrate interim progress between 2020 and 2029. The currently proposed timeline for plan submittal is:

- By 2016 for states filing solo (single-state) compliance plans, or one year from the date the Clean Power Plan is finalized;
- By 2017 for states that are granted an extension. Extensions are available in certain circumstances, but annual progress toward plan development must be demonstrated even if an extension is granted;

[2] For a comprehensive review of the established SIP process see the 2012 report from the Regulatory Assistance Project: *State Implementation Plans: What Are They and Why Do They Matter? A Primer on SIPs for Energy Regulators.* Available at: http://www.raponline.org/document/download/id/508.

- By 2018 for states that notify EPA of their intention to file joint compliance plans. This notification must be made by 2016.

States can follow EPA's building blocks or come up with additional and/or alternative measures for reducing CO_2. States may adopt the rate-based target set by EPA or convert the rate-based target to the comparable mass-based target. The ways in which these approaches might be modeled are described in Section 5.2 of this guide.[3] A state can submit a solo plan demonstrating how it will comply with the performance standards on its own, or it can team up with other states to develop a joint plan. In multi-state plans, individual targets would be replaced with an equivalent multi-state target.

States may also work together using an alternative approach to multi-state compliance wherein states submit individual plans addressing all elements of a coordinated plan for solo compliance. In this joint plan approach, states' individual plans utilize trading mechanisms that will allow their states to interact with other states by exchanging commodities like renewable energy credits (RECs), energy efficiency credits, CO_2 credits, or other types of allowances or certificates in order to reduce emissions and achieve their targets. Synapse addresses multi-state compliance in detail in a forthcoming report for NASUCA entitled *Multi-State Compliance with the Clean Power Plan in CP3T.*

In its proposed rule, EPA outlined two potential ways states could design their compliance plans:

- Generators are solely responsible for compliance: A state may submit a "direct emission limits" plan that holds affected sources solely responsible for achieving a performance standard. These affected sources (power plants) would have to demonstrate compliance by obtaining credits for measures taken at the plant as well as "beyond the fenceline" measures. With this type of plan, only affected sources would be subject to federally enforceable requirements.

- Generators and other entities are responsible for compliance: A second type of compliance would utilize a portfolio approach in which entities in addition to affected sources, such as state agencies or electric distribution utilities, take on a portion of the responsibility for reducing CO_2 emissions in the state. In this type of plan, all emission limits and "beyond the fenceline" measures become federally enforceable; but instead of the affected sources bearing the full burden of compliance, others would be subject to mandatory measures (such as renewable energy and energy efficiency) that would ultimately reduce emissions at the affected sources.

While not currently part of the proposed rule, there is a third possible planning approach:

- State is responsible for compliance: This approach is referred to as "state commitment" in which a state takes responsibility for achieving an aggregate amount of reductions through "beyond the fenceline" measures, such as renewable energy and energy efficiency programs. With this approach, it is the

[3] For more information on the development of the state emission targets, see: Stanton, et al. 2014. *Implications of EPA's Proposed "Clean Power Plan."*

state's commitment to achieve specific reductions—and not the programs themselves—that is federally enforceable. This approach is similar to the way in which California currently designs its SIPs.

Whichever options a state or group of states chooses, Clean Power Plan compliance strategies must meet four general criteria and contain 12 specific components in order for EPA to deem them "satisfactory" under Clean Air Act Section 111(d)(2)(A). The four general criteria are as follows:

- First, all state plans must contain enforceable measures that reduce CO_2 emissions from affected sources;
- Second, these enforceable measures, when taken together, must be projected to achieve the equivalent or better than the 2030 emission targets set by EPA;
- Third, CO_2 emission performance from affected sources must be quantifiable and verifiable; and
- Fourth, the state plan must include a process for state reporting of plan implementation at the level of the affected entity, state-wide CO_2 emission performance outcomes, and implementation of corrective measures if the initial measures fail to achieve the expected reductions.

The 12 components each state compliance plan must contain are listed below:

1. *Identification of Affected Entities*. A state plan must list all affected sources, provide an inventory of emissions from those sources for the most recent calendar year, and identify any other affected entities with responsibilities for implementation and enforceable obligations under the plan.
2. *Description of Plan Approach and Geographic Scope*. The plan must describe its approach and geographic scope, including whether the state will achieve its required level of CO_2 emission performance on an individual state basis or jointly through a multi-state demonstration.
3. *Identification of State Emission Performance Level*. The plan must identify the rate-based or mass-based emission performance level that will be met. If the state chooses a mass-based goal, the plan must include a description of the analytic process by which EPA's rate-based target was translated to a mass-based target.
4. *Demonstration that the Plan is Projected to Achieve the State's Emission Performance Level.* The plan must demonstrate that the measures included will achieve the interim and final performance levels. This demonstration must include a detailed description of the analytic process, tools, and assumptions used to project performance.
5. *Milestones.* The plan must include periodic milestones to show progress in program implementation and to ensure performance during the performance period is meeting expectations.

6. *Corrective Measures.* The plan must also specify corrective measures that will be implemented if the state does not meet its performance milestones, as well as a process and schedule for implementing any such measures.

7. *Identification of Emission Standards and Any Other Measures.* A state plan must identify the affected entities to which each emission standard applies (e.g., individual affected electric generating units (EGUs), groups of affected EGUs, all the state's affected EGUs in aggregate, other affected entities that are not EGUs), as well as any implementation and enforcement measures for such standards. It must also describe each emission standard and the process for demonstrating compliance with it.

8. *Demonstration that Each Standard is Quantifiable, Non-Duplicative, Permanent, Verifiable, and Enforceable*. "Quantifiable" means it can be reliably measured, using technically sound methods, in a manner that can be replicated. "Non-duplicative" means it is not already incorporated in another state plan, except in instances where incorporated in another state as part of a multi-state plan. "Permanent" means the standard must be met for each applicable compliance year or period, or replaced by another emission standard in a plan revision. "Verifiable" means adequate monitoring, recordkeeping, and reporting requirements are in place to enable the state and EPA to independently evaluate, measure, and verify compliance.

9. *Identification of Monitoring, Reporting, and Recordkeeping Requirements.* The plan must include monitoring, reporting, and recordkeeping requirements for CO_2 emissions and useful energy output (if using a rate-based approach) consistent with the requirements specified in the emission guidelines.

10. *Description of State Reporting.* A plan must require that the state will submit reports to EPA detailing plan implementation and progress.

11. *Certification of State Plan Hearing.* The plan must certify that a public hearing was held on the state plan, including a witness list and a summary of presentations and written comments.

12. *Supporting Material.* The state must provide supporting material and technical documentation related to applicable components of the plan, including a demonstration that the state has adequate legal authority for each measure included in the plan.

EPA proposed both an "interim goal" that a state must meet on average over the ten-year period from 2020 – 2029, and a "final goal" that a state must meet at the end of that period in 2030 and thereafter. Ultimately, states will need to demonstrate compliance by comparing the actual emission performance of their affected sources against the final goal on a three-year rolling basis (2030 – 2032). States must then maintain this level of emission performance indefinitely (unless Clean Power Plan targets are made more stringent in the future). For the interim goal, states will be required to compare the actual emission performance of their affected sources during the period of 2020-2029 against the interim goal.

Performance checks will be required during this period to make sure states are on track for meeting their interim and final goals.

If a state fails to submit a plan or submits a plan that EPA deems unsatisfactory, EPA has the authority to promulgate a federal plan for that state.[4] If a state fails to meet either its interim or its final goals, EPA maintains there should be consequences.[5] However, in its proposal, EPA has not yet defined what those consequences should be. EPA identifies several potential consequences, such as the triggering of corrective measures, the requirement to achieve additional reductions on top of those needed to meet the state target (similar to a concept in the Acid Rain Program), or a "SIP-call" mechanism, which would require the development of a new plan upon the failure of an approved plan to meet a particular milestone.

While awaiting the final version of the Clean Power Plan, states should begin contemplating which options and approaches would be best for them. Section 2.1 describes a number of key steps states will need to take in the development of effective, least-cost compliance plans.

2.1. Step 1: Identify and engage key agencies and stakeholders

Responsibility for developing and submitting a compliance plan rests with the state environmental agency; however, proper planning for Clean Power Plan compliance should involve substantial collaboration with other key agencies and stakeholders, including state energy regulators, public utilities commissions (PUCs), regional transmission organizations (RTOs), utilities, consumer advocates, and other stakeholders:

- *State Environmental Regulators.* State air regulators have primary authority to develop compliance plans under the Clean Air Act. They have extensive expertise in the regulation of emissions and in implementing environmental regulations. Their responsibilities include permitting and setting emission standards for electricity generators, monitoring ambient air quality, and designing and implementing plans to meet state and federal standards.
- *State Energy Offices.* Elected state representatives enact laws governing state energy efficiency and renewable energy portfolio standards, as well as regulations governing CO_2 and other pollutants. The state energy office is often the entity charged with administering state energy efficiency and renewables programs and aligning them with the policies of the state PUCs. To the extent that energy efficiency and renewable energy standards are made more stringent by legislatures with the goal of Clean Power Plan compliance, energy offices in many states will be charged with ensuring that those policies are reflected in state programs.

[4] 79 Federal Register at 34908.

[5] 79 Federal Register at 34907-8.

- *Public Utilities Commissions (PUCs).* State PUCs oversee, engage in, and/or monitor most state electric planning processes and—in retail-choice states—default service or similar procurement proceedings. PUCs are concerned with costs, risks, rate and bill impacts, reliability, and continuity of service. Many PUCs do not have direct knowledge of environmental regulatory matters or permitting processes and may rely on utilities and other regulated entities to present that information. The PUCs' primary enforcement mechanism is the regulation of rates and financial incentives or penalties to utilities. PUCs generally have a wide range of latitude in these matters.

  Because PUCs regulate electric planning in their states, which generally includes oversight of renewable energy and energy efficiency programs, they have an important role to play in the evaluation of compliance strategies under the Clean Power Plan.

- *Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs)*. RTOs and ISOs coordinate, control, and monitor the operation of the regional electric grid—covering a territory that often includes several states. RTOs and ISOs examine both electric system adequacy and reliability, focusing on load forecasting, anticipated retirements, and the integration of new resources. Some RTOs and ISOs also administer regional electricity markets.

  RTOs and ISOs play a crucial role in regional planning. The Clean Power Plan will necessitate changes in electric system investment and dispatch, and it is imperative that these changes are made in the context of an adequate and reliable grid. In regions where RTOs and ISOs exist, it will be essential to engage them in the development of Clean Power Plan compliance plans.

- *Utilities.* Electric utilities engage in the generation, transmission, and/or distribution of electricity and exist in many forms. They may be investor-owned utilities (IOUs), municipal government entities, cooperatively owned utilities run by industrial and residential consumers, or even federal entities (as in the case of the Tennessee Valley Authority and Bonneville Power Association). Generally, state utility commissions oversee the rates and costs at IOUs, while municipally owned utilities are regulated by local government, and member-owners oversee cooperatives. IOUs tend to have the greatest degree of state oversight through a variety of resource planning requirements as well as rate cases. Utilities own or procure energy from the fossil-fuel sources targeted by the Clean Power Plan, and therefore have an important role to play in the development of compliance strategies.

- *Consumer Advocates.* Consumer advocates are designated by the laws of their respective jurisdictions to represent the interests of utility consumers before state and federal regulators and in the courts. Consumer advocates intervene in regulatory cases before state PUCs to challenge rate increases and other utility planning decisions, and are at the forefront of protecting consumers during the ongoing transition from monopolies to less regulated, competitive markets. Today, state consumer advocates focus increasingly on consumer protection issues such as service quality, reliability, and price stability. As entities long established as key players in state electric planning processes, consumer advocates will have a vital role to play in the development of Clean Power Plan compliance strategies in their states and in ensuring that planning for least-cost compliance is front and center in their state planners' minds.

- *Other Stakeholders.* In many states, planning processes are open to the public and formal "intervenors" may attend meetings, review compliance planning materials, and submit comments and suggestions. Industrial groups, environmental advocacy groups, and other public interest groups frequently engage in electric planning dockets as well as Clean Air Act compliance planning.

Development of the compliance plan should allow for meaningful stakeholder involvement throughout the process and should incorporate stakeholder recommendations as appropriate. In particular, stakeholder input should be solicited for the development of the following:

- Planning objectives
- Range of scenarios to be analyzed
- Resource options to be considered
- Forecasts of future conditions
- Screening of options
- Criteria for ranking of resource plans
- The choice of final plan

Stakeholder input will help to ensure that equity concerns are adequately addressed, and that assumptions are appropriately vetted.

2.2. Step 2: Identify planning objectives and criteria for evaluating plans

Compliance with EPA's emission targets is a primary objective of the planning process, but it is not the only objective. Compliance plans should also focus on meeting other state energy policy goals, such as ensuring energy remains affordable, improving equity, increasing resource diversity, reducing risk, improving system reliability, promoting resiliency in the face of severe weather events, and empowering customers. These objectives should be identified at the outset and referenced throughout the planning process in order to ensure that they are effectively captured in all relevant planning decisions. For example, resource planners may want to ask themselves the following questions:

- What are the potential impacts on distributional equity? Who will likely benefit, and who will likely bear the costs?
- Will the identified energy efficiency options be designed to maximize participation, thereby increasing the number of customers experiencing lower overall bills as a result of efficiency investments?

- Will low-income customers be able to benefit from distributed energy resources through community solar projects or other means?
- Is the resource portfolio overly dependent upon a single fuel or technology that may be vulnerable to fuel price spikes?

A state's planning objectives should also inform the identification of criteria for evaluating and selecting potential resource portfolios for compliance. Typically, the planning process will result in several candidate resource portfolios, all with different strengths and weaknesses. While it may be tempting to choose the portfolio with the lowest cost, this may not be in consumers' best interests. Factors such as risk and equity must also be taken into account, and all relevant selection criteria should be clearly identified.

2.3. Step 3: Assess current and future system conditions

EPA calculated Clean Power Plan emission rate targets by applying "building block" pollution-reduction measures to each state's power system as it existed in 2012 to assess how much of a reduction in CO_2 each state could achieve by 2030. For planning in 2015 and beyond, states will need to determine how their electric systems have changed since 2012 and will continue to change in the future. A comprehensive understanding of the current and expected future electric system will facilitate identification of areas where additional CO_2 reductions can be cost-effectively attained.

These changes must be assessed to determine the degree to which additional CO_2 reduction measures will be needed for compliance. For example, some states will have retired older fossil units and constructed new, cleaner generation since 2012, thereby moving the state closer to its goal. States may also have experienced changes to load beyond what was assumed by EPA—whether as the result of energy efficiency programs, unexpected population or industrial growth, or some other factor. And certain fossil-fired plants could have been announced for retirement in the years between 2012 and 2020, which could impact the state's ultimate plan for compliance.

In taking stock of their current and projected future electric system, states or regions should attempt to characterize that system as accurately as possible, including capabilities of the existing generation fleet and other key system attributes:

- Generator longevity
- Utilization rates (capacity factors) relative to nameplate capacity
- Ramping abilities
- Emission rates and installed environmental controls
- Variable operating costs
- Power Purchase Agreements
- Transmission constraints

- Effectiveness of existing energy efficiency programs
- Current levels of distributed generation

Policies that impact the electric system, such as funding levels for energy efficiency, current building efficiency standards, state appliance standards, net metering policies, and renewable portfolio standards, are also important for identifying both the potential for and cost of related emission reductions.

2.4. Step 4: Formulate a range of potential compliance plans

In planning for Clean Power Plan compliance, it will be crucial to evaluate and compare multiple approaches. With all the flexibility built into the Clean Power Plan, states have nearly endless possibilities for compliance. In developing potential compliance approaches, states should be considering not just EPA's building block measures, but other supply- and demand-side resource options, treatment of new resources, and options for multi-state coordination as well.

Compliance measures

EPA set state emission rate targets using four building blocks that were developed based on what could be achieved from the best measures and programs currently in existence. These include increased efficiency at coal plants, re-dispatching from coal to combined-cycle natural gas plants, increased deployment of renewable energy, preservation of at-risk nuclear generation, and increased utilization of demand-side energy efficiency. States are not required to adopt all or even any of these measures, so long as they can demonstrate compliance with the targets through other means. However, it is essential that states evaluate the building block measures and alternate measures as potential components of a compliance strategy. Section 3 provides additional details on these options.

Treatment of new fossil-fueled resources

It is not yet certain how the final rule will treat new fossil-fuel resources (those covered by the proposed New Source Performance Standard under Section 111(b) of the Clean Air Act) but as older, dirtier resources retire, new resources could play a crucial role in a state or regional compliance strategy.

Level of integration with other states

A state can go it alone and develop a strategy to comply with EPA's target on an individual basis (referred to as a "solo plan"). A second approach allows states to collaborate with others and develop a joint strategy on behalf of all the participating states (referred to as a "joint plan"). In this type of plan, RECs, energy efficiency or CO_2 credits can be traded across state lines as one type of compliance mechanism. Third, states may work together using an alternative approach to multi-state compliance wherein states submit individual plans addressing all elements of a coordinated plan for compliance. Synapse gives a number of examples of different types of plans in a forthcoming report for NASUCA entitled *Multi-State Compliance with the Clean Power Plan in CP3T.*

States should keep in mind that EPA compliance plans must demonstrate how actions included in the plan lead to reductions in CO_2 emissions and, ultimately, to compliance with the established target. To the extent that a solo state wishes to capitalize on the actions of its neighbors (e.g., counting on energy efficiency programs in a neighboring state to reduce generation from the solo state's marginal units) without cooperating in the development of a joint compliance plan, the solo state could be vulnerable to having its plan disapproved by EPA for failing to show actionable in-state measures.

For states wishing to participate in the development of a multi-state joint plan, EPA's proposed rule requires a single plan to be submitted on behalf of all participating states. The joint compliance plan would be signed by authorized officials for each of the states participating in the multi-state agreement and would have the same legal effect as an individual submittal for each participating state. The joint submittal would need to adequately address plan components that apply jointly for all participating states and for each individual state in the multi-state plan, including necessary state legal authority to implement the plan, such as state regulations and statutes.

The ability to comply on a multi-state basis as opposed to a single-state basis is a key point of flexibility in the proposed rule that offers the potential to significantly reduce compliance costs for states. Multi-state compliance plans are likely to be more cost-effective than single-state compliance as many of the constraints associated with single-state plans are relieved. First, multi-state compliance expands the number of potential emission reduction opportunities. States will differ in the amount of "at risk" nuclear they have available to preserve, the quantity of wind or solar energy available, and the amount of coal and oil generation that they can offset through greater utilization of NGCCs.

Second, multi-state compliance allows least-cost opportunities in the region to be exploited, similar to how RTO and ISO regions enjoy efficiencies of dispatch of plants across state borders. A multi-state plan would provide system operators with greater flexibility and may result in one state reducing emissions only slightly, while another state lowers emissions significantly due to differences in the marginal cost of emission reduction. One logical grouping for multi-state implementation would roughly follow the current boundaries of the wholesale market areas, although the boundaries do not align precisely with state borders.

Alternative state groupings are also possible, and states may wish to form groups that are not contiguous. Such groupings could successfully exploit highly diverse resource endowments (solar, wind, geothermal), existing infrastructure ("at risk" nuclear plants, natural gas capacity, plant efficiencies), and fuel price differentials (particularly natural gas).

Multi-state compliance may also reduce administrative costs by allowing states to pool resources to create a centralized, standardized administration. Close collaboration would also facilitate the sharing of best practices.

States may also coordinate with each other without developing a single joint compliance plan. In this approach, states' individual plans utilize trading mechanisms that will allow their states to interact with other states without entering into a complex, multi-state planning process. They could do this by exchanging commodities like RECs, energy efficiency credits, CO_2 credits, or other types of allowances or certificates in order to reduce emissions and achieve their targets.

It is still uncertain exactly how the final rule will treat existing trading mechanisms in compliance, and how energy efficiency or CO_2 credits would work for Clean Power Plan purposes. There are many current examples of interstate trading programs, including the Regional Greenhouse Gas Initiative (RGGI) in the Northeast and the Cap-and-Trade Program in California, which could serve as starting points for the development of such trading mechanisms. States should consider all of these options when evaluating possible compliance strategies to determine which ones would provide the most effective, least-cost compliance options.

2.5. Step 5: Identify key uncertainties with compliance outcomes

Developing a compliance plan involves numerous uncertainties that can make planning difficult. Inaccurate projections could put a state's compliance with federal regulations in jeopardy, lead to costly build-out of excess infrastructure, or leave ratepayers vulnerable to fuel price volatility.

Uncertainties increase the risk that a compliance plan will not achieve the intended results either in cost or in ability to comply with federal regulations. The potentially large financial costs of these uncertainties underscore the need to evaluate plans based on risk, as well as overall cost. Taking the time to identify uncertainties at the outset of the planning process will help to ensure that such uncertainties are properly accounted for in the planning exercise and in the selection of the final plan.

These uncertainties fall into four primary categories: (1) uncertainties regarding the rule itself; (2) uncertainties regarding future environmental regulations (federal or state); (3) uncertainties regarding the cost or performance of various resources in the future, including technological improvements and fuel prices; and (4) uncertainties around how neighboring states' compliance decisions affect a state's strategy.

- *Uncertainties in the rule itself.* The final rule will resolve many questions regarding how certain resources will be counted for compliance under the Clean Power Plan, considerations for evaluation, measurement, and verification (EM&V), and other issues. In the interim, identifying these uncertainties can help to guide discussions with regulators and the creation of contingency plans. Further, understanding the proposed rule's nuances will enable states to quickly assess how the final rule will impact compliance planning activities and which assumptions should be changed.

- *Uncertainties regarding future environmental regulations.* Upcoming changes to environmental regulations, such as the anticipated final steam effluent limitation guidelines and the new ozone standard, could have a significant impact on resources already under pressure from the Clean Power Plan. However, the flexibility of the Clean Power Plan should allow states to take into account other policy considerations and work toward a compliance strategy that addresses multiple regulatory concerns.

- *Uncertainties regarding the future cost and performance of various resources.* These issues can be dealt with in the modeling process through the use of scenario analysis and sensitivities, as will be discussed in greater detail in the following sections.

- *Uncertainties around how neighboring states' compliance affects a state's strategy.* This is a fourth uncertainty that is fairly unique to the Clean Power Plan. The ways in which a state approaches its Clean Power Plan compliance could impact its neighbors' options for compliance. This uncertainty emphasizes the value of multi-state coordination.

Upfront identification of uncertainties will ensure that the scenarios are constructed appropriately and capture the range of possible future circumstances and variations in key assumptions. In this way, states can appropriately manage the risk associated with these uncertainties.

3. Potential Compliance Measures

Under Section 111 of the Clean Air Act, EPA must set performance standards based on the "best system of emission reduction" (BSER) that has been adequately demonstrated. Under the proposed Clean Power Plan, EPA has determined that BSER includes not only upgrades and operational changes that could be made at the plant itself, but also "beyond the fenceline" measures that indirectly affect emissions from power plants. EPA categorized its BSER measures in four building block categories:

- **Building Block 1:** Reduce coal-fired emission rate: a 6-percent heat rate improvement in the state's coal fleet

- **Building Block 2:** Re-dispatch to existing and under-construction NGCCs: raising the average capacity factor of the state's NGCC units to 70 percent

- **Building Block 3:** Nuclear and renewables: 5.8 percent of each state's nuclear capacity credited starting in 2020, and state-specific renewable targets that average to 13 percent of capacity across the states by 2030

- **Building Block 4:** End-use energy efficiency: on average across the states, a 10.7-percent cumulative savings by 2030

EPA uses these building blocks to determine the reasonably achievable emission reduction for each state (the target emission rate). To be clear, these building blocks are not a required recipe for state compliance. EPA will allow measures other than the identified building blocks to count toward emission reductions, and many alternative compliance measures are described in the sections below. Each state will need to develop a compliance plan that estimates the emission reduction potential and costs of both building block and non-building block measures based on state-specific data.

This section describes many of the measures that are available to states for compliance with the Clean Power Plan, including both EPA building blocks and alternative means of compliance. Table 1 summarizes these measures. The following sections also note special considerations associated with particular resource options, particularly where EPA has not yet determined whether a measure will be allowed to count towards a state's emission target.

Table 1. Building block and non-building block measures that may be used for Clean Power Plan compliance

	Supply Side	Demand Side
Building Blocks	• Heat rate improvements at coal plants	• Energy efficiency
	• Increased dispatch of NGCC units	
	• Nuclear and renewable energy	
Alternative Measures	• Heat rate improvements at non-coal fossil plants	• Transmission and distribution efficiency
	• Carbon capture and storage	• Distributed energy storage
	• Fuel switching	• Distributed generation
	• Co-firing with biomass	• Combined heat and power
	• Integrated renewable technology	• Alternative forms of energy efficiency
	• New natural gas capacity	• Smart grid innovations
	• Credits from new plant over-compliance	• Demand response
	• Increased utilization of NGCCs	
	• Plant retirements	

3.1. Supply-side building block measures

Heat rate improvements at coal plants

Building Block 1 reduces the carbon intensity of generation at individual coal plants by improving the efficiency with which these units convert coal to electricity (i.e., heat rate improvements). EPA found that best practices to reduce hourly heat rate variability at coal plants could improve heat rates, on average, by 4 percent, while equipment upgrades could achieve an additional average 2-percent improvement. Overall, EPA determined that an average 6-percent heat-rate improvement for each state's coal-fired power plants was achievable. In its technical support document, EPA provides a description of numerous technologies that may improve the efficiency of coal-fired units, ranging from combustion control optimization to cooling-system heat loss recovery.[6]

Considerations for compliance: Improving the heat rate of coal plants will reduce not only emissions, but also fuel costs, thereby improving the economics of the power plant. Potential heat rate improvements for each coal generator will likely vary significantly by state and unit. States should consult guidance documents, such as the Electric Power Research Institute's 2014 *Range and*

[6] EPA. 2014. Emission Guidelines for Greenhouse Gas Emissions from Existing Stationary Sources: Electric Utility Generating Units. GHG Abatement Measures Technical Support Document for Carbon Pollution Guidelines for Existing Power Plants. Federal Docket ID No. EPA-HQ-OAR-2013-0602, June 2014.

Applicability of Heat Rate Improvements for an overview of the methodologies and tools to assess achievable heat rate improvements for existing coal-fired power plants.[7] States may also wish to conduct an engineering survey of all coal-fired power plants within the state to identify potential improvements.

Increased dispatch of NGCC generators

Building Block 2 reduces emissions by shifting electricity generation from the most carbon-intensive units (coal and oil steam generators) to less carbon-intensive NGCCs. A typical NGCC produces less than half the CO_2 per megawatt-hour (MWh) of a typical coal-fired unit. According to EPA, these resources are only being utilized at a U.S. average capacity factor of 46 percent, and therefore increasing the average NGCC to 70-percent capacity factor would result in CO_2 reductions at a reasonable cost. When developing each state's emission target, EPA took into consideration that a state's generation can only be re-dispatched to this average 70-percent NGCC capacity factor level if the state has enough existing coal and oil generation to displace.

Building Block 2 also includes re-dispatch to NGCC units currently under construction. This applies to any unit that came online in 2013, or was under construction, site preparation, or testing by January 8, 2014. In states that have under-construction NGCCs, EPA assumes the capacity factor of these units under a business-as-usual scenario would be 55 percent and—up to that level—would be unavailable for re-dispatch.[8] Building Block 2 assumes that—given sufficient coal and oil generation to displace—these under-construction NGCCs could also achieve a capacity factor of 70 percent and, therefore, a 15-percentage point increase to their ultimate capacity factor is assumed to be available for re-dispatch purposes.

Considerations for compliance: States should be careful not to artificially limit the amount of redispatch to NGCCs that could be achieved in their state. While EPA assumed a maximum average capacity factor for NGCCs of 70 percent, some states may find that a higher—or lower— average capacity factor is more economic. In addition, it is important to consider the constraints states may face with respect to natural gas delivery infrastructure and availability.

Maintaining existing nuclear resources

In Building Block 3a, EPA evaluates the quantity of existing nuclear capacity that is considered "at risk" of being retired and the total under-construction nuclear capacity in a state in 2012. Nationwide, EPA assumes that 5.8 percent of nuclear generation is at risk of retirement, and therefore includes a credit for 5.8 percent of each state's existing nuclear generation in the calculations of each state's emission

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[7] Electric Power Research Institute. 2014. *Range and Applicability of Heat Rate Improvements*. Available at: http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002003457.

[8] EPA includes these emissions and MWh in the Clean Power Plan emission rate formula under "other."

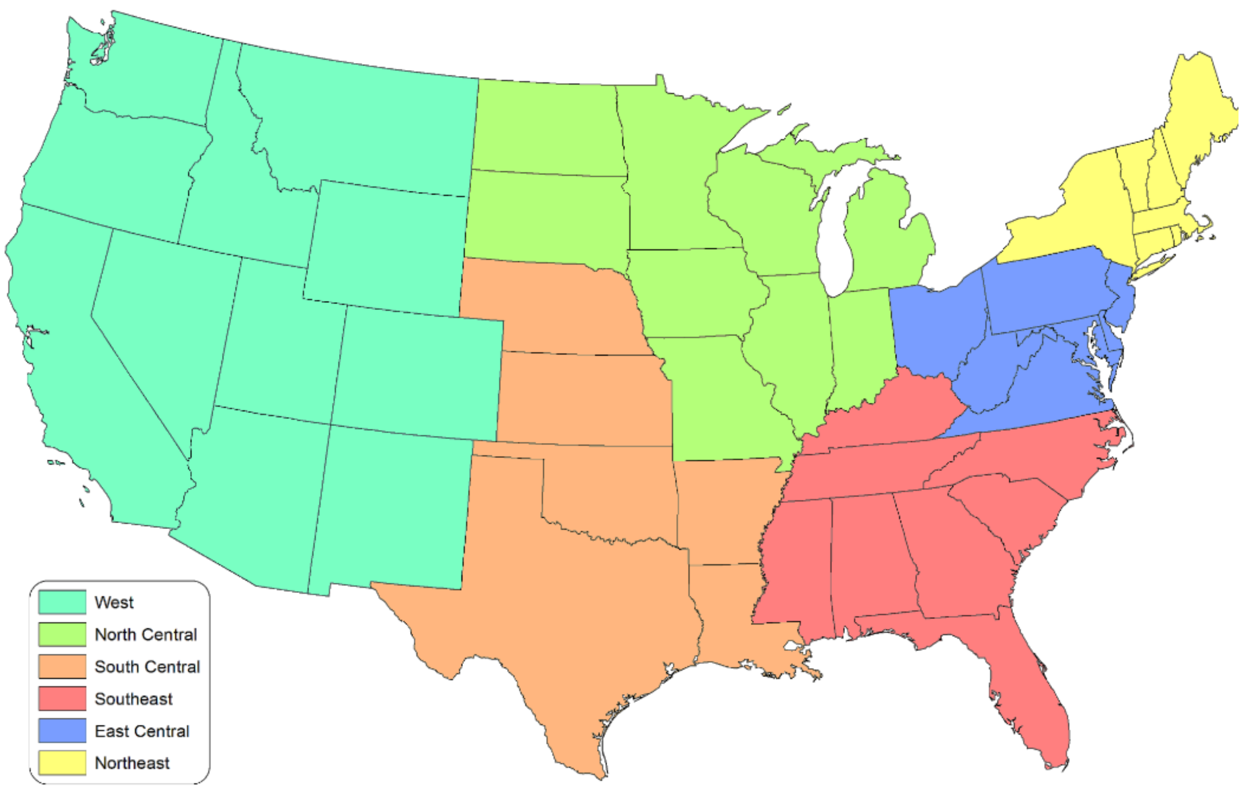
rate target.[9] Nuclear generation that is under-construction receives credit for 100 percent of its capacity at the assumed 90-percent capacity factor. States may use energy from at-risk and under-construction nuclear generation to count toward compliance, to the extent that their nuclear resources are preserved or completed.

Considerations for compliance: If states with existing or under-construction nuclear plants retire these resources before the compliance period, they will not be able to include this generation in compliance.

Expanding renewable energy resources

In Building Block 3b, EPA determined its best practices scenario for renewables based on average existing RPS requirements in each region. The regions EPA uses to assess these best practices, called regional compliance zones, are shown in Figure 3.

Figure 3: EPA regional compliance zones for renewables



Source: 2014 EPA Clean Power Plan Regulatory Impact Analysis at 3-13

The renewable energy targets that EPA assumes for each compliance zone are shown in Table 2:

[9] EPA assumes an average 90-percent capacity factor for each state's 2012 nuclear resources.

Table 2: EPA renewable energy targets

Regional Renewable Energy Generation Targets			
Alaska	10%	North Central	15%
East Central	16%	South Central	20%
Hawaii	10%	Southeast	10%
Northeast	25%	West	21%

Source: Goal Computation Technical Support Document and supporting workbook

States should ensure that EPA's assumptions for target-setting are not used to artificially constrain the amount of renewable energy that a state might develop, nor should it be assumed that the quantity of renewable energy assumed in the EPA building block would be cost-effective. Because EPA developed its assumptions based on regional estimates, some states may find that the assumed technical and economic renewable potential is either over- or under-estimated. For this reason, each state should conduct a renewable potential study and use state-specific cost data, taking into consideration expected changes in renewable costs over time.

Currently, uncertainty also remains regarding whether EPA will allow states to use tradable RECs for compliance. REC trading would allow both in-state and out-of-state renewable generation to count toward a state's compliance and would reduce the cost of compliance for many states. Although markets for RECs exist in many areas of the United States, if these credits are to be relied upon for Clean Power Plan compliance, REC tracking systems will need to be expanded to areas where they are not currently used. They may also need to be upgraded to provide additional information about the timing and location of renewable energy generation.

3.2. Supply-side measures beyond the building blocks

Heat rate improvements at non-coal fossil plants

CO_2 emissions can be reduced through efficiency improvements at any fossil-fired unit, not only coal units.

Considerations for compliance: States should take into account the potential and cost of reducing emissions through heat rate improvements at oil-fired units, gas-fired steam units, and both simple-cycle and combined-cycle natural gas units.

Carbon capture and storage

Carbon capture and storage (CCS) can reduce CO_2 emissions from both coal and natural gas-fired power plants.

Considerations for compliance: At the present time, CCS technologies for coal and natural gas plants come with high costs and impose a large energy penalty on the power plant.[10]

Fuel switching

Some coal-fired units can be converted to natural gas (reducing emissions by approximately 40 percent), or natural gas can be co-fired at a coal or oil unit. Capital costs for associated plant modifications are roughly $100 - $300 per kilowatt, excluding pipeline costs.

Considerations for compliance: When evaluating the potential for converting coal units to natural gas, several factors should be taken into account, including the age of the unit, whether the boiler is already being considered for a major upgrade or rebuild, and access to natural gas pipelines.[11] An engineering study can help states evaluate which units would be the best candidates for fuel switching. As with any measure that increases reliance on natural gas, states should be aware of the potential for increased exposure to natural gas price volatility.

Co-firing with biomass

The use of biomass-derived fuels can reduce CO_2 emissions relative to conventional fossil fuels, but the amount of CO_2 reduction depends on the type of biomass and the way in which the biomass is grown, harvested, and processed. Thus different types of biomass and different combustion processes will have different emission rates per MWh of electricity generated.

Considerations for compliance: In its proposed rule, EPA acknowledged the potential for biomass to reduce CO_2 emissions and that many states may wish to include biomass in their state implementation plans. For this reason, the agency is in the process of revising its draft accounting framework for assessing CO_2 emission reductions from biomass and is considering next steps for developing guidance to states. At the present time, it is unclear when such guidance will be made available to states.

Integrated renewable technology

Integrated renewable technology refers to using energy from both a concentrating solar installation and a fossil fuel unit to power a steam turbine for electricity. These plants may also be referred to as hybrid plants, and they can be operated using any conventional fossil fuel, including coal and natural gas.

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[10] The EIA estimates that the levelized cost of energy from an IGCC plant with CSS will be more than 50-percent higher than a conventional coal plant. Similarly, the levelized cost of energy from an advanced NGCC is expected to be more than 40-percent higher than an advanced NGCC without CCS. EIA. 2014. "Levelized Cost and Levelized Avoided Cost of New Generation Resources." *Annual Energy Outlook 2014*. Available at: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm.

[11] Binkiewicz, F.J. Jr. et al. 2010. *Natural Gas Conversions of Existing Coal-Fired Boilers*. Babcock & Wilcox Power Generation Group, Inc. Available at: http:/www.babcock.com/library/Documents/MS-14.pdf.

Generally, hybrid fossil and solar systems are more economic than using concentrated solar power (CSP) alone.[12]

One example of this technology is the integrated solar combined-cycle system, which utilizes solar thermal power to reduce fuel consumption and emissions while producing the same output, and replaces supplementary (duct) firing in the heat recovery steam generator with heat from the solar plant on hot days.[13] Such plants are currently in use in northern Africa and the Middle East. Integrating CSP with coal may also be an option, as demonstrated by Xcel Energy's solar-coal hybrid plant in western Colorado.[14]

Considerations for compliance: Although integrated renewable technology is gaining traction, it is still a relatively new technology that may not prove economic for many regions of the United States.

New natural gas capacity

New NGCC units could offer substantial reductions in emissions, provided that the generation displaced is within the state building the new plant.

Considerations for compliance: When considering new natural gas units states may need to account for new pipeline infrastructure to ensure adequate supply. States should also be aware that prices for natural gas could rise as regions begin to rely more on natural gas for electricity production and demand for natural gas grows. The importance of using appropriate fuel price forecasts is discussed in greater detail in Section 4.

EPA has not yet determined how emissions from new NGCC units will be accounted for in determining a state's compliance under either rate-based or mass-based approaches in the final rule. Specifically, EPA has requested comment on how "emissions changes under a rate-based plan resulting from substitution of generation by new NGCC for generation by affected EGUs should be calculated toward a required emission performance level for affected EGUs. Specifically, considering the legal structure of Clean Air Act section 111(d), should the calculation consider only the emission reductions at affected EGUs, or should the calculation also consider the new emissions added by the new NGCC unit, which is not an affected unit under section 111(d)? Should the emissions from a new NGCC included as an enforceable measure in a mass-based state plan (e.g., in a plan using a portfolio approach) also be considered?"[15]

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[12] By co-locating a CSP system at the site of a natural gas unit, the integrated system can utilize existing infrastructure such as transmission links and site access.

[13] Gulen, S.C. 2015. "Second Law Analysis of Integrated Solar Combined-Cycle Power Plants." *J. Eng. Gas Turbines Power* 137, no. 5. Forthcoming release May 1.

[14] Xcel Energy, *Colorado Integrated Solar Project*, Fact Sheet, (2009), https://www.xcelenergy.com/staticfiles/xe/Corporate/Environment/09-10-204%20CameoSolarFS[1]%20V%204%20111109.pdf.

[15] 79 Federal Register at 34924.

EPA's rate-to-mass technical support document, released in November 2014, proposed two approaches to calculating a mass-based target, one that would include only affected EGUs, and another in which new generation would count towards the mass-based target. The affected-EGU-only approach assumed that load growth would be met by new natural gas units (which would presumably fall under 111(b) regulations for new generation). The other approach used load growth assumptions from EIA's Annual Energy Outlook (AEO) to calculate an aggregate target that could be met, in part, through the use of new NGCC units.[16]

Credits from new plant over-compliance

In the proposed rule, EPA invited comment on whether new fossil fuel-fired units that do better than New Source Performance Standards under 111(b) should be allowed to contribute to a state's compliance with the Clean Power Plan under 111(d). Over-compliance with New Source Performance Standards could be achieved through full application of CCS at coal units or through adoption of CCS at natural gas units.

Considerations for compliance: At the time of writing, it is uncertain whether this measure will be allowed under the final rule. In addition, CCS technologies may not be cost-effective, due to the high technology cost and energy penalty imposed on plants, as discussed above.

Increased utilization of natural gas combustion turbines

The Clean Power Plan highlights the potential for NGCCs to reduce CO_2 emissions. However, increased utilization of simple-cycle natural gas combustion turbines could also provide emission reductions. While not as efficient as NGCCs (and therefore having higher emission rates), natural gas combustion turbines have lower emission rates than either coal or oil generators.

Considerations for compliance: As noted above, states should consider whether any infrastructure expansion would be required to ensure adequate fuel supplies, and evaluate the risk of fuel price increases due to heightened demand.

Plant retirements

Retiring carbon-intensive fossil fuel units may be more economic for states than maintaining these units at lower capacity factors.

Considerations for compliance: Retiring fossil fuel units may be the most economic choice, particularly when considered in light of other future environmental regulations (and related emission controls) and exposure to fuel price volatility. For this reason, the evaluation of whether a plant should be retired should consider the combined effect of compliance with all anticipated future environmental

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[16] EPA. 2014. Translation of the Clean Power Plan Emission Rate-Based CO_2 Goals to Mass-Based Equivalents, Technical Support Document (TSD) for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units Federal Docket ID No. EPA-HQ-OAR-2013-0602.

Table 3: Future federal environmental regulations

Rule	Current Status as of Release	Next Deadline(s)	Pollutants Covered
Clean Air Act, Section 111	EPA released a revised 111(b) rule, New Source Performance Standards for GHGs from new sources, in September 2013	Awaiting final rule; expected before or in conjunction with release of final 111(d) rule	CO_2 and other greenhouse gases
	EPA released a draft 111(d) rule controlling GHGs from existing sources on June 2, 2014	Summer 2015: EPA must finalize standards for existing power plants Summer 2016: States must submit state compliance plans to EPA	
National Ambient Air Quality Standards (NAAQS)	1-Hour SO_2 NAAQS was finalized in June 2010	Initial designations based on monitoring data were made in June 2013; additional designations required by consent decree by July 2, 2016 with remaining designations by end of 2017	Sulfur dioxide; nitrogen dioxide; carbon monoxide; ozone; particulate matter; and lead
	PM2.5 annual NAAQS was finalized on December 2012	Final designations announced December 18, 2014; SIPs due in April 2018 with attainment required by 2020	
	EPA proposed to strengthen the 8-Hour Ozone NAAQS on November 24, 2014	SIPs for the existing (2008) standard are due in spring of 2015	
		Revisions to the 2008 standard must be finalized by October 1, 2015	
Cross State Air Pollution Rule (CSAPR)	The U.S. Supreme Court reinstated CSAPR in April 2014, finding that EPA had not exceeded its authority in crafting the rule	Court lifted stay of CSAPR on October 23, 2014; on November 21, 2014, EPA published rules tolling CSAPR deadlines three years – Phase 1 began January 1, 2015 and Phase II begins January 1, 2017	Nitrogen oxides and sulfur dioxide
Mercury and Air Toxics Standards (MATS)	Finalized in December 2011	April 16, 2015: Compliance deadline (rule allows for a one-year extension if certain conditions are met)	Mercury, metal toxins, organic and inorganic hazardous air pollutants, and acid gases
Coal Combustion Residuals (CCR) Disposal Rule	EPA issued final rule regulating CCR on December 19, 2014	Compliance timeline is structured to take into account overlap with yet-to-be-determined ELG compliance obligations	Coal combustion residuals (ash)
Steam Electric Effluent Guidelines (ELGs)	EPA released a proposed rule with eight regulatory options in June 2013	Final rule for release of toxins into waterways must be finalized by September 30, 2015	Toxins entering waterways
Cooling Water Intake Structure (316(b)) Rule	EPA released a final rule for implementation of Section 316(b) of the Clean Water Act on May 19, 2014	Final rule became effective October 14, 2014 and requirements will be implemented in NPDES permits as they are renewed	Cooling water
Regional Haze Rule	Regional Haze Rule issued in July 1999	States must file SIPs and install the Best Available Retrofit Technology (BART) controls within 5 years of SIP approval	Sulfur oxides, nitrogen oxides, and particulate matter

regulations, rather than only the next set of regulations. Expected future environmental regulations are shown in Table 3 above.

3.3. Demand-side building block measures

Energy efficiency

Building Block 4 is the reduction of electricity demand—and, therefore, electric sector emissions— with demand-side energy efficiency measures. For Building Block 4, EPA estimates that each state can achieve annual incremental energy savings from energy efficiency of 1.5 percent by 2025, ramping up to this level over a period of years starting in 2017. Each state's 2012 reported annual savings rate is assumed to be the starting point for 2017 calculation of the state target. The ramp-up from states' 2012 energy efficiency levels to an annual savings rate of 1.5 percent is assumed to occur at a rate of 0.2 percentage points per year, with all states expected to reach the 1.5 percent target rate by 2025 at the latest.

There are many different vehicles for achieving energy efficiency savings. In many states, electric utilities are required by law to implement energy efficiency programs that are funded by ratepayers. However, in some states these programs are funded by ratepayers but carried out by third-party administrators, such as Focus on Energy in Wisconsin and Efficiency Vermont. Regardless of the entity that manages and implements the programs, ratepayer-funded energy efficiency programs typically deliver energy efficiency to the residential, commercial, and industrial classes. These programs may include audits, technical assistance, rebates, and financing.

In addition to ratepayer-funded programs, federal, state, and local governments can drive energy efficiency investments in a variety of ways. For example, governments can encourage energy efficiency through activities such as the following:

- Adoption of more stringent building codes and appliance standards
- Promulgation of, or certification with, uniform energy management standards (such as EPA's Energy Star Program, ISO 50001, or the U.S. Department of Energy's (DOE) Superior Energy Performance (SEP) Program
- Improving product labeling practices
- Issuing bonds to help provide funds for energy efficiency financing, such as Property Assessed Clean Energy (PACE) programs
- Supporting energy efficiency research and development (R&D) activities
- Providing tax credits
- Providing weatherization programs for low-income customers
- Leading by example through the installation of energy efficient equipment within their own buildings and operations

- Working to ensure that energy efficiency can participate in wholesale electricity markets

Some of these programs may be carried out by government agencies themselves, whereas others are implemented through nonprofits.

On the private sector side, energy service companies (ESCOs) generally deliver energy savings through performance contracts, which are based on a guarantee that the energy savings will exceed the cost of the ESCO's fee. Through these contracts, ESCOs implement retrofit projects, typically providing the engineering services required, arranging financing, procuring and installing equipment, and monitoring and verifying savings. The ESCO industry in the United States currently exceeds $6 billion in revenues, and is targeted largely to large institutional and public facilities.[17]

Figure 4, below, provides a simplified overview of many of these actors and the forms of energy efficiency that they deliver. The figure also indicates whether some of the impacts of these programs may be embedded in forecasts of energy consumption.

Considerations for compliance: Energy efficiency is expected to play a key role in many states' implementation plans, largely because of the relatively low cost of this resource and the widespread ability of states to implement this measure. There are several important aspects of compliance that states should consider, as discussed below:

1. States should develop their own forecasts of energy efficiency potential and costs.
2. Energy efficiency savings must be above that which is assumed to occur in a baseline load forecast (e.g., the AEO reference case) for mass-based compliance, and possibly also for rate-based compliance.
3. EM&V protocols for some forms of energy efficiency may need to be developed prior to inclusion in state compliance plans.
4. States that are net importers of electricity are permitted to count only a prorated amount of their energy efficiency savings, proportional to the percentage of in-state generation.

In terms of costs and potential, EPA estimates that energy efficiency will cost, on average, 4.5 cents/kWh (excluding participant costs), and that each state will be able to attain annual incremental energy efficiency savings of 1.5 percent by 2025. However, a review of 10 recent studies indicates that the average cost is likely to be less than 3.4 cents/kWh,[18] and potential savings may vary significantly across the country. For this reason, each state should develop its own estimates of cost and potential.

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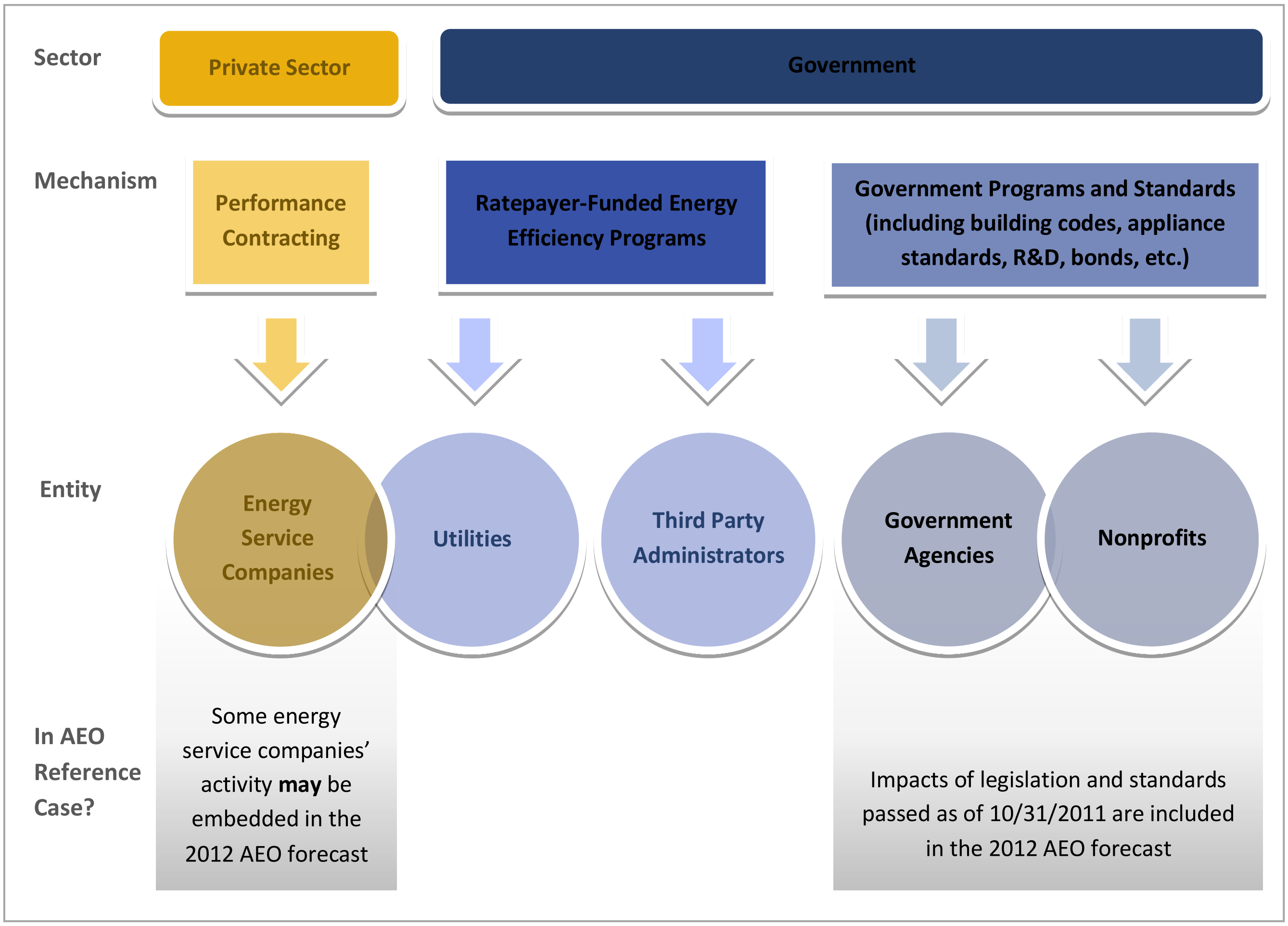
[17] Juan Pablo Carvallo, Peter Larsen, and Charles Goldman, *Estimating Customer Electricity Savings from Projects Installed by the U.S. ESCO Industry* (Lawrence Berkeley National Laboratory, 2014), http://emp.lbl.gov/publications/estimating-customer-electricity-savings-projects-installed-us-esco-industry.

[18] See: Stanton, et al. 2014. *Implications of EPA's Proposed "Clean Power Plan."*

Figure 4: The energy efficiency landscape



Note: There is overlap between the "energy service companies" and "utilities" circles because utilities can have energy service company affiliates. The "government agencies" and "nonprofits" circles overlap because these entities often work together to deliver energy efficiency programs.

States with well established energy efficiency programs and funding mechanisms may find that achieving 1.5 percent annual incremental savings or more requires only modest additional effort and funding beyond current efforts. In fact, several states are currently achieving annual energy savings of more than 1.5 percent.[19] States may also find that pursuing energy efficiency savings well beyond 1.5 percent is cost-effective. As with other building blocks, states should ensure that the potential for energy efficiency savings is not artificially constrained to 1.5 percent during the modeling process.

[19] According to EPA's calculations based on EIA Form 861, Vermont, Maine, and Arizona all achieved greater than 1.5 percent savings in 2012.

It is also possible that some states may find annual incremental energy efficiency savings of 1.5 percent harder to achieve or maintain. For example, states that have less experience with energy efficiency may require additional time to work out program kinks, including coordination of programs across utilities and other entities, measurement and verification methods, and cost-effectiveness screening. However, there exists a wide array of resources (including best practice guides, technical reference manuals, skilled contractors, and knowledgeable consultants)[20] that states can utilize in order to quickly and successfully ramp up their energy efficiency programs.

Another important consideration is that EPA's estimates of achievable efficiency savings for Building Block 4 intend to exclude naturally-occurring energy efficiency. That is, EPA assumes that states can achieve 1.5 percent annual incremental savings beyond the energy efficiency savings that would have otherwise occurred.[21]To estimate the savings that were achieved by an energy efficiency program, EM&V protocols are frequently applied that control for free-ridership and spillover effects. Savings are also estimated relative to a technology baseline that improves over time.

For this reason, EPA may require that states' compliance plans that include projections of energy efficiency savings also account for free-ridership and improvements in baseline technology efficiency. At this point, EPA has not provided guidance for how states should exclude naturally occurring energy efficiency in their compliance plans, but it is possible that EPA will base such estimates on the amount of energy efficiency that is embedded in the AEO reference case. Therefore, states may wish to familiarize themselves with the amount of energy efficiency assumed in the AEO reference case, as explained in the EIA's *Assumptions to the Annual Energy Outlook 2012.*

For example, the 2012 AEO reference case assumes that all states adopt the International Energy Conservation Code (IECC) 2006 code by 2017, that appliances continue to be replaced with more efficient models, and that many efficient technologies continue to experience cost decreases—leading to increased adoption. Legislation and standards that were passed as of October 31, 2011 are assumed to be implemented, including the Energy Independence and Security Act of 2007, which sets standards for a variety of residential and commercial appliances, including light bulbs, boilers, and dishwashers.[22] On the other hand, *AEO 2012* does not assume any "radical" changes in technology or consumer behavior. The *AEO 2012* assumptions state:[23]

> With the exception of efficiency levels described in consensus agreements among equipment manufacturers and efficiency advocates, no new regulations of efficiency beyond those currently embodied in law or new government programs fostering

[20] See Appendix A for a list of these resources.

[21] The EPA bases its estimate of the potential CO_2 reductions from energy efficiency on "what has already been achieved or required by policies… of the leading states." These leading states have energy efficiency savings requirements of at least "1.5 percent of the electricity demand that would otherwise have occurred." (79 Federal Register at 34872)

[22] EIA. 2012. *Assumptions to the Annual Energy Outlook 2012, p. 33*.

[23] EIA. 2012. *Assumptions to the Annual Energy Outlook 2012*, p. 28.

> efficiency improvements are assumed. Technologies which have not gained widespread acceptance today will generally not achieve significant penetration by 2035. Currently available technologies will evolve in both efficiency and cost. In general, at the same efficiency level, future technologies will be less expensive, in real dollar terms, than those available today. When choosing new or replacement technologies, consumers will behave similarly to the way they now behave. The intensity of end uses will change moderately in response to price changes. Electric end uses will continue to expand, but at a decreasing rate.

If the EPA's final rule requires that states exclude naturally occurring energy efficiency, states should ensure that any efficiency savings they claim for compliance with the Clean Power Plan represent savings beyond the amount embedded in the AEO forecast. Failure to do so could result in double-counting of savings and difficulty in meeting compliance targets.

Accounting for energy efficiency savings under the mass-based approach may afford states greater latitude in determining the quantity of efficiency savings embedded in the load forecast. Translating a rate-based goal into a mass-based goal requires the use of some forecast of future energy consumption. EPA's technical support document uses average annual load growth rates from the *2013 Annual Energy Outlook*, but it is possible that states will also be permitted to develop their own load projections, which could potentially include more or less embedded energy efficiency savings.[24] It is likely that any load growth projections would be required to meet certain standards and verification protocols that EPA has not yet established.

In addition, certain forms of energy efficiency, such as building codes and appliance standards, will require further development of EM&V protocols. These measures are discussed in more detail under the section titled "Alternative Forms of Energy Efficiency" below.

A final consideration is that net-importing states will not receive full credit for their energy efficiency savings under the rate-based approach. In calculating each state's target emission rate, states that are net importers of electricity receive credit in their Clean Power Plan emission rate formula for the product of their cumulative energy efficiency savings and their share of in-state generation. Hence net importers may only take credit for a prorated amount of their energy efficiency savings, proportional to their percentage of in-state generation.

[24] EPA. 2014. *Translation of the Clean Power Plan Emission Rate-Based* CO_2 *Goals to Mass-Based Equivalents*, Technical Support Document (TSD) for Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units Federal Docket ID No. EPA-HQ-OAR-2013-0602.

3.4. Demand-side measures beyond the building blocks

Alternative forms of energy efficiency

A variety of energy efficiency measures that have not historically been subject to stringent EM&V protocols hold the potential for significant emission reductions.[25] This guide refers to these measures as "alternative" forms of energy efficiency. Examples of these measures include future building codes and appliance standards, programs targeted at changing consumer behavior, energy efficiency financing, and non-ratepayer-funded energy efficiency programs. These alternative measures warrant consideration in compliance plans, particularly those innovative programs that could be highly cost-effective. For example, energy efficiency financing provides low-cost loans to customers rather than incentives, which can significantly reduce energy efficiency program costs. Behavioral programs also offer a potentially cost-effective means of reducing energy consumption. Note, however, that while EPA has not discouraged alternative measures, the agency has stated that EM&V may pose additional challenges for some measures and require further development of protocols prior to their approval in compliance plans.[26]

Energy efficiency programs and services are aimed at increasing the amount of energy efficiency that is implemented beyond what would have otherwise occurred. However, as technology evolves and efficient products become less expensive, customer adoption also naturally occurs.

In addition, it is possible that EPA will require demonstration that savings from such measures go beyond that which would have otherwise occurred (as estimated by the AEO reference case). Although it is not clear whether the EPA will allow for energy efficiency that is embedded in the AEO forecast reference case to count for compliance under the rate-based approach, it appears that claiming such efficiency savings will not be permitted under the mass-based approach. The reason for this is that the mass-based approach requires the use of a load growth forecast, which generally includes some estimates of naturally occurring efficiency. In the EPA's technical reference manual, EPA assumes load growth rates consistent with the EIA's 2013 AEO reference case.[27] As discussed previously, in forecasting load growth, the AEO accounts for some baseline energy efficiency, such as the gradual adoption of increasingly efficient appliances and improvements in building shells.[28] To the extent that these

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[25] This is not meant to imply that EM&V protocols do not exist, but rather that such EM&V protocols are still relatively new and have not yet been widely adopted.

[26] 79 Federal Register at 34921.

[27] The use of the AEO forecast is one approach illustrated by EPA, but states may be able to use other methodologies to set their mass-based targets.

[28] In its NEMS model, AEO assumes that efficiency levels described in consensus agreements among equipment manufacturer and efficiency advocates are implemented and that currently available technologies for buildings and appliances evolve in both efficiency and cost. Improvements in new building shells in the commercial sector, for example, are projected to increase in efficiency by 15 percent over the AEO projection horizon. However, the AEO does not assume that new regulations of efficiency beyond those currently embodied in law are adopted. EIA, *Assumptions to the Annual Energy Outlook 2013* (EIA, May 2013).

assumed adoption rates are fueled by non-ratepayer-funded energy efficiency programs, such as those provided by energy service companies, continuation of these programs at current levels may not increase efficiency savings beyond what is assumed in the baseline load forecast, and therefore it is possible that such savings will not count for compliance. Conversely, an increase in energy service company programs may help states achieve compliance with the Clean Power Plan.[29]

As discussed in the energy efficiency section above, states may be permitted to develop their own load projections. Nevertheless, it is possible that EPA will still require that savings from energy service companies and other alternative energy efficiency measures exceed what would have otherwise occurred.

Combined heat and power

Combined heat and power (CHP) is a distributed energy resource located at or near a customer's site that produces both useful thermal energy and electricity using the same fuel stock. By reusing otherwise wasted thermal energy, CHP conserves fuel and reduces emissions. As with energy efficiency and other distributed energy resources, CHP systems serve to remove a portion of the site's electric load from the grid through behind-the-meter electric and thermal energy production.

There are two types of CHP systems: "topping cycle" and "bottoming cycle." The topping cycle uses fuel to first generate electricity or mechanical energy, with a portion of the waste heat then converted to useful thermal energy. This is the most common form. In contrast, bottoming cycle first produces heat through combustion or another form of chemical reaction, from which some of the heat is recovered to generate electricity. In general, CHP systems are used where there is a sustained requirement for thermal energy. A majority of CHP units rely on natural gas for fuel, but approximately 28 percent of current CHP is fueled by other sources, including wood, biomass, landfill gas, oil, process wastes, and fuel cells.[30]

Considerations for compliance: Although potentially a useful means of reducing overall emissions, EPA has not yet determined whether industrial CHP will count for compliance under the rate-based method. Specifically, EPA writes "The agency requests comment on whether industrial combined heat and power approaches warrant consideration as a potential way to avoid affected EGU emissions, and whether the answer depends on circumstances that depend on the type of CHP in question."[31] Under the mass-based approach, however, a CHP unit will unambiguously reduce emissions from electric generating

[29] Energy service companies typically receive much of their revenue through performance-based contracting for energy efficiency, and revenues have grown steadily since the 1990s. It is estimated that revenues for the ESCO industry in 2013 totaled $6.4 billion, and it is projected that ESCO revenues in 2020 could range from $10.6 billion to $15.3 billion. Elizabeth Stuart et al., *Current Size and Remaining Market Potential of the U.S. Energy Service Company Industry* (Lawrence Berkeley National Laboratory, September 2013), 1–3.

[30] ICF. 2013. CHP Database. Available at: http://www.eea-inc.com/chpdata/.

[31] 79 Federal Register at 34924

units. However, as with other forms of energy efficiency, states should account for CHP that might already be included in AEO (or other) growth rate forecasts.

It is also important to note that some very large CHP facilities may meet the criteria for an affected source (i.e., an affected EGU), rather than a demand-side measure. This would be the case if the CHP unit is fossil-fueled, is capable of combusting at least 250 million Btu per hour, and sells at least 219,000 MWh per year and one-third of its potential electrical output to a utility distribution system.[32]

Distributed generation

Distributed renewable generation refers to the installation of renewables on customer premises or elsewhere on the distribution system, rather than centrally located, utility-scale renewable generation. Distributed renewable generation reduces the energy consumed from central-station fossil fuel generators, thus reducing emissions. In addition, by locating distributed resources close to customer load, some electricity losses on the transmission system may be avoided.

Considerations for compliance: In some cases, the variable nature of renewable distributed generation may increase the amount of ramping and cycling required of fossil fuel generation, which could result in small reductions in the efficiency at which fossil fuel units operate.[33] Upgrades to the distribution system may also be required to integrate large amounts of distributed generation. In addition, as with energy efficiency, states should account for distributed generation that might already be included in AEO (or other) growth rate forecasts.

Energy storage

Storage facilitates the integration of variable resources (such as wind and solar) and reduces the need for fossil-fueled backup generation, which in turn reduces overall emissions. Energy storage technologies are capable of quickly delivering energy when needed, while storing excess energy (such as that produced by high winds in the middle of the night). Storage will thus be particularly important for states that anticipate additional need for fast-ramping to integrate significantly more renewable energy, whether from utility-scale projects or small, distributed generators.

Considerations for compliance: Until recently, the high cost of storage has limited its deployment. However, storage costs are rapidly falling while the technologies used are improving significantly. According to IHS, Inc., in 2014, the United States added approximately 163 MW of new solar storage

[32] 79 Federal Register at 34854.

[33] Lew, D. et al. 2012. *Impacts of Wind and Solar on Fossil-Fueled Generators*. National Renewable Energy Laboratory website. Available at: http://www.nrel.gov/docs/fy12osti/53504.pdf.

systems in the residential, commercial, and utility sectors. In 2018, new installations are expected to total 2,875 MW.[34]

Smart grid innovations

Many states are currently undertaking initiatives to modernize the electric grid through implementation of new utility-facing and consumer-facing technologies.

- *Utility-facing side:* Utilities can achieve greater efficiencies in grid operations through the use of technologies such as tap-changing transformers, line-drop compensators, voltage regulators, and capacitor and recloser controls. A prime example is the use of conservation voltage reduction, which can produce annual energy reductions of up to 4 percent.[35]
- *Consumer-facing side:* Smart grid technologies (such as smart meters that measure usage in hourly increments) and related applications increase the amount and granularity of energy usage information available to consumers. End-user technologies can help consumers interpret this information and reduce energy usage or shift load from on-peak hours to off-peak hours,36 thereby potentially reducing emissions.

States and utilities may also be able to combine energy usage data from smart grid technologies with sophisticated algorithms to better target energy efficiency offerings to the locations where it would have the greatest impact, and to the customers who would benefit the most. Utilities can use such data to target energy efficiency and demand response programs to locations experiencing overloaded circuits (thereby reducing line losses), or to more effectively tailor energy efficiency program offerings to consumers, targeting those with the greatest potential for energy savings.

Considerations for compliance: The cost-effectiveness of smart grid technologies should be assessed in reference to the expenditures that utilities would have made without the Clean Power Plan. That is, if a utility's meters are approaching obsolescence, installation of smart meters may have little, if any, additional incremental cost beyond what would have been incurred anyway. Properly accounting for these incremental costs (rather than the full cost of the technologies) will help states more accurately identify cost-effective smart grid investments.

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[34] IHS. 2015. "IHS Ranks the Top 10 Technologies That are Transforming the World." Press release January 12. Available at: http://press.ihs.com/press-release/technology/ihs-identifies-technologies-transform-world-over-next-five-years.

[35] Warner, K. and R. Willoughby. 2013. "Conservation Voltage Regulation: An Energy Efficiency Resource," *IEEE Smart Grid*. Available at: http://smartgrid.ieee.org/april-2013/842-conservation-voltage-regulation-an-energy-efficiency-resource.

[36] Consumers only face the incentives to shift load from peak to off-peak periods when they face a price signal through time-varying rates, or some other financial incentive.

Transmission and distribution efficiency

The EIA estimates that approximately 6 percent of the electricity generated is lost as it travels over transmission and distribution lines.[37] During peak hours and hot summer days, line losses can greatly exceed this average.[38] Reducing line losses through upgrades to transmission and distribution equipment can reduce the amount of electricity generation required to meet load, thereby also reducing emissions.

Considerations for compliance: In estimating emission reductions from transmission and distribution upgrades, states may want to consider the impact on marginal line loss rates, rather than only average line loss reductions. That is, understanding how upgrades impact line losses at different time periods (for example, during peak summer days) is important for estimating the generation unit and associated emissions that will be displaced.

Demand response

Traditionally demand response has been focused on shifting load from periods of peak demand to off-peak periods. This load shifting typically does not reduce energy consumption, and could result in either an increase or decrease in emissions, depending on the units that are operating at the margin during peak and off-peak periods. However, with the introduction of more sophisticated and automated controls, demand response is increasingly being used for load-following and regulation services. Some types of demand response are even capable of increasing load (rather than only decreasing load) in response to operator dispatch signals, particularly those with some form of thermal storage or physical storage (e.g., cold storage or municipal water pumping facilities).[39]

Considerations for compliance: While traditional demand response may or may not impact CO_2 emissions (depending on what unit is operating on the margin when the demand response is deployed), more sophisticated forms of demand response can facilitate renewable integration through storing excess energy produced by solar or wind installations, and by providing fast-ramping load-following and regulation services to help grid operators manage variable renewable resources. Demand response should therefore be considered by states that are contemplating increased renewable resource penetration, whether from distributed or utility-scale generation facilities. In some cases, state or market rules may need to be modified in order to permit third-party aggregators to operate and to ensure demand response providers receive proper incentives.

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[37] EIA. 2014. "How Much Electricity Is Lost in Transmission and Distribution in the United States?" *U.S. Energy Information Administration FAQs*. Available at: http://www.eia.gov/tools/faqs/faq.cfm?id=105&t=3.

[38] Lazar, J. and X. Baldwin. 2011. *Valuing the Contribution of Energy Efficiency to Avoided Marginal Line Losses and Reserve Requirements.* Regulatory Assistance Project. Available at: www.raponline.org/document/download/id/4537.

[39] Hurley, D., P. Peterson, and M. Whited. 2013. *Demand Response in the USA: A Review of Demand Response Program Designs and Performance.* Synapse Energy Economics, Inc.

Water conservation

The nexus between water and energy offers significant opportunities for efficiency programs to save both energy and water simultaneously and cost-effectively. The treatment, pumping, and distribution of water consume significant amounts of energy, while the generation of electricity from thermoelectric sources requires vast quantities of water. Water conservation measures not only reduce water use, but also lower the amount of electricity required for water and wastewater treatment. Some energy efficiency measures (e.g., low-flow showerheads) can save both water and energy on-site. These interconnections may provide opportunities to save both energy and water simultaneously and cost-effectively.

Considerations for compliance: Opportunities to address the water-energy nexus are currently not fully exploited and are generally not well understood. Implementing measures that address the water-energy nexus will likely require local water utilities and energy efficiency providers to work together in new ways in order to ensure cost-effective deployment through resource sharing and coordination.

4. PROJECTIONS OF FUTURE CONDITIONS

Formulating scenarios of Clean Power Plan compliance requires the best possible projection of future conditions related to the electricity sector. While each input variable might need to be projected in a specific way, there are elements of the forecasting methodology that are universal to all assumptions.

- Forecasts of future conditions should be developed specifically for the utility service territory, state, or region (depending on the assumption), and aggregated as necessary for Clean Power Plan compliance.
- Expectations regarding future conditions are constantly changing and planning entities must carefully review the best and (often) most recent versions of all forecasts used in compiling their compliance plan.
- Forecasted assumptions should be reasonable and forecasting methodology should be updated as necessary to reflect more sophisticated forecasting techniques as they become available.
- Forecasts should be created by independent third-party entities where possible, and should be well documented, cited, and made available to stakeholders for additional review.

Key forecasted input variables used to develop Clean Power Plan compliance scenarios are described in more detail in this section. Much of the information in each of these variables is held by electric utilities as part of the integrated resource planning or procurement planning processes in a number of states, and compliance planners should draw on this knowledge where possible.

4.1. Sales and peak load forecasts

Electric sales and peak load forecasts are a fundamental element in any energy planning process. Estimates of annual and peak energy usage are essential in determining the need for new and existing resources, as well as the type of resources, that must be added over a given time period to meet consumer demand. In vertically integrated states, utilities often develop their own projections of consumer demand based on assumptions about local population changes, industrial growth, and other economic factors. In states with restructured electricity markets, sales forecasts are often based on econometric models and are developed jointly by utilities and RTOs.

Electric sales forecasts and their underlying assumptions should be fully documented and made available for review by stakeholders and/or the public. Resource needs can rise or fall dramatically over a short period of time, and frequent, up-to-date reassessment of sales forecasts are necessary for planning entities to adequately assess the quantity and type of additional resources that might be needed in a specific planning period. As discussed in Section 2.5, uncertainty around electric demand may significantly impact Clean Power Plan compliance planning. High and low sales and peak load sensitivity cases should be developed and modeled to help better understand these demand uncertainties.

4.2. Fuel prices

Fuel costs make up a significant portion of the overall cost of generation for facilities using gas, coal, oil, or biomass. They also influence the relative competitive value of clean energy resources that do not consume these fuels. The hourly dispatch of power plants is highly sensitive to fuel prices. When gas prices are lower, redispatch from coal to existing natural gas (EPA's Building Block 2) would be a lower cost option than when natural gas prices are higher. Conversely, if natural gas prices are high, additional energy efficiency and renewable energy may be less costly than increasing the dispatch of existing combined-cycle units. Fuel markets can also be volatile, and prices of individual fuels may change dramatically over short periods of time, making up-to-date fuel price forecasts a critical part of the resource planning process. Fuel prices are a variable with significant uncertainty, and analyzing a range of possible fuel prices can allow resource planners to examine the effects of fuel price changes on resource portfolios and their resulting emissions.

4.3. Capital costs of generation, transmission and distribution equipment

Forecasts of capital costs are critical to any planning process. For Clean Power Plan compliance key capital cost forecasts include: new generating resources, retrofits to existing units necessary for compliance with environmental regulations, and transmission and distribution equipment. Capital costs can vary widely across resource types, and depend on the availability and cost of raw materials and skilled labor, construction schedules, and the timing of compliance with environmental regulations. The pace of change in capital costs over time is also resource specific. A 2013 EIA report compared estimates of capital costs in 2010 and 2012 for various technologies, and found that over this period:

- Costs for integrated gasification combined-cycle (IGCC) coal plants rose by approximately 19 percent;
- Costs for conventional NGCC plants declined by 10 percent;
- Costs for onshore wind declined by 13 percent; and
- Costs for solar photovoltaic technologies declined by 22 percent.[40]

Costs for transmission and distribution infrastructure are also critical. Clean Power Plan compliance may call for the addition of new generating units in locations that are currently not connected to load centers via transmission and distribution lines. Compliance may also require upgrades to existing transmission and distribution infrastructure to help relieve congestion on those lines. While the pace of change in capital costs may be much slower for this type of equipment than for generation resources, it is still necessary to obtain accurate and up-to-date cost forecasts.

Expected capital costs for generating resources and transmission and distribution infrastructure may change from year to year as new information becomes available. It is important that resource planners consider the best, most recent cost estimates for any supply-side technologies included in a Clean Power Plan compliance plan. In a recent review, the National Renewable Energy Laboratory found that for solar resources "most [interviewed] utilities had forecast a declining cost curve in their planning assumptions, only to see the actual costs decline much more steeply than anticipated."[41] These costs might also be location specific, and planners should ensure that cost estimates reflect conditions in their region. Arizona provides an example of best practice in this regard: state regulations note that renewable energy costs and attributes change over time and should be kept up to date. As such, the state's utility planners are required to update assumptions for renewable energy capacity values every other year, in addition to supply and integration costs.[42] In addition, cost uncertainties can affect generating technologies in different ways, and states have found it useful to require utilities to model a range of possible capital costs for supply-side alternatives.

4.4. Technology performance characteristics

With respect to many renewable technologies, performance has improved at the same time that capital costs have fallen.[43] The average capacity factor[44] of solar PV modules installed in 2012 rose to almost 30

[40] EIA. 2013. *Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants.* Available at: http://www.eia.gov/forecasts/capitalcost/.

[41] National Renewable Energy Laboratory. 2013. *Treatment of Solar Generation in Electric Utility Resource Planning*. Available at: http://www.nrel.gov/docs/fy14osti/60047.pdf.

[42] Arizona Corporation Commission. Decision No. 71722. Docket No. RE-00000A-09-0249. June 3, 2010.

[43] American Council for an Energy-Efficient Economy. 2014. *The Best Value for America's Energy Dollar: A National Review of the Cost of Utility Energy Efficiency Programs.* Available at: http://aceee.org/research-report/u1402.

percent, compared to an average solar capacity factor of just under 25 percent for projects installed in either 2011 or 2010.[45,] Similarly, capacity factors for wind averaged 30 percent for projects installed from 2000 to 2005 and have risen to an average of 32 percent for projects installed between 2006 and 2013.[46] Advances in wind turbine technology are expected to continue improving capacity factors in sites with higher wind speeds, and make it possible to install turbines in areas with lower wind speeds where wind generation has previously been uneconomic.

It is also important to forecast the performance of conventional fossil fuel generating resources and nuclear units. Forecasts of generating output from coal-fired units might help planners identify those plants that could benefit from efficiency upgrades under EPA's Building Block 1, while forecasts of natural gas-fired units would reveal those units at which output could be increased through redispatch under Building Block 2. EPA's Building Block 3 gives credit for a portion of a state's nuclear generation, and states should make sure this is factored into 111(d) compliance plans.

4.5. Renewable energy potential

Factors affecting renewable energy potential vary across states, based on geographical and meteorological conditions specific to each state. States located along the coasts or the Great Lakes, for example, have access to offshore wind and potentially to hydrokinetic or marine technologies like tidal power. States in the middle of the United States —Texas, Oklahoma, Kansas, Nebraska, South Dakota, and North Dakota—have the highest potential for land-based wind energy, as seen in Figure 5 below. The greatest potential for solar power—photovoltaics and concentrated solar power—exists in the Southwestern states, as shown in Figure 6 below.

When considering renewable energy potential, it is also important to consider cost-effectiveness of renewables. While the Midwest may have the greatest potential for wind energy, for example, higher energy prices in the Northeast may lead to a greater cost-effectiveness of wind energy in that region.

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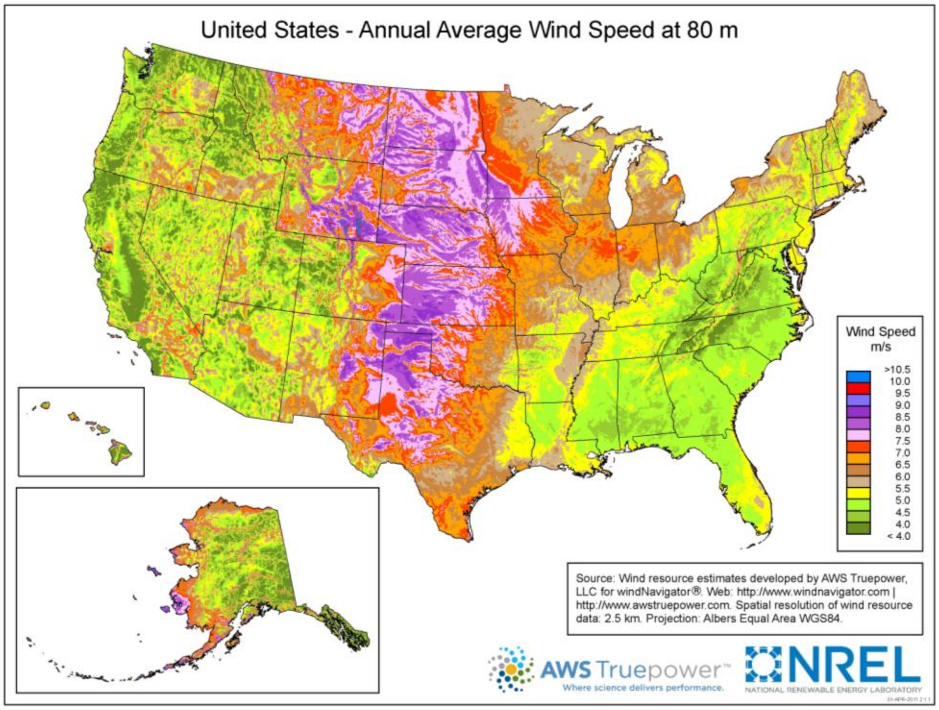
[44] Capacity factor is a measure of the productivity of a power plant, calculated by dividing the amount of energy a plant actually produces by the amount of energy the plant could produce if running at full capacity during a specific time period.

[45] The project-specific range of capacity factors is 16.6 to 32.8 percent. See: Lawrence Berkeley National Laboratory. 2014. *Utility-Scale Solar 2013: An Empirical Analysis of Project Cost, Performance, and Pricing Trends in the United States*. Available at: http://emp.lbl.gov/sites/all/files/lbnl-6912e.pdf.

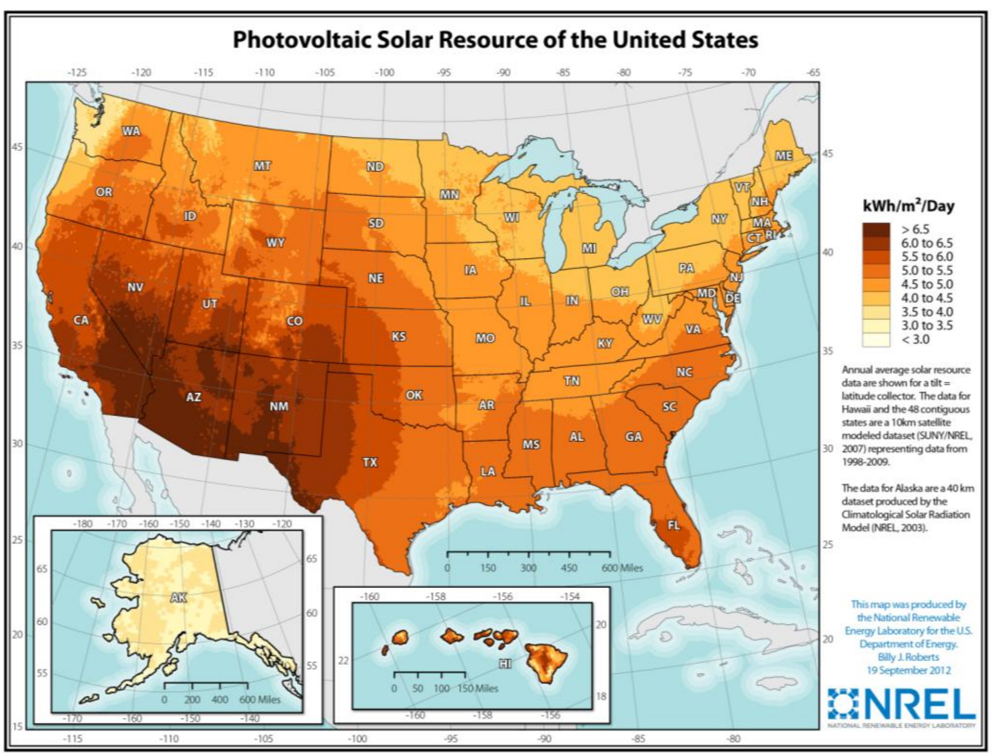
[46] U.S. DOE. 2015. *Wind Vision: A New Era for Wind Power in the United States*. Available at: http://energy.gov/sites/prod/files/WindVision_Report_final.pdf.

Figure 5: Annual average wind speeds in the United States at an 80 meter hub height



Source: National Renewable Energy Laboratory. Wind Maps. 2012.
Available at: http://www.nrel.gov/gis/wind.html.

Figure 6: Potential for solar photovoltaic resources in the United States



Source: National Renewable Energy Laboratory. Solar Maps. 2009.
Available at: http://www.nrel.gov/gis/solar.html.

States have found that credible and independent studies of the potential for both renewable energy and energy efficiency (discussed in the next section) can be critical to the creation and updating of resource and environmental compliance plans. These studies identify and examine the technical, economic, and achievable potential of new renewable energy and energy efficiency within a market and should be incorporated directly into state energy planning processes for Clean Power Plan compliance.

4.6. Energy efficiency potential and program cost

Each state has a unique potential for energy efficiency, and program costs will differ from state to state. EPA's *National Action Plan for Energy Efficiency* states that: "(N)ational public data sources should be considered sources of last resort: they provide data averaged over large regions, sometimes are not very current, and it is often difficult to ascertain sufficient background information to fully understand the underlying methods used to determine what biases may exist."[47] Factors affecting the potential for energy efficiency and the costs of those programs include: existing and proposed federal, state, and local standards and codes; baseline energy sales forecasts; weather; average income and income distribution; market segmentation data and end use; data on energy efficiency measures, including type of program, expected energy savings and measure costs; program administration costs; and expected market penetration and participation rates of energy efficiency measures. Comprehensive energy efficiency potential studies provide the basis for reasonable long-term trajectories in compliance plans, and should be done by third parties where possible. For instance, Efficiency Maine Trust, the efficiency program administrator in Maine, commissioned energy efficiency potential studies to develop multi-year efficiency plans and goals.[48]

Energy efficiency measures are often categorized based on types of potential: technical potential is the highest amount of energy efficiency that might be achieved given technical limits; economic potential is the portion of technical potential that is cost-effective; and achievable potential is the portion of the economic potential that is possible given program infrastructure and the barriers to convincing end users to adopt efficiency measures. Cost-effective energy efficiency is an important element to Clean Power Plan compliance planning, and is discussed in Section 4.7.

4.7. Avoided cost of generation

As a means to evaluate energy efficiency programs and renewable energy installations, some states require the development of "avoided costs" to quantify the benefits attributable to energy efficiency and renewables. Avoided costs are the costs of electricity generation, transmission, and distribution that are avoided when energy efficiency or renewables reduce generation from conventional units. Avoided

[47] U.S. EPA and U.S. DOE. 2006. *National Action Plan for Energy Efficiency*. Available at: http://www.epa.gov/cleanenergy/documents/suca/napee_report.pdf.

[48] Cadmus Group, Inc. 2012. *Assessment of Energy-Efficiency and Distributed Generation Baseline and Opportunities*. Prepared for Efficiency Maine Trust. Available at: http://www.efficiencymaine.com/docs/Cadmus-Baseline-Opps.pdf

costs include projected values for both energy and capacity costs, and in some states, a comprehensive estimate of avoided cost is used to determine the amount of energy efficiency that is cost-effective.[49] Other avoided cost categories sometimes incorporated in state energy planning processes include: emission compliance, price suppression effects, resources (other fuels and water), RECs, transmission and distribution costs, and/or other non-energy benefits.

Some states already require utilities to include all cost-effective energy efficiency in their resource plans. The *Pacific Northwest Electric Power Planning and Conservation Act*, for example, requires that regional resource planning (in Washington, Oregon, Idaho, and parts of Montana, Nevada, Utah and Wyoming) incorporates "all power savings that are cost-effective for the region and economically feasible for consumers."[50] For Building Block 4, best practices in Clean Power Plan compliance planning should call for all states to pursue all cost-effective energy efficiency in order to meet emission reduction targets. Frequent updates to avoided cost estimates will allow states and utilities to identify additional energy efficiency measures that become cost-effective over time as technologies improve and electricity markets change.

4.8. Resource availability and constraints

Compliance with the Clean Power Plan will likely require both the addition of new resources and the retirement of existing resources, and planners will need to prepare forecasts of these additions and retirements. This is already done at the RTO and ISO level on a shorter-term basis, and these assumptions about resource availability may need to be extended beyond the current forecast period.

Constraints on resource availability may exist for two reasons. The first is that physical characteristics specific to a region may not allow for certain types of generation. Land-based wind sites in certain parts of the country may be uneconomic given current technologies and wind speeds, for example. The second is that as more states move to integrate additional natural gas and/or renewable generation, the demand for generation equipment or fuel delivery infrastructure will increase. This could impact the costs of these resources or the availability of equipment or fuel, constraining their availability.

4.9. Transmission upgrades or constraints

Decisions regarding the maintenance, enhancement, or construction of transmission infrastructure have important consequences for the development of generation resources. This is especially true for utility-scale renewable resources located far away from load centers. Transmission lines may become congested at times, making it difficult to use certain types of generation, particularly wind, to meet

49 Hornby, et al. 2013. *Avoided Energy Supply Costs in New England: 2013 Report*. Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2013-07.AESC_.AESC-2013.13-029-Report.pdf.

50 Pacific Northwest Electric Power Planning and Conservation Act. *16 United States Code Chapter 12H (1994 & Supp. I 1995). Act of December 5, 1980, 94 Stat. 2697. Public Law No. 96-501, S. 885.* Available at: https://www.nwcouncil.org/media/5227150/poweract.pdf

energy demands. Electricity resource planning should consider the ways in which transmission lines, or the lack thereof, can affect the siting, and thus the feasibility, of new supply-side technologies. The transmission planning process undertaken at the RTO and ISO level requires that these entities understand the type and quantity of resources likely to be available in future years, and best practice requires that Clean Power Plan compliance plans take this into consideration as well.

4.10. Lead times for permitting and construction

There is a limited window between the time when states and regions determine the best methods for Clean Power Plan compliance and the time at which those resulting policies must be implemented. Permitting for new generating resources and/or transmission lines often takes significant lead time, which may not be compatible with the expected timing of implementation of compliance plans. Likewise, unmet demand for materials and labor may delay construction in certain instances. Planners should be aware of necessary lead times for permitting and materials, and build these into Clean Power Plan implementation timelines.

4.11. Future regulations

Numerous policies and regulations that affect electric utilities have been promulgated at the federal, regional, and state levels, with several others either proposed or under consideration. It is likely that additional policies will take effect in each of these jurisdictions between now and 2030, the end of the Clean Power Plan compliance period. These rules will likely affect utility operations at some future date. Uncertainty around future environmental regulations is a critical modeling consideration because utility responses to specific rules, i.e. retirements or retrofits, can have a significant effect on electric grid operations and market prices. States have found that consideration of future regulations in planning may require including an emission allowance price in its analysis, planning for the installation of one or more pollution control technologies, changing the operations of one or more generating units, or procuring alternative types of supply- and demand-side resources needed to meet demand. It is important to recognize and identify cases where future regulations may require strategies that conflict with Clean Power Plan compliance and cases where they may create complementary strategies.

4.12. Resource adequacy and reliability

Resource adequacy is typically defined as having electric generation capacity equal to the projected peak demand plus a reserve margin. Reserve requirements call for adequate capacity based on a rigorous analysis of system characteristics and proper treatment of intermittent resources. Regulators and system operators set reserve margins to the level at which involuntary load shedding due to inadequate supply (called "loss of load events" or LOLE) would occur only once in 10 years.[51] The system characteristics affecting resource adequacy and reliability include load shape, generating unit forced-outage rates, generating unit maintenance-outage requirements, number and size of the generating units in a region or service territory, transmission interties with neighboring utilities, and availability and effectiveness of intervention procedures.[52]

Mechanisms exist to address and resolve potential reliability violations that could potentially be associated with the retirement of power plants resulting from the Clean Power Plan. For example, PJM states utilize the following mechanisms: "extending unit operations through 'reliability must run' contracts, accelerated procurements of demand and supply resources, temporary waivers of regulatory requirements if or when reliability is an issue, and fast-tracking resource siting and permitting when needed."[53] These tools have been useful to PJM in dealing with past reliability challenges, including retirements related to low natural gas prices and the Mercury Air Toxics Standard (MATS), as well as stresses on the fleet relating to the cold weather during the Polar Vortex of 2014. These mechanisms may also be used to mitigate any challenges to reliability from the Clean Power Plan.

5. MODELING COMPLIANCE SCENARIOS

The development of Clean Power Plan compliance strategies and portfolios will require detailed modeling of the electric sector. This section discusses screening tools and electricity system models that may be relevant to Clean Power Plan compliance planning, and explains the importance of scenario and sensitivity analysis in planning.

There are several types of electric system models designed to answer different types of questions. Common types of models used in electricity planning include:

- *Screening tools:* Screening tools can be useful as a first step in the modeling process by providing high level results that allow resource planners to get a sense of the impacts of a specific course of action without the need for in-depth analysis. Specific strategies for compliance might be eliminated from the outset using screening tools, and this can save time and money spent on more detailed electric sector planning. For example, screening tools are commonly used in the

51 Brattle Group and Astrape Consulting. 2013. *Resource Adequacy Requirements: Reliability and Economic Implications.* Prepared for the Federal Energy Regulatory Commission. Available at: http://www.ferc.gov/legal/staff-reports/2014/02-07-14-consultant-report.pdf.

52 Biewald, B. & Bernow, S. 1988. *Electric Utility System Reliability Analysis: Determining the Need for Generating Capacity*. Boston: Energy Systems Research Group.

53 Analysis Group. 2015. *Electric System Reliability and EPA's Clean Power Plan: The Case of PJM.* Available at: http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Electric_System_Reliability_and_EPAs_Clean_Power_Plan_Case_of_PJM.pdf.

electric industry to review available demand- or supply-side energy resource based on cost. Planners can calculate a levelized cost for resources that could be available during the planning period, and eliminate those resources the cost of which they find to be unreasonable. Narrowing the pool of available resources allows more detailed modeling to proceed at a faster pace.

- *Integrated models:* These models tend to be larger scale, long-term models designed to evaluate different federal or regional policies and forecast how these policies will affect multiple electricity generators. Integrated models simplify unit dispatch and operations in order to arrive at a solution in a reasonable timeframe.

- *Electric system dispatch models:* Dispatch models are designed to determine how one or more individual generators will dispatch into the electricity grid on an hourly (or even five-minute) basis over a period of months or years. These models produce output results detailing unit generation, emissions, and electricity market prices.

- *Capacity expansion models:* Expansion models are designed to determine the types of generating resources in which a utility may want to invest and are commonly used to evaluate which resource choices best meet customer peak and energy requirements at the least cost while still meeting any applicable emission requirements.

Table 4, below, shows the different models that are common to the electric industry and their various capabilities.

Table 4. Names of common electricity sector models and their capabilities

Model Type	Model Name
Screening tools	Clean Power Plan Planning Tool (CP3T)
Integrated	National Energy Modeling System (NEMS) Integrated Planning Model (IPM)
Dispatch	PROMOD IV Market Analytics MIDAS
Dispatch and capacity expansion	ReEDS AuroraXMP
Capacity expansion	EGEAS Strategist System Optimizer

Each state or region may choose to use a different model, or set of models, to examine Clean Power Plan compliance, with the goal of creating a number of different resource portfolios under a set of specific scenarios. Sensitivity analyses are performed with model results, testing the robustness of these plans as certain input variables change. Ultimately, these models should arrive at a preferred resource portfolio that meets future energy needs, complies with CO_2 emission targets, and qualifies as least-cost under a set of scenarios or sensitivities that might reasonably be expected to occur. This section discusses each category of electric system planning model in detail.

5.1. Screening tools

Early in the planning process, environmental planners and regulators may wish to gain a high-level sense of the impact of various strategies for compliance before making investments in more detailed modeling exercises using electric system dispatch or capacity expansion models. Simplified spreadsheet tools like Synapse's own Clean Power Plan Planning Tool (CP3T)[54] can provide valuable first-pass detail on generation, emissions, and costs during the Clean Power Plan's compliance period. CP3T is a free, open-source tool available on the Synapse website; however many other "screening tools" have been developed by utilities or environmental regulators for their own use, although few are made available to the public. While these type of tools do not provide data at a monthly or hourly resolution, and cannot capture precise system dynamics such as generator dispatch or transmission constraints, they can help the planner gain a first-order sense of how different scenarios might compare in terms of emissions or costs, and can help streamline planning by selecting scenarios for the more rigorous and comprehensive modeling.[55]

5.2. Electric system models

Integrated models

In general, larger scale, long-term models are designed to evaluate different federal or regional policies and forecast how these policies will affect multiple electricity generators. These models simplify unit dispatch and operations in order to arrive at a solution in a reasonable timeframe. The EIA uses the National Energy Modeling System (NEMS) to develop its projections of energy system consumption and output. The same model is used to perform analytical studies for the Executive Office of the President, the Congressional Budget Office, and various federal agencies. NEMS has been used in the past to model the effects of proposed cap-and-trade legislation for CO_2 on the electric sector and the U.S. economy as a whole. EPA utilizes ICF International's proprietary Integrated Planning Model (IPM) to analyze proposed clean air rules and regulations, including the Clean Power Plan. Both the EIA and EPA publish model outputs on their respective websites for public review. The Rhodium Group and CSIS Energy have

[54] CP3T is available at: http://www.synapse-energy.com/tools/clean-power-plan-planning-tool-cp3t.

[55] The American Council for an Energy-Efficiency Economy (ACEEE) has recently released its State and Utility Pollution Reduction (SUPR) Calculator. This tool is designed to help state planners understand the costs and emission benefits of 19 different Clean Power Plan compliance options. The tool is available here: http://aceee.org/research-report/e1501.

used EIA's NEMS model to analyze the effects of the Clean Power Plan on both electric and natural gas use in the United States.[56]

Dispatch models

Simulation dispatch models (also commonly referred to as "production cost" models) are designed to determine how one or more individual generators will dispatch into the electric grid on an hourly, 15-minute, or even five-minute basis over a period of months or years. These models produce outputs related to generation, emissions, and operating costs on both a unit- and system-wide basis. Examples of these types of models include PROMOD IV, Market Analytics, MIDAS, ReEDS, and AuroraXMP. The PJM RTO recently examined the costs of compliance with the Clean Power Plan using the PROMOD IV model, analyzing a number of different scenarios with different natural gas prices and the amounts of installed renewable energy and energy efficiency. To comply with Clean Power Plan targets, PJM found that necessary CO_2 prices ranged from $5 to $30 per short ton, except in high natural gas price scenarios where required CO_2 prices ranged from $35 to $55 per short ton.[57]

Rate-based versus mass-based compliance

Because simulation dispatch models contain input information about CO_2 emission rates and estimate electric generation and emissions, they are critical to accurate modeling of compliance with emission targets. EPA's proposal offers two different pathways for Clean Power Plan emission compliance: states may choose to meet a rate-based target (defined in pounds per MWh) using the building blocks and/or other measures, or a mass-based target, measured in total tons of CO_2 per year. Mass-based compliance is something that is already familiar to electric system modelers, may be more conducive to multi-state compliance, and can be least-cost. Rate-based compliance offers something different, and modeling compliance with rate-based targets will require techniques different than those needed to model mass-based compliance.

Most electric system planners are familiar with modeling mass-based system emission constraints and have been modeling limits on sulfur dioxide emissions in tons since cap-and-trade programs began in 1990. Planners have less experience with rate-based limitations, and software developers are working on modifications to current models that will allow them to perform these calculations. This section describes the ways in which the mass-based and rate-based compliance pathways might be modeled using existing tools.

The mass-based compliance pathway is essentially an annual cap on the number of tons of CO_2 emitted by the electricity sector in a given state. States using mass-based targets may choose to use a

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[56] Larsen et al. 2014. *Remaking American Power: Potential Energy Market Impacts of EPA's Proposed GHGH Emission Performance Standards for Existing Electric Power Plants*. CSIS and Rhodium Group. Available at: http://csis.org/publication/remaking-american-power.

[57] Sotkiewics, P. and M. Abdur-Rahman. 2014. *EPA's Clean Power Plan Proposal Review of PJM Analyses Preliminary Results.* PJM Members Committee Webinar November 17. Available at: http://www.pjm.com/~/media/documents/reports/20141117-epas-clean-power-plan-proposal-review-of-pjm-analyses-preliminary-results.ashx.

cap-and-trade scheme for compliance, such as is currently employed for CO_2 in California and the RGGI states,[58] but may also employ other compliance measures. Modeling mass-based compliance effectively requires finding a price[59] for CO_2 that maintains emissions under the cap. State resource planners should model the impact of mass compliance on the state's entire fleet of EGUs to determine an effective CO_2 price. For states in which electricity is traded bilaterally or as part of an RTO or ISO, the market price of electricity should also account for the CO_2 price impacts.

The rate-based compliance mechanism is a target in pounds per MWh for each state based on an (outwardly) simple formula, in which emissions from existing generators are divided by generation from existing generators plus generation from energy efficiency and renewable energy. States seeking to model the impact of the Clean Power Plan under a rate-based compliance scheme need to find a least-cost strategy to reduce the numerator while expanding the portion of the denominator that is renewable energy and/or energy efficiency. Effectively, modeling a rate-based compliance mechanism requires states to simultaneously optimize the operations of existing power plants with energy efficiency and renewable energy, while also accounting for how compliance in neighboring states impacts its generators and the price for market electricity. Neighboring states may impose different restrictions on fossil generators, altering the dispatch stack in a way that changes the type of resource that is on the margin in a given hour. Because the new marginal resource may have very different operating costs, the resulting impact on market electricity prices could be significant.

Capacity expansion models

Capacity expansion models are a third type of electric sector model designed to determine the optimal generating resources for utility investment. Capacity expansion models are commonly used to evaluate which resource choices best meet customer peak and annual energy requirements at the least cost while still meeting any applicable emission requirements. These models can place supply- and demand-side resources on equal footing, and should be used in this way during Clean Power Plan planning to ensure that models are choosing the optimal level of energy efficiency to be used for compliance.

Examples of capacity expansion models include EGEAS, Strategist, and System Optimizer. These models do contain electric dispatch capability, but it is a simplified version of the capabilities found in the dispatch models discussed above. Two dispatch models, ReEDS and AuroraXMP, also have capacity expansion capabilities. The MISO RTO used the EGEAS model to examine two scenarios: one that used EPA's building blocks to meet compliance targets, and one that limited CO_2 output based on EPA's mass-

[58] Under RGGI, proceeds from the auctioning of CO_2 allowances are reinvested in consumer benefit programs for energy efficiency and renewable energy, lowering costs to consumers.

[59] These prices may be real or "shadow." A shadow price is defined as a price for a good or service for which no actual market price exists. Shadow prices are a model output and represent the price per ton of CO_2 that would need to exist in order to reduce emissions to desired levels.

based targets. Under the building block approach, costs were projected to be $60 per ton of CO_2 reduced, while the mass-based approach resulted in costs of $38 per ton of CO_2 reduced.[60]

In some states' electric sector planning processes, different models are used in sequence to: define regional electricity market prices, then a capacity expansion pathway, and then individual EGU operations. Models can be extremely helpful in arriving at least-cost solutions; however, each model has its own strengths and weaknesses in answering particular questions or reflecting particular behaviors of the power system. It is important to note that almost all of the models used for these purposes are licensed by model vendors and require significant expertise to operate and vet. Input assumptions about utility forecasts (load, price, and emissions) and individual generating units (such as capital and operating costs, ramping ability or maintenance outages) may be considered proprietary information. Thus, while models are the framework in which assumptions are used, they are often also the most complex and opaque components of utility planning.

Consumer advocates should be aware of the various types of available models, and understand the capabilities of the models used in their state or region. Model inputs and outputs should be provided to stakeholders and subjected to a thorough review. If consumer advocates have the funds and expertise to license electric system dispatch or capacity models and execute their own modeling analysis, this can facilitate the discovery of incorrect assumptions or unreasonable constraints and the creation of alternate compliance plans. In some jurisdictions, energy and environmental regulators may provide day-long model briefings, usually at the request of consumer advocates or other stakeholders, which provide interested parties with the opportunity to learn more about the functions and outputs of the specific model used for planning.

5.3. Scenarios and sensitivities

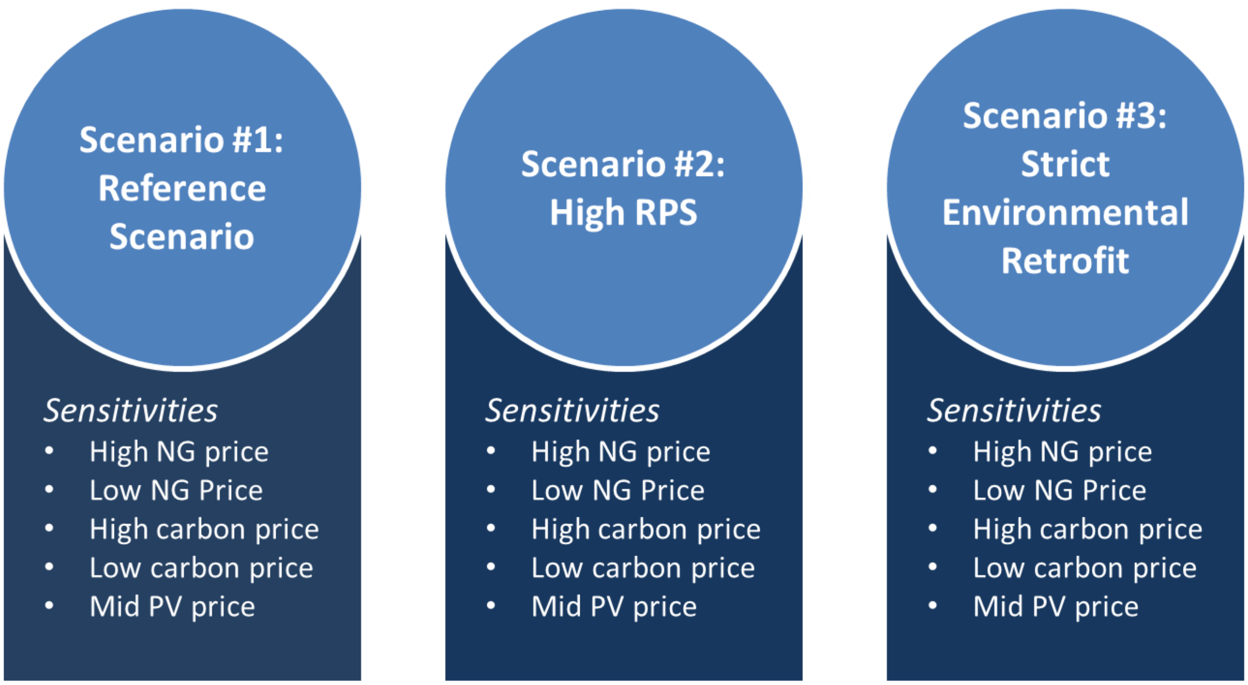
Utility and state resource or environmental compliance plans are often designed to produce a single "preferred" resource portfolio to serve customer requirements over a specific time period. This resource portfolio might include: new demand-side resources like energy efficiency, new conventional or renewable generating units, upgrades to existing units (including pollution control equipment or efficiency upgrades), and existing unit retirements. Utilities and other planning entities often arrive at this "preferred" portfolio by undertaking a process known as "scenario analysis". In scenario analysis, planners design multiple scenarios, each with its own set of defining, major characteristics. A "base case" or "reference case" is usually the first scenario that is developed, and represents a future that can reasonably be expected to occur. Additional scenarios represent distinct policy outcomes, and might include the following: conditions that produce higher or lower energy demand from consumers; an increase to a state's renewable energy requirement under an RPS; the presence or absence of certain environmental regulations; or the existence of production or investment tax credits for certain generating technologies. Because these futures are quite different from the reference case, the

[60] MISO. 2014. *GHG Regulation Impact Analysis – Initial Study Results*. Available at: http://www.eenews.net/assets/2014/09/18/document_ew_01.pdf.

preferred resource portfolio is likely to vary from one scenario to the next. Planners must weigh the likelihood of each of these scenarios occurring in the future when selecting the resource portfolio to pursue.

While scenarios represent distinct policy outcomes, sensitivity analysis represents uncertainty around specific input variables.[61] Fuel prices and emission allowance costs are variables that are commonly tested as sensitivities. To illustrate the difference between scenarios and sensitivities, futures with and without regulation of CO_2, for example, would represent different scenarios, while variations in the price of CO_2 would be considered sensitivities. In sensitivity analysis, resource portfolios are locked into place, and resource choices are not allowed to vary. Sensitivity analysis thus tests the robustness of the preferred resource portfolio under changed conditions. If a resource plan performs well under various sensitivities, it should be given more consideration as a final plan than one that performs poorly under sensitivity analysis. Figure 7 further illustrates the difference between scenarios and sensitivities. In Scenario #1, a planner may be interested in the robustness of that scenario's results to changes in the natural gas price, the CO_2 price, or the price of PV panels. Often, low, mid, and high sensitivities are tested by resource planners. Typically, each scenario is tested under the same set of sensitivities.

Figure 7. Illustration of scenarios versus sensitivities



[61] Scenarios and sensitivities have been defined in a particular way in this document, but other terminology is used throughout the industry to define these same concepts. Scenarios can also be referred to as "futures," "worlds," or "cases." The term "sensitivity analysis" may also encompass scenario analysis in certain jurisdictions. It is important to define the terminology from the outset of the planning process so that all parties are aware of the methodology being used for compliance planning.

Fuel prices and emission allowances prices are sensitivity variables that are commonly tested by utilities across the country, but there may be other key input assumptions that are regional or local in nature. Utilities in Oregon, for example, are heavily dependent on hydroelectric generation and are required by law to consider sensitivities in their resource plans that vary the amount of regional hydroelectric output. States like Arizona, New Mexico, or Florida may want to examine sensitivities that vary the amount of solar output when doing long-term planning. Utilities located in arid regions, or those owning a significant number of generation assets that are dependent on the availability of a water source for power plant cooling, may want to analyze a scenario where water becomes increasingly scarce over time as a result of climate change impacts, or a sensitivity where water is at too high a temperature to be useful for cooling during the summer months in a single year. Individual states and regions must determine those input assumptions that are subject to variability, and properly account for risks and uncertainties.

In many cases, performing single-factor sensitivity analysis may not be very informative. Instead, as noted by the Brattle Group, testing resource portfolios against scenarios that include more than one different policy outcome can more effectively support planning in an uncertain environment. [62] In these cases, more sophisticated techniques, such as probabilistic techniques or those that combine uncertainties may be warranted. For example, planners may analyze the sensitivity of a scenario to a high natural gas price and a low CO_2 price.

Scenario and sensitivity analysis analyze various resource portfolios and produce outputs that quantify total cost, risk and uncertainty, and rate impacts. Energy and environmental planners must review these results and choose the optimal portfolio for their state's compliance with the Clean Power Plan requirements. Consumer advocates should review resource portfolio outputs carefully and offer suggestions on the resulting preferred compliance plan based on the evaluation criteria that are particularly important to ratepayers in their states.

6. Selecting a Compliance Plan to Submit to EPA

Section 5 describes the ways in which electricity and environmental planners model multiple compliance plans under a range of scenarios and sensitivities. This is a critical element of planning that allows planners to make comparisons between plans based on the goals that have been identified by stakeholders in Step 2 of the planning process (described in Section 2.2 above). Planners can then determine which of the resulting resource plans are top performers on those metrics that have been deemed most important by stakeholders.

[62] Brattle Group. 2008. *Reviving Integrated Resource Planning*. Available at: http://www.brattle.com/system/publications/pdfs/000/004/363/original/ENERGY_Newsletter_2008_No_1_-_IRP.pdf?1378772101.

Compliance with EPA's emission targets is a primary objective of the compliance planning process, but it is not the only objective. Electricity and environmental planners should review a variety of other quantitative metrics in evaluating Clean Power Plan compliance plans:

- *Lowest long-term system cost:* "Least cost" is a primary consideration for planners, and generally refers to the lowest total system cost over time discounted to present-day dollars. As such, "least cost" requires the consideration of all costs that may be incurred in future years.
- *Reliability implications:* State planners should also consider any reliability implications at both the system and local levels, and on electricity market price stability.
- *Meeting other state energy policy goals:* Compliance plans must meet other energy policy goals, such as ensuring energy remains affordable, improving equity, increasing resource diversity, reducing risk, promoting resiliency in the face of severe weather events, meeting state and federal environmental laws, and empowering customers.
- *Flexibility:* States may wish to prioritize compliance plans that maintain the state's ability to modify and adjust future compliance plans, based on changes in technology, economic conditions, and other variables over time. For example, investments that can be made in small increments, such as increases in energy efficiency or distributed generation programs, enable states to make future adjustments as needed. In contrast, investing in a new base-load power plant locks the state into a technology for the next forty years, regardless of whether future fuel prices or technologies render the plant uneconomic in later years.

Resource plans should be transparently prioritized or ranked based on key criteria such as those described above. Some states may also choose to assign weights to each criterion to facilitate a ranking of the candidate compliance plans. It is highly unlikely that a single resource portfolio will be the best choice on every metric evaluated. A resource portfolio that performs well across several criteria may be a better choice for planners even if it is not the top performer on any single metric.

Energy and environmental planners should solicit comments and input on planning processes, results, and criteria for plan selection from a wide variety of stakeholders, including utilities and generation owners, default service providers, competitive suppliers, consumer advocates, renewable developers, environmental advocates, and energy efficiency advocates. Consumer advocates should be prepared to offer comments on both processes and plan outcomes.

7. Conclusions and Recommendations

Ultimately, Clean Power Plan compliance plans will trigger significant changes at the utility-level. As the legislated advocates of utility consumers, NASUCA's members can and should play a crucial role in ensuring that ratepayers do not end up shouldering unnecessary costs as a result of those changes. At the end of the day, consumers pay, through rate increases, for the costs of compliance measures such as building new generating units, upgrading existing generating units, or implementing additional energy efficiency programs. NASUCA members should have robust and timely participation in the decision-making and implementation processes that form Clean Power Plan compliance strategies.

While the Clean Power Plan will certainly have implementation costs, it could also lead to significant consumer benefits. These benefits include not only reduced health impacts and welfare risks from climate change, but also savings from reduced energy bills through new end-use energy efficiency programs. To maximize these benefits, it is critical for consumer advocates to be involved in the process early on and to push for appropriate least-cost planning from states as they develop their compliance strategies.

The first step in successful advocacy is claiming a seat at the table (Step 1 in Section 2 above). Consumer advocates must make sure they are present with other stakeholders throughout the planning process, and should also participate in:

- Step 2: Identifying planning objectives and criteria for evaluating plans;
- Step 3: Assessing current and future electric system conditions;
- Step 4: Formulating a range of potential compliance plans; and
- Step 5: Identifying key uncertainties that might affect compliance outcomes.

These steps provide a framework for planners to develop emission compliance strategies and should be established from the outset to help guide the process.

Energy and environmental planners have a range of compliance measures from which to choose when developing emission reductions strategies under the Clean Power Plan. These measures include EPA's four building blocks, as well as a number of alternatives, and consist of a combination of supply- and demand-side resources. Consumer advocates should be well versed in these potential compliance measures and have an understanding of which are most feasible for compliance in their particular state or region.

Formulating scenarios of Clean Power Plan compliance requires the best and most reasonable projections of future conditions in the electric sector. There are a range of important input variables that consumer advocates should review in order to promote transparency and accuracy in the planning process. These variables include but are not limited to: forecasts of electric load and fuel prices; capital and operating costs of various technologies, as well as potential and performance characteristics of these technologies; and any resource or regulatory constraints that may exist. There may be additional input variables warranting third-party review that are state or region specific. Assumptions regarding future conditions should be up-to-date and be backed by sound forecasting methodology.

Creating Clean Power Plan compliance strategies and resource portfolios will require some form of electric sector modeling. This can be the most challenging part of the process for participating consumer advocates and other intervenors. Models can be extremely helpful in evaluating a range of different resource portfolios under a variety of scenarios and sensitivities, and in arriving at least-cost solutions. But electric sector modeling can require significant expertise to both operate and vet.

Each model has its own strengths and weaknesses. Consumer advocates should be aware of the capabilities of each of these models, and should offer input to planners regarding the best model for use in compliance planning. Model inputs and outputs should be reviewed if feasible, and results that seem contrary to expected outcomes should be investigated thoroughly. Consumer advocates can request that model briefings or short trainings be provided in order to add additional transparency to the planning process. Finally, consumer advocates can review previous planning studies and studies from other states to inform the results in their own state's planning processes.

Compliance planning should be designed to produce a range of possible plans tested under a variety of scenarios and sensitivities. Energy and environmental planners must then compare these plans to arrive at the best, most reasonable compliance plan for their state. Compliance with EPA's emission targets is the primary objective of this planning process, but it is not the only one. Other outcomes that are useful to examine include: long-term system cost; reliability implications; electricity market price stability; and other energy policy goals relating to affordability, equity and diversity. Resource compliance plans should be transparently ranked based on key criteria that were identified in the initial stages of the planning process. A resource portfolio that performs well across several metrics, but perhaps is not the top performer on any single metric, may in fact be the best choice for utility planners.

Consumer advocates have both the opportunity and the responsibility to represent ratepayers during Clean Power Plan compliance planning, and to guide the development of outcomes favorable to consumers over the Clean Power Plan compliance period. The planning practices described here provide a useful toolkit to assist in their advocacy efforts.

APPENDIX A

Energy Efficiency Potential Studies

Neubauer, Max. 2014. *Cracking the TEAPOT: Technical, Economic, and Achievable Potential Studies*. U1407. American Council for an Energy-Efficient Economy. Available at: http://aceee.org/research-report/u1407.

Reed, Glenn, and Chris Karmer. 2012. *Ten Pitfalls of Potential Studies*. Regulatory Assistance Project. Available at: http://www.raponline.org/document/download/id/6214.

Estimating Savings from Energy Efficiency

Technical Reference Manuals

Technical Reference Manuals (TRMs) provide guidance on estimating energy savings and demand reductions achieved from the installation of energy efficiency measures. TRMs may provide "deemed savings" values, algorithms for the calculation of savings, and/or assumptions to be used in estimating impacts. Savings estimates contained in TRMs may vary significantly across states based on assumptions regarding product usage, lifetimes, free-ridership, spillover effects, or other factors.[63] Below are examples of recent TRMs.

Mid-Atlantic Technical Reference Manual:

> http://www.neep.org/file/1026/download?token=_ZCrEo70
> The TRM documents common savings assumptions for over fifty prescriptive residential and commercial/industrial electric and gas energy efficiency measures.

California Database for Energy Efficient Resources (DEER):

> http://www.deeresources.com/
> The Database for Energy Efficient Resources is a California Energy Commission and California Public Utilities Commission sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life all with one data source. The users of the data are intended to be program planners, regulatory reviewers and planners, utility and regulatory forecasters, and consultants supporting utility and regulatory research and evaluation efforts. DEER has been has been designated by the CPUC as its source for deemed and impact costs for program planning.

[63] Net savings account for free-ridership and spillover effects.

Hawaii Energy Technical Reference Manuals:

https://hawaiienergy.com/about/information-reports

Illinois Statewide Technical Reference Manual:

http://www.ilsag.info/technical-reference-manual.html

Efficiency Maine Technical Reference Manuals:

http://www.efficiencymaine.com/about/library/policies/technical-reference-manual-archive/

Massachusetts Technical Reference Manual:

http://ma-eeac.org/wordpress/wp-content/uploads/TRM_PLAN_2013-15.pdf

Pennsylvania Technical Reference Manuals:

http://www.puc.pa.gov/filing_resources/issues_laws_regulations/act_129_information/technical_reference_manual.aspx

Michigan Energy Measures Database:

http://www.michigan.gov/mpsc/0,4639,7-159-52495_55129---,00.html

Minnesota Technical Reference Manual:

http://mn.gov/commerce/energy/images/MN-TRM-2014-ver1%252E0.pdf

New Jersey Energy Savings Protocols:

http://www.njcleanenergy.com/main/public-reports-and-library/market-analysis-protocols/energy-savings-protocols/energy-savings-pr

Northwest Regional Technical Forum:

http://rtf.nwcouncil.org/measures/Default.asp?sort=Sector&order=asc

Texas Deemed Savings Values:

http://www.texasefficiency.com/index.php/regulatory-filings/deemed-savings

Efficiency Vermont Technical Reference User Manual (2013):

http://www.greenmountainpower.com/upload/photos/371TRM_User_Manual_No_2013-82-5-protected.pdf

Wisconsin Focus on Energy Technical Reference Manual (2015):

https://focusonenergy.com/sites/default/files/Focus%20on%20Energy_TRM_January2015_0.pdf

Evaluation, Measurement, and Verification

U.S. Department of Energy Uniform Methods Project: Protocols for determining energy savings:

> http://energy.gov/eere/about-us/ump-protocols
> The Uniform Methods Project is working to improve the consistency and transparency of methods for determining energy efficiency savings. Under the project, a collaborative of energy efficiency program administrators, stakeholders, and EM&V consultants with vast experience are working to develop standardized measurement and verification protocols for determining energy savings for common energy efficiency measures.

Schiller, Steven, Charles Goldman, and Elsia Galawish. 2011. *National Energy Efficiency Evaluation, Measurement and Verification (EM&V) Standard: Scoping Study of Issues and Implementation Requirements*. LBNL-4265E. Lawrence Berkeley National Laboratory. Available at: http://emp.lbl.gov/sites/all/files/lbnl-4265e.pdf.

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