Multi-State Compliance with the Clean Power Plan in CP3T

Prepared for NASUCA

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1. 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.

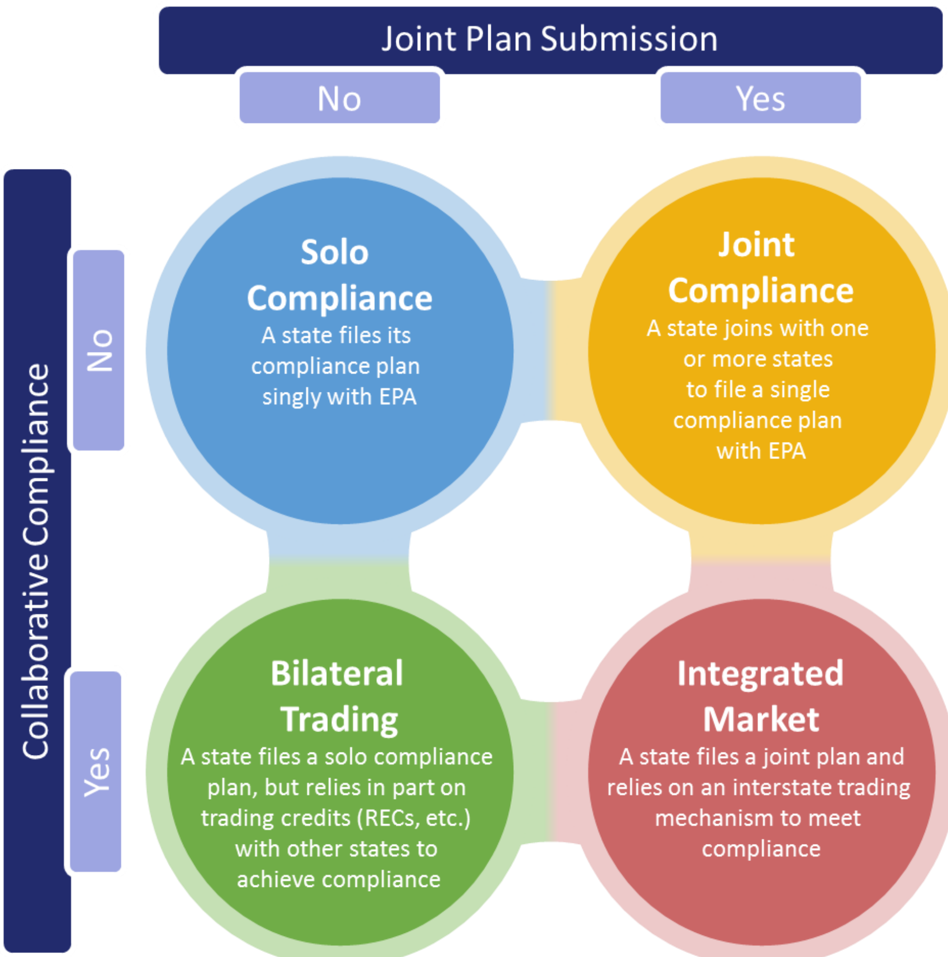
Consumers ultimately shoulder most of the costs of new environmental initiatives. NASUCA's members are designated by the laws of their respective jurisdictions to represent the interests of utility consumers in their states. Preparing NASUCA members to be able to effectively participate in the decision-making 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.

EXECUTIVE SUMMARY

On June 2, 2014, the U.S. Environmental Protection Agency (EPA) released its proposed Clean Power Plan under Section 111(d) of the Clean Air Act. The Clean Power Plan aims to reduce emissions of carbon dioxide (CO_2) from existing fossil fuel-fired power plants by approximately 30 percent below 2005 levels by 2030. States are currently evaluating their options for compliance while they await EPA's release of the final rule, expected in Summer 2015. Among the strategies states must consider is the choice of whether to submit their own single-state compliance plan to EPA or to collaborate to submit a plan jointly with other states. Multi-state collaboration towards compliance can take several forms, as shown in Figure ES-1.

Figure ES-1. State compliance planning collaboration strategies



Synapse performed analysis exploring several issues surrounding multi-state compliance using our Clean Power Plan Planning Tool (www.cp3t.com) using three illustrative combinations of states, all four strategies for compliance shown in Figure ES-1, and several scenarios of future investments in electric-sector resources. Our analysis revealed the following key findings:

- ***Filing a Clean Power Plan compliance plan jointly may result in savings, depending on the states involved.*** Some states may achieve savings by complying jointly with other states. These savings stem from capturing energy efficiency "leakage", preferential renewable siting, or by avoiding duplication in administrative costs. However, savings attributable to joint compliance are likely to be small, and for some state combinations there may be no savings but these states are unlikely to be worse off from joint filing.

- ***States achieve savings from purchasing RECs only when other compliance strategies are more expensive.*** In some states, the trading of RECs or other compliance credits may be the least-cost compliance option. However, this is only likely to occur where energy efficiency and renewables are prohibitively expensive, or where they are disfavored by state policymakers.

- ***States may participate in "RGGI-like" allowance trading initiatives either with or without joint compliance with the Clean Power Plan.*** States that file singly could become involved in integrated markets with CO_2 allowance trading. However, if they do, they forego the potential advantages of joint filing: energy efficiency "leakage" prevention, preferential renewable siting, and avoided administrative costs.

- ***States using integrated markets to meet compliance will only see cost benefits if they continue to pursue least-cost resources.*** Participation in integrated markets with CO_2 allowance trading is an effective way to utilize existing natural gas generation for compliance, and to generate revenues for energy efficiency programs and renewable generation. However, this strategy is unlikely to result in cost savings unless the lowest-cost resources are aggressively pursued.

Collaboration among states may result in cost savings, at least for some states. However, these savings are far from guaranteed. Each state must carefully consider the expected costs of each potential Clean Power Plan compliance strategy in the light of its own unique electric-sector characteristics.

2. Understanding Multi-State Compliance

On June 2, 2014, the U.S. Environmental Protection Agency (EPA) released its proposed Clean Power Plan under Section 111(d) of the Clean Air Act. The Clean Power Plan aims to reduce emissions of carbon dioxide (CO_2) from existing fossil fuel-fired power plants by approximately 30 percent below 2005 levels by 2030. To accomplish this goal, the plan sets binding, state-specific CO_2 emission reduction targets that reflect the degree of emissions reductions achievable through the application of the "best system of emission reduction" or BSER. In determining BSER, EPA conducts a technology review that identifies what systems for emission reductions exist and how much they reduce targeted air pollution.

In its Clean Power Plan, EPA defines the term "system" broadly to include measures that are "beyond the fence-line" of affected power plants. This is because the highly interconnected nature of the electric system lends itself to a much broader range of controls. Here, EPA has determined that BSER includes not only upgrades and operational changes that could be made at plants themselves, but also measures such as: re-dispatch from higher-emitting resources like coal to lower-emitting resources like natural gas combined-cycle (NGCC) units, increased renewable energy deployment, and increased demand-side energy efficiency. These measures—called "building blocks" by EPA—reduce emissions at fossil fuel power plants by lowering their total required output of electricity.

In order to meet the emission reduction goals set by EPA, states must develop plans that will reduce their average CO_2 emission rate at affected generating units from a 2012 baseline rate to a lower target rate by 2030. In its proposed Clean Power Plan, EPA gives states significant flexibility to determine how to meet the emission rate targets set for them:

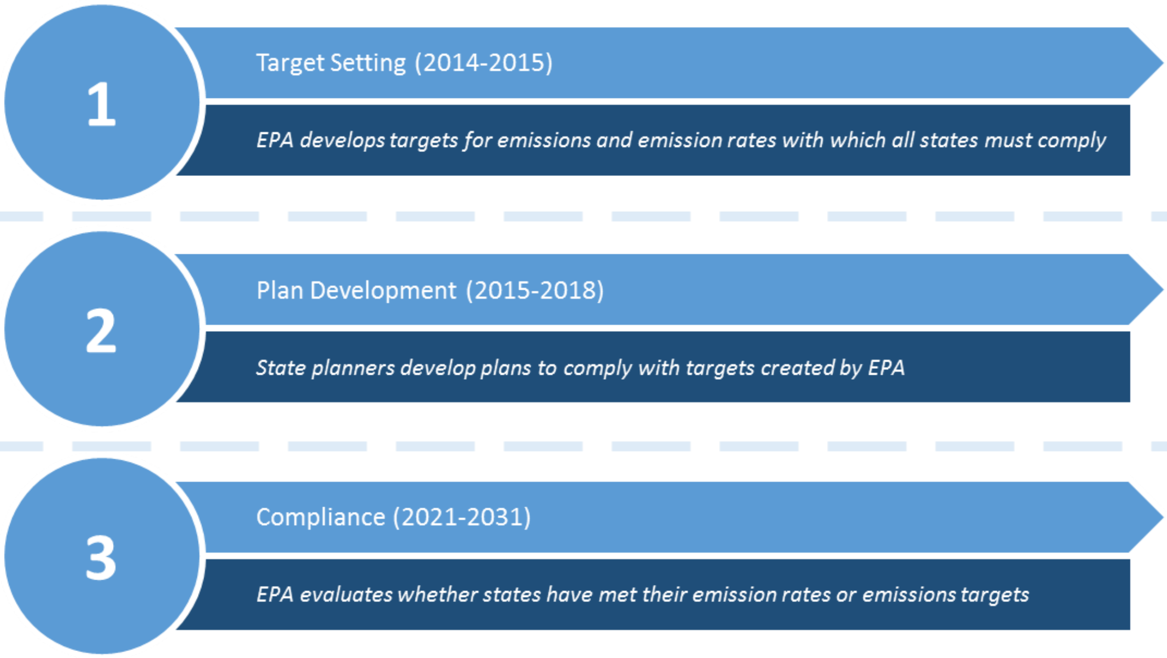
- States may follow EPA's building-block emission-reduction measures or come up with additional and/or alternative measures for reducing CO_2.
- States may adopt the emission-rate-based target set by EPA or convert their rate-based target to the comparable mass-based target.
- States may choose to comply singly or in collaboration with other states.

The focus of this report is the exploration of potential cost savings when states choose to comply with the Clean Power Plan through collaboration with other states. Here, we review existing multi-state cooperation mechanisms, model the potential impacts of different combinations of states complying collaboratively using Synapse's Clean Power Plan Planning Tool (CP3T), and identify key challenges for states that choose to work together to comply with the Clean Power Plan.

Clean Power Plan targets

To comply with the Clean Power Plan, states must meet either a specific CO_2 emission rate or a total CO_2 emissions target over the ten-year compliance period from 2020-2030. Within the Clean Power Plan, there are three "moments" in which emission rates and/or total 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 the initial setting of targets, which, as described above, is the determination of what overall level of CO_2 reductions can be achieved in each state using the four building blocks identified by EPA.

The second moment is in planning for compliance. In this step, state planners develop strategies for their states to comply with the targets set out by EPA. Because states are free to develop their own approaches for complying with the targets, they must demonstrate to EPA that the projected emission rates and/or total emissions of their chosen strategy will meet the Clean Power Plan goals. This report focuses on multi-state compliance in this second moment: compliance planning. For a more detailed discussion of compliance planning and the role of consumer advocates as stakeholders in this process see Synapse's April 2015 report for NASUCA, *Best Practices in Planning for Clean Power Plan Compliance: A Guide for Consumer Advocates.*[1]

The final moment in which emission rates and/or total emissions are calculated is in retrospectively determining compliance. This occurs both over the interim compliance period (2020-2029) and in the final compliance year (2030). This calculation involves the state air agency and EPA evaluating emissions and emission rates within each state to see if the original targets (calculated in the first moment) have been achieved. Here, EPA assesses whether states' compliance plans succeeded in achieving the targets set in the Clean Power Plan.

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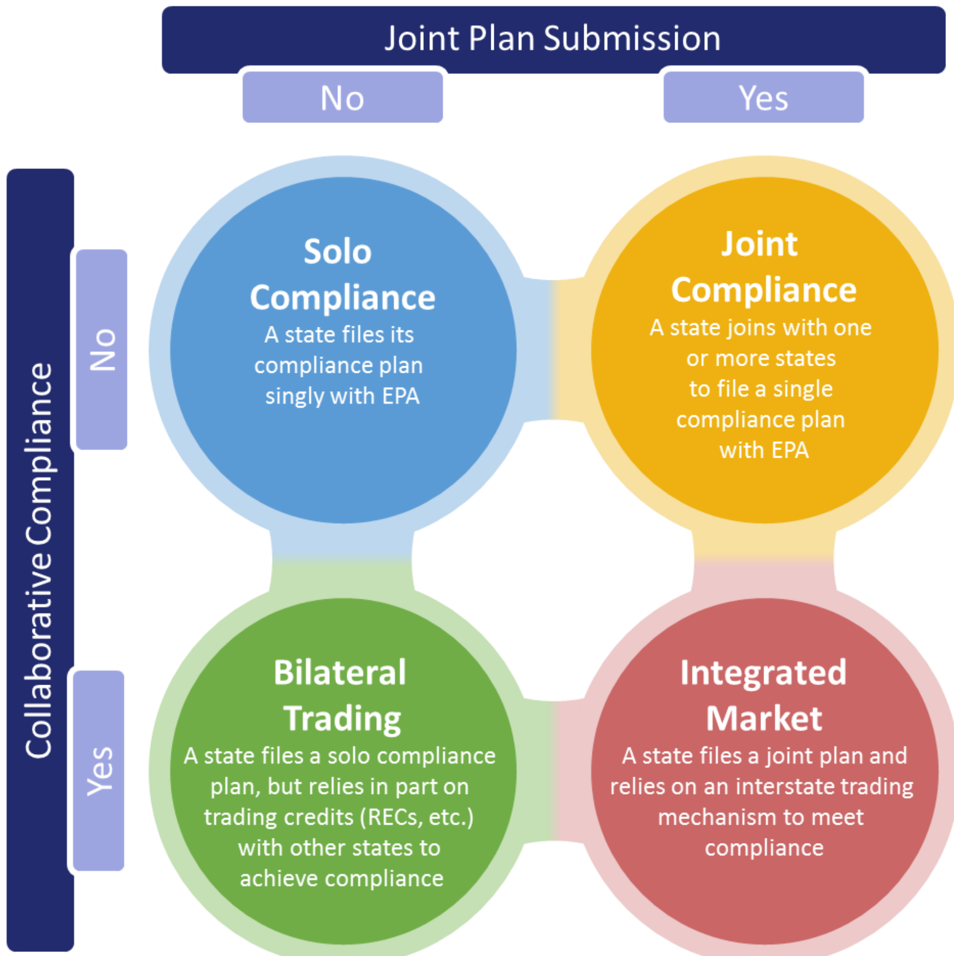
[1] Wilson, et al. (2015). Available at: http://synapse-energy.com/project/clean-power-plan-reports-and-outreach-national-association-state-utility-consumer-advocates.

Complying singly or collaboratively

Once the Clean Power Plan is finalized (now anticipated in "mid-summer" 2015), states will develop and submit plans laying out how they will meet the 2030 emission targets and demonstrate interim progress between 2020 and 2029. With flexibility as a guiding principle, EPA's proposed rule includes a variety of compliance options for collaboration with other states, with differences along at least two dimensions: (1) joint submission of plans, and (2) interstate markets (see Figure 3).

Figure 3. State compliance planning collaboration options



It is important to recognize that despite the flexibility offered in the Clean Power Plan, states' compliance strategies must, among other things, still meet four general criteria 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 emissions performance from affected sources must be quantifiable and verifiable ("quantifiable" means it can be reliably measured, using technically sound methods, in a manner that can be replicated, and "verifiable" means adequate monitoring, recordkeeping, and reporting requirements are in place to enable the state and EPA to independently evaluate, measure, and verify compliance); and
- Fourth, the state plan must include a process for state reporting of plan implementation at the level of the affected entity and state-wide CO_2 emission performance outcomes, and also a process to implement corrective measures if the initial measures fail to achieve the expected reductions.

These requirements are standard to all Clean Air Act compliance planning and ensure the integrity of the program is not lost in the otherwise broad flexibility offered by the Clean Power Plan.

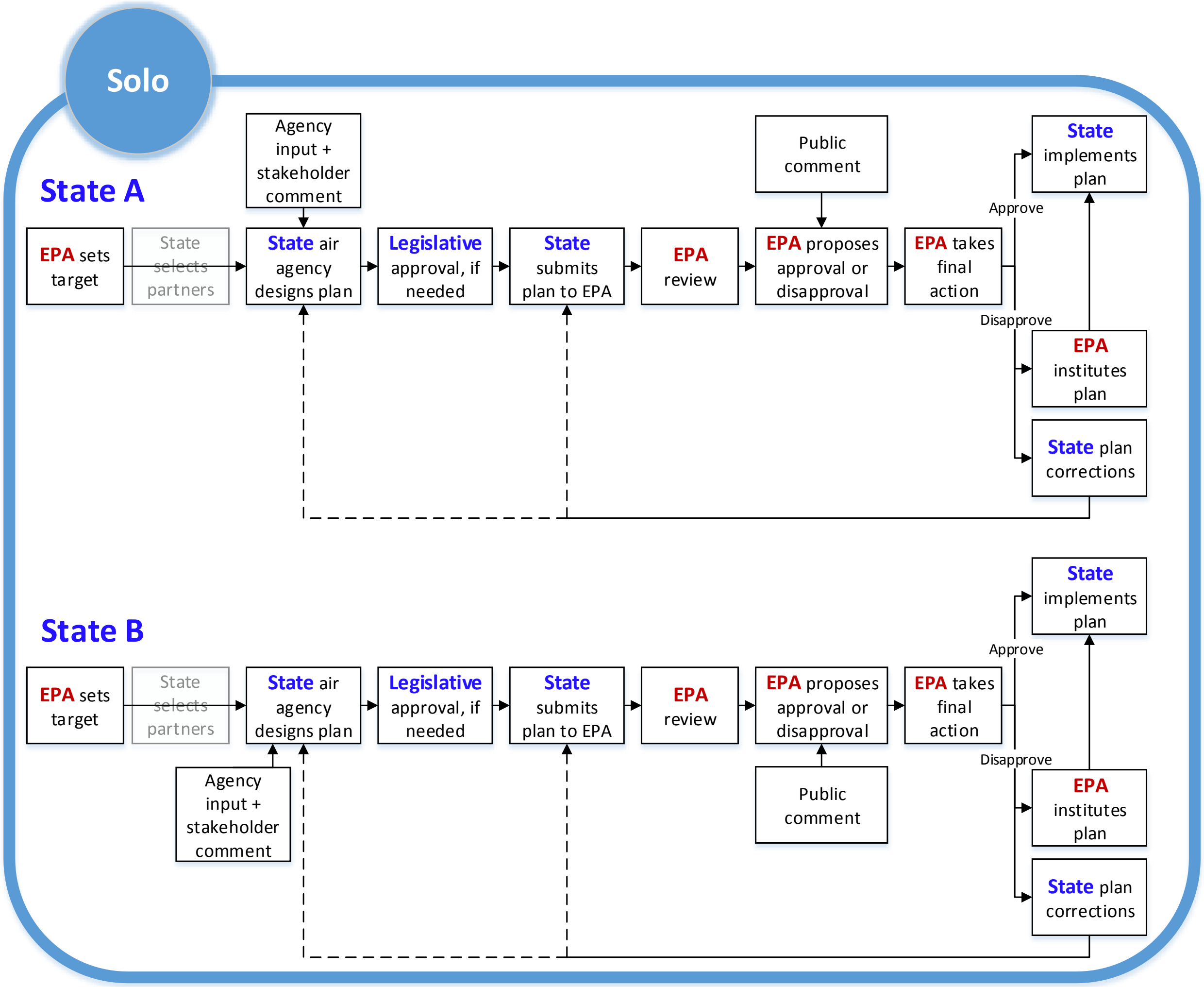
Solo compliance

States may choose to draft a compliance plan on a solo basis, without relying on the actions of other states (referred to as "solo compliance"). Under this approach, the state's air quality agency would work with other relevant state agencies and stakeholders to develop a state-focused strategy for meeting the targets set by EPA.

The compliance plan development process must be open to all interested parties and must include at least one public hearing to present the state's preferred strategy. Key stakeholders, such as industry, consumer advocates, and members of the general public must be given an opportunity to comment on the draft plan. Depending on the measures selected for compliance, legislative approval may be needed before a plan can be submitted to EPA. Once the plan is finalized, the state will submit it to EPA for review. EPA will then propose to approve or disapprove the plan and will take public comment. If EPA ultimately approves the plan, then it will become federally enforceable and the state must implement it. If EPA disapproves the plan for failing to meet the required criteria, the state has an opportunity to fix it. If the state does not adequately correct the plan, EPA will institute a federal plan which the state must implement.

Figure 4 below illustrates the process for plan development that states developing solo compliance plans would go through.

Figure 4. Solo plan development process for two states complying singly and separately



A state that chooses to develop a plan limited in geographic scope to its own boundaries must demonstrate that it will achieve its emission target based solely on its own actions. While a solo compliance approach may be more straightforward than other options, it will also limit the scope and range of compliance options available to a state and may limit the degree to which the state can take advantage of beneficial interstate efficiencies.

Bilateral trading

EPA's proposed rule allows for several different approaches to multi-state compliance. In a bilateral trading approach, states submit individual compliance plans that include reliance on interstate trading programs developed in coordination with other states. The plan development process here would be similar to that in the solo compliance plan process, except that states would work together to design one or more trading mechanisms to use for compliance in their states. In this approach, each state's individual compliance plan takes into account trading mechanisms to buy or sell commodities such as renewable energy certificates (RECs), energy efficiency credits, CO_2 credits, or some other type of tradable certificate for emission reduction.

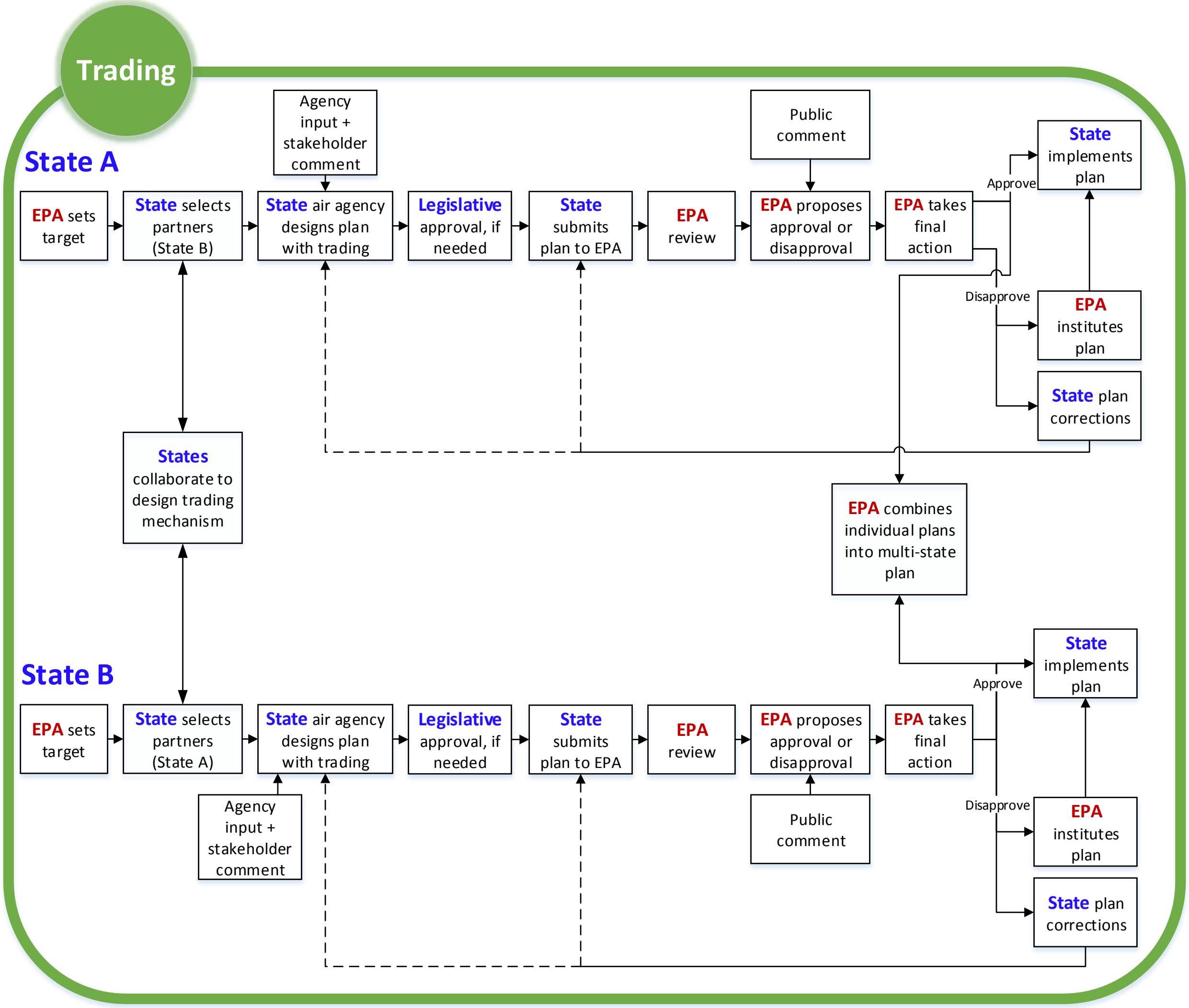
Trading mechanisms can take one of two main forms: (1) REC-like certificate trading, or (2) "RGGI-like" allowance trading. In Section 4, we review several existing mechanisms for interstate cooperation in complying with emission standards, among these REC trading and the Northeast's Regional Greenhouse Gas Initiative (RGGI). Trading for Clean Power Plan compliance could resemble either of these precedents:

- ***REC-like certificate trading***: Certificates (for renewable generation, energy efficiency credit, CO_2 reductions, or Clean Power Plan over-compliance) are bought and sold on an open market. Neither the amount nor the price of certificates in the market is planned—both are set dynamically in the market. Centralized certificate registration and tracking prevents sales of invalid (unverified) certificates or sale of a single certificate to multiple buyers.

- ***"RGGI-like" allowance trading***: States participating in this mechanism set a cap on annual electric-sector CO_2 emissions and agree on a state-by-state distribution of proceeds from the market. Electric generators purchase available CO_2 allowances quarterly in an auction, and may only emit tons of CO_2 for which they have purchased allowances. The allowance price is set dynamically in this market, and proceeds are distributed to states to spend as designated by their individual legislatures. Allowance trading systems, like other CO_2 price mechanisms, may be applied at the regional transmission organization (RTO) level but need not be. RGGI, for example, includes states in three RTOs.

The individual plans developed in each state would need to demonstrate how participation in these trading programs would facilitate the state's compliance with the Clean Power Plan. Each state's plan would undergo public scrutiny and legislative approval (which would probably be necessary to enable participation in an interstate trading program) and would be submitted to EPA for review just as with solo plans. EPA will then propose to approve or disapprove the plans, giving the public another chance to comment. Finally, EPA will take final action to either approve or disapprove the plan. If approved, these individual plans would be treated as a form of multi-state compliance by EPA. If disapproved, the state can work to correct the plan or EPA will institute a federal plan that the state must implement (see Figure 5).

Figure 5. Bilateral trading plan development process

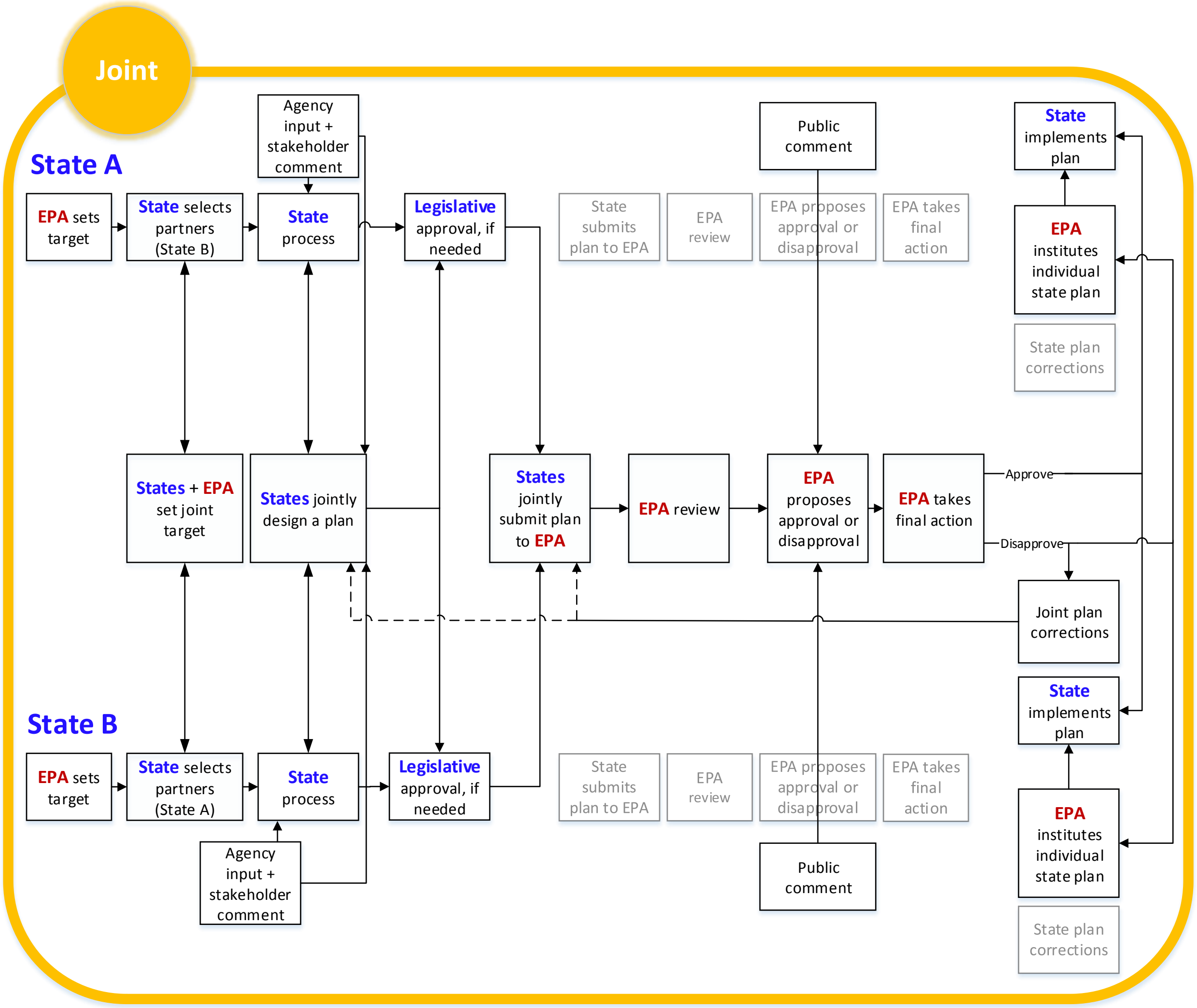


Using the "trading compliance" approach, multiple states share resources without entering into a complex, multi-state compliance planning process. While the proposed Clean Power Plan did not include details of exactly how trading compliance plans would work, we have laid out what we believe is a reasonable interpretation of what that type of individual but coordinated compliance planning process might look like. Guidance will be needed from EPA in the final rule to help states in the development of this compliance option. States trading REC-like certificates or participating in a "RGGI-like" initiative could choose to submit joint compliance plans but would not be obligated to, as long as they can adequately demonstrate the emission reduction benefits of trading in their individual compliance plans.

Joint submittal

The Clean Power Plan allows multiple states to collaborate on a single joint plan covering all participating states (referred to as "joint compliance"). The joint compliance approach would require significant harmonization across all participating states to develop a single, coordinated strategy for submittal to EPA (see Figure 6).

Figure 6. Joint submittal plan development process for two states complying under one plan



First, a state would determine with which other states it makes sense to join. Once states have formed a partnership, they will need to work together to draft a joint strategy and develop a single plan covering all participating states. The joint plan would require authorization by officials for each of the participating states, including the legislatures, if necessary, and would have the same legal effect as an individual submittal for each state. This process must also provide for stakeholder involvement at both the state and the multi-state levels. Once a joint plan is finalized, the states will submit it to EPA for review. As with the solo compliance plan, EPA will propose to approve or disapprove the plan and the public will be given the chance to comment on EPA's proposed action. If EPA finalizes approval of the joint plan, then it becomes federally enforceable and all participating states must implement it. If EPA disapproves the plan, the states have an opportunity to correct the problems. If they cannot fix the plan, EPA will likely institute individual federal plans for each participating state.

Submitting a joint compliance plan could provide several benefits. It allows states that are filing rate-based plans to take credit for energy efficiency credits for which they would not be eligible under solo compliance. Under joint compliance, the combination of states receives credit for the in-combination-generation share of savings, although states that are net importers of electricity may only receive credit for the in-state-generation share of energy efficiency savings.[2] Joint submittal also makes it possible for states to take advantage of the administrative efficiencies and larger set of compliance options available to the combined states but, at the same time, the requirement for all involved states to produce a single governing document may present significant challenges.

Integrated markets

The integrated markets approach to Clean Power Plan compliance combines trading in certificates or allowances with joint plan submittal. Coordinated filing of a single compliance plan for multiple states may or may not be necessary for demonstrating emission reductions from trading. Using the REC-like trading mechanism, joint submittal may prove superfluous as long as EPA does not require that states provide evidence that sufficient certificates will be available for sale. Using the "RGGI-like" trading mechanism, however, joint submittal might be a useful way to demonstrate the existence of a functioning market for allowances (see Figure 7).

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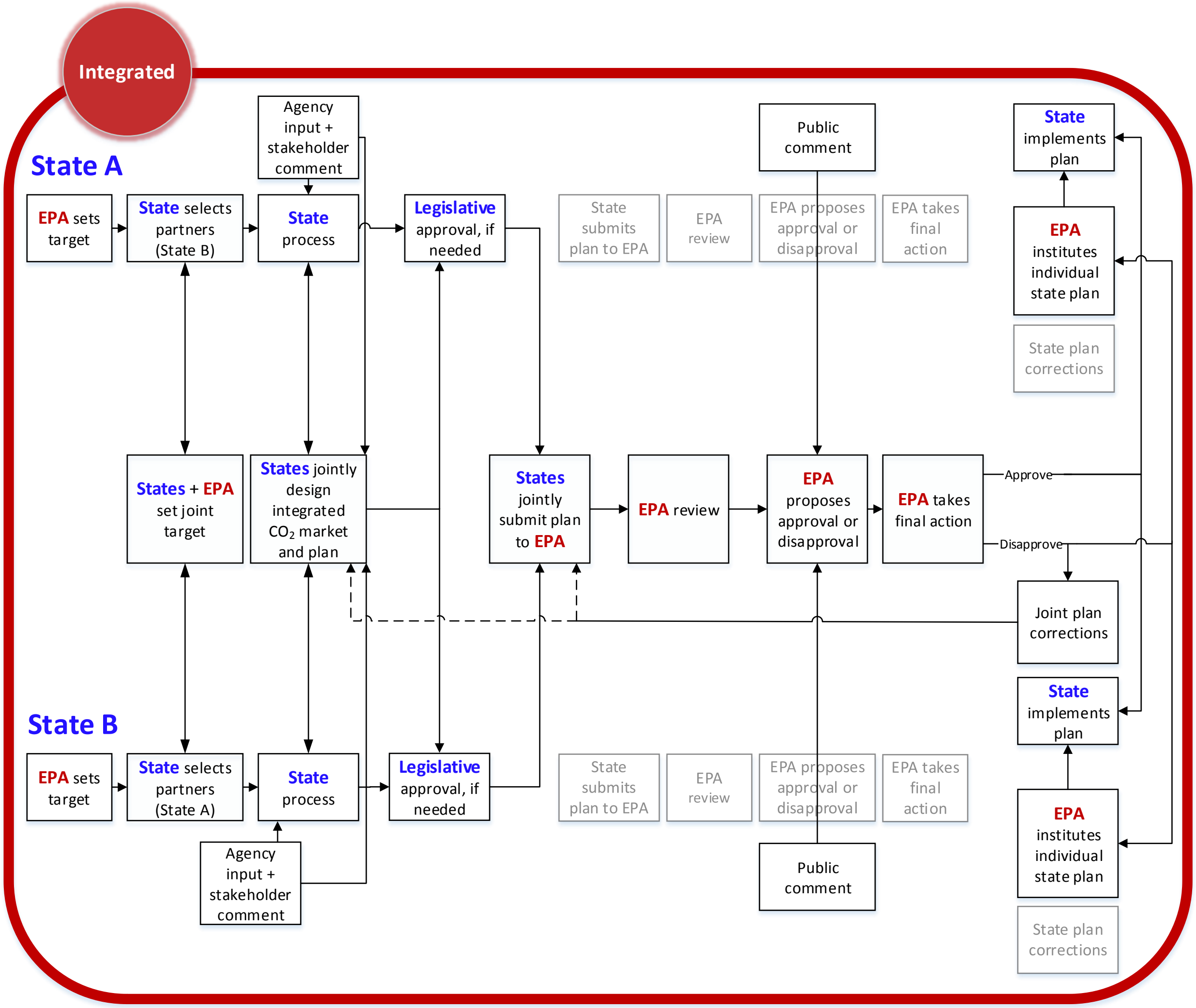
[2] For a more detailed explanation see Stanton, E. A., S. Jackson, B. Biewald, M. Whited. Nov. 2014. Final Report: Implications of EPA's Proposed "Clean Power Plan." Synapse Energy Economics for the National Association of State Utility Consumer Advocates. Available at: http://www.synapse-energy.com/sites/default/files/Final%20Report%20-%20Implications%20of%20EPAs%20Proposed%20Clean%20Power%20Plan%2014-026.pdf.

Figure 7. Integrated market plan development process for two states complying under one plan



In this report, we review existing cooperative multi-state emission-reduction mechanisms, model the potential impacts of different combinations of states complying both singly and collaboratively using Synapse's Clean Power Plan Planning Tool, and identify key challenges for states that choose to work together to comply with the Clean Power Plan. We model several combinations of states and compliance strategies under solo compliance, bilateral trading, joint submittal, and integrated market plan options in order to shed light on the cost-effectiveness of different approaches to Clean Power Plan compliance.

3. LEVERAGING EXISTING COOPERATION BETWEEN STATES

Interstate collaboration on emission reduction need not be an insurmountable obstacle to compliance with the Clean Power Plan; in fact, it has been going on in the context of both electricity planning and air quality management for years. Electricity knows no state boundaries and is commonly dispatched across multi-state regions. Likewise, air pollution is blind to state lines, and numerous interstate trading programs have been developed to address emissions on a regional basis. Below, we describe several ways in which states are already working with electricity planners and environmental agencies across state lines to deliver electricity and reduce air pollution, including the following:

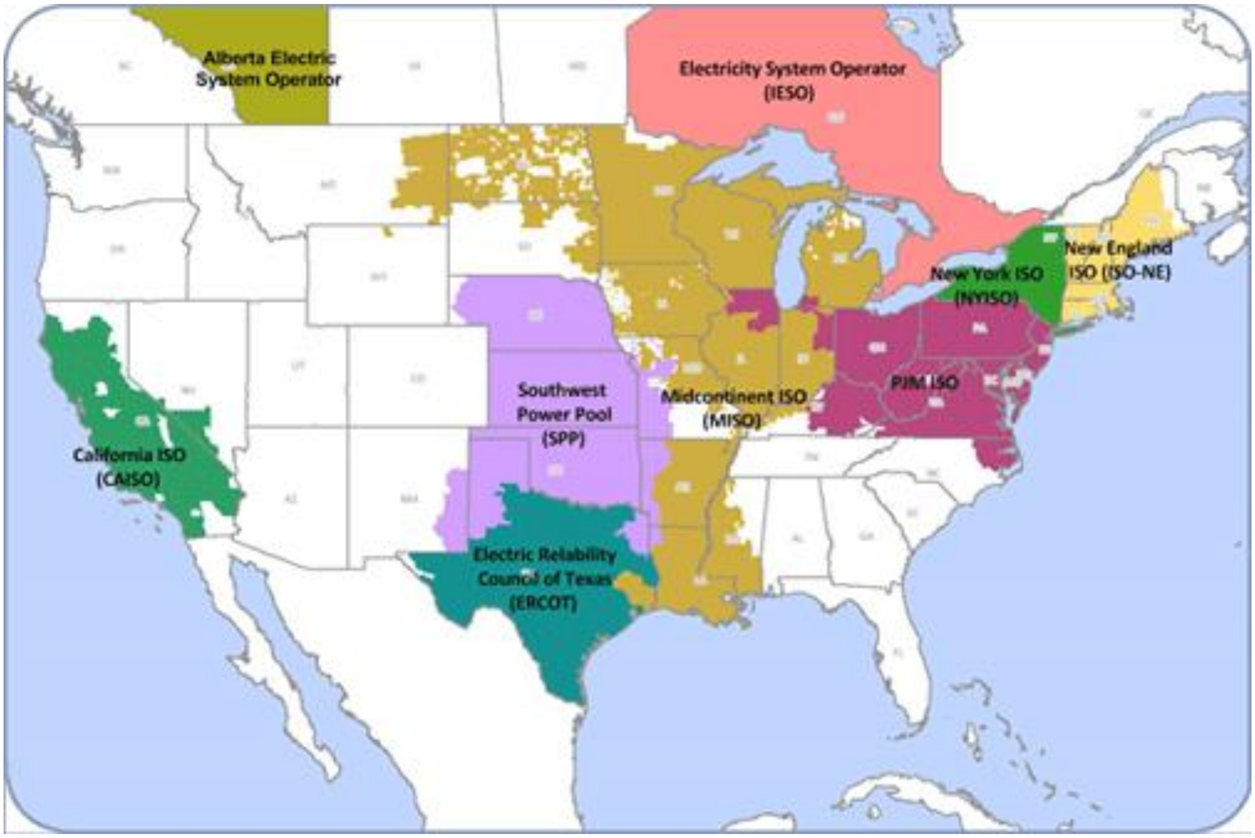
- Cooperating with regional transmission organizations and independent system operators;
- Working with multi-state, vertically integrated utilities;
- Trading RECs across state boundaries; and
- Participation in interstate trading programs aimed at reducing acid rain, ozone, particulate matter, mercury, and greenhouse gases from the electric sector.

Working across state lines frequently presents challenges, but states can draw upon their experiences with these many existing programs and relationships to guide development of coordinated multi-state compliance strategies for the Clean Power Plan.

3.1. RTOs and ISOs

Regional transmission organizations (RTOs) and independent system operators (ISOs) are independent non-profit organizations established to manage and operate the bulk electric power systems across many regions of the United States and Canada. Their primary job is to plan the electric system to ensure the reliability of the grid and to optimize the supply and demand of electricity through wholesale power markets. There are 10 RTOs/ISOs in North America (three are located primarily in Canada but do interconnect with U.S. states) that manage the generation and transmission of electricity for more than two-thirds of U.S. consumers across 35 states (see Figure 8).

Figure 8. RTO/ISO regions



Source: Map reproduced from Federal Energy Regulatory Commission. Available at: http://www.ferc.gov/industries/electric/indus-act/rto.asp

Note: The New Brunswick ISO is not shown on this map. This ISO covers the Maritime Provinces and parts of eastern Maine.

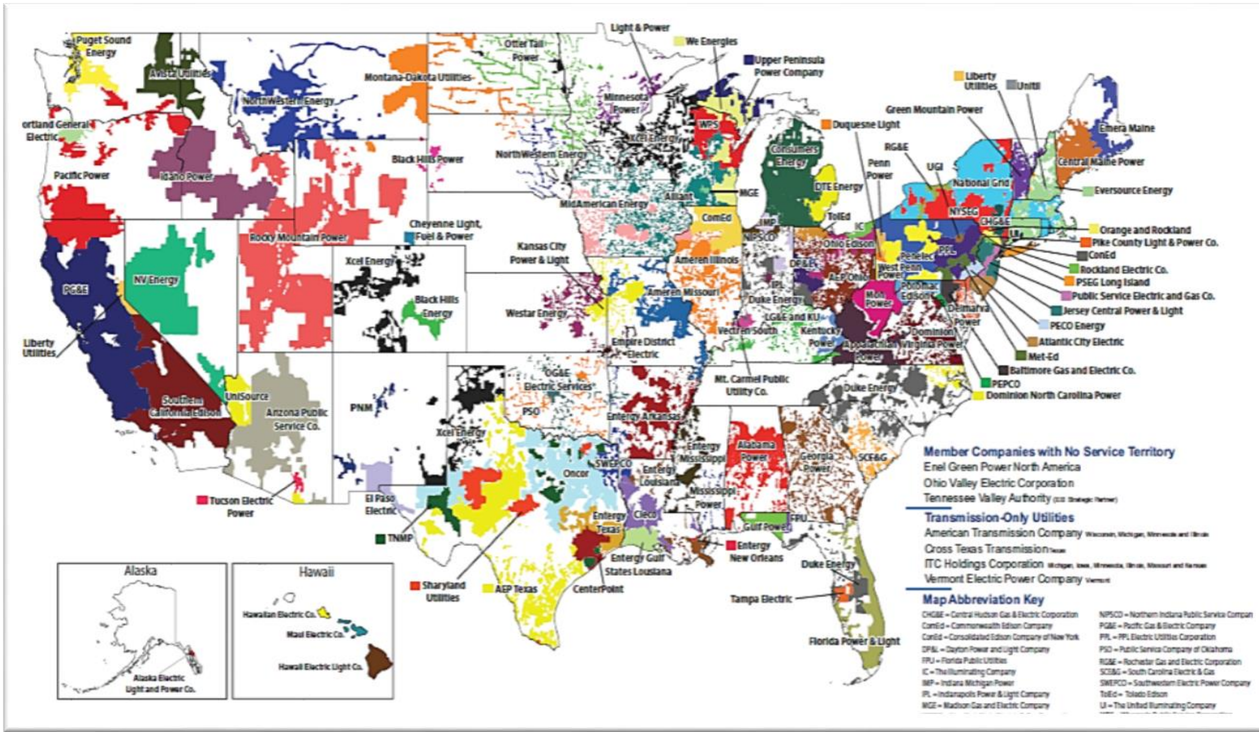
RTOs and ISOs have long worked with states and other stakeholders to ensure the reliable delivery of electricity to consumers. They coordinate this complex exchange of electricity across state borders while taking into account the compliance requirements of a multitude of individual state policies regulating everything from air and water quality to renewable portfolio standards. In the PJM region, for example, where some states participate in a regional greenhouse gas emission trading program (described below) and other states do not, the RTO is able to seamlessly integrate the generation covered by the trading program with the rest of the system.

3.2. Multi-state, vertically integrated utilities

In regions of the country that are not part of an RTO, electricity systems are operated by individual utilities or utility holding companies. In these areas, individual utilities act as the primary planners for and dispatchers of the electric systems they oversee. They generally hold a monopoly on the production and sale of power.

In many cases, these utilities have service territories that span two or more states and often include parts of multiple states (see Figure 9).

Figure 9. Electric utility service territories



Source: Map reproduced from Edison Electric Institute U.S. Member Company Service Territory. Available at: http://www.eei.org/about/members/uselectriccompanies/Documents/EEIMemCoTerrMap.pdf

Utilities such as American Electric Power, Berkshire Hathaway Energy, Entergy, FirstEnergy, Southern Company, and Xcel Energy produce and distribute power across dozens of states to millions of consumers. These utilities must navigate the regulatory processes for each of the states in which they operate and must integrate into their system plans any regulatory requirements that impact their power facilities.

3.3. Interstate REC trading

Many states have adopted regulatory mandates to increase production of energy from renewable sources such as wind, solar, and other alternatives to fossil and nuclear electric generation. Twenty-nine states have adopted renewable portfolio standards (RPSs) and eight more have adopted voluntary renewable energy targets. These programs generally require a state's utilities (and in some states, municipalities and electric cooperatives) to provide a certain percentage of their electric sales from eligible renewable resources.

Table 1. Existing multi-state air quality programs and measures

Program	Lead Agency	States Included	Pollutant(s) Covered	What is Traded?
Mandatory RPS policies	States	AZ, CA, CO, CT, DE, HI, IL, IA, KS, ME, MD, MA, MI, MN, MO, MT, NV, NH, NJ, NM, NY, NC, OH, OR, PA, RI, TX, WA, WI	N/A	RECs
Voluntary renewable targets	States	IN, ND, SC, SD, OK, UT, VA, VT	N/A	RECs

Most states with RPS programs include REC trading as a mechanism by which to track the amount of renewable power being sold. Typically, each megawatt-hour of renewable energy generated is equal to one REC. RECs must be redeemed to show compliance with RPS standards and can be sold in conjunction with the underlying energy (RECs are often referred to as an "attribute" of that energy) or separately. Several programs exist to track REC issuance and ownership (e.g., WREGIS in the west, M-RETS and PJM-GATS in the mid-west and PJM, and NEPOOL GIS in New England). These tracking systems help ensure that unverified certificates are not being sold and that a single certificate is not sold to multiple buyers.

Interstate trading of RECs allows RPS requirements to be met with both out-of-state procurement of renewable energy and local renewable generation, which can lower the cost of compliance with the RPS by creating a market for RECS and therefore the most efficient and cost-effective compliance solutions. In fact, all states with RPS requirements allow REC trading across state lines, as long as the characteristics of the out-of-state RECs match the requirements of the home state's RPS. For instance, Connecticut requires that 20 percent of its RPS be met with Class I RECs, which are limited to certain types of renewable resources, including solar, wind, and fuel cells. Therefore, any RECs purchased from outside the state for compliance with the 20-percent Class I requirement would have to verify that they were generated from eligible renewable resources.

3.4. Multi-state air quality programs and measures

States also have experience with interstate cooperation to address air quality issues. Existing programs aimed at reducing acid rain, ozone, particulate matter, mercury, and greenhouse gases from the electric sector all allow states to work together to cost-effectively solve serious environmental challenges. Multi-state compliance with the Clean Power Plan can build off of the experience states have with existing programs (see Table 2).

Table 2. Existing multi-state air quality programs and measures

Program	Lead Agency	States Included	Pollutant(s) Covered	What is Traded?
Cross State Air Pollution Rule (CSAPR)	EPA	AL, AR, FL, GA, IL, IN, KS, KY, LA, MD, MI, MN, MS, MO, NE, NJ, NY, NC, OH, OK, PA, SC, TN, TX, VA, WV, WI	NO_x, SO_2	NO_x and SO_2 allowances
Regional Haze Backstop Trading Program	EPA	NM, UT, WY	SO_2	SO_2 allowances
Title IV Acid Rain Program	EPA	All	SO_2, NO_x	SO_2 and NO_x allowances
Regional Greenhouse Gas Initiative (RGGI)	States	CT, DE, ME, MD, MA, NH, NY, RI, VT	CO_2	CO_2 allowances
Western Climate Initiative	CARB, Québec	CA, Québec	CO_2	CO_2 allowances

Other electric-sector programs have been replaced over the years by new approaches but may still serve as examples of interstate cooperation where states had the flexibility to reduce emissions through cost-effective, market-based approaches (see Table 3).

Table 3. Expired multi-state air quality programs and measures

Program	Lead Agency	States Included	Pollutant(s) Covered	What is Traded?
Clean Air Interstate Rule (CAIR) *(replaced by CSAPR)*	EPA	AL, AR, CT, DE, FL, GA, IL, IN, IA, KY, LA, MD, MI, MS, MO, NJ, NY, NC, OH, PA, SC, TN, TX, VA, WV, WI	NO_x, SO_2	NO_x and SO_2 allowances
NO_x Budget Trading Program *(replaced by CAIR)*	EPA	CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT, VA	NO_x	NO_x allowances
Ozone Transport Commission (OTC) Trading Program *(replaced by NO_x Budget Trading Program)*	EPA & OTC States	CT, DE, DC, ME, MD, MA, NH, NJ, NY, PA, RI, VT, VA	NO_x	NO_x allowances
Clean Air Mercury Rule (CAMR) *(replaced by MATS)*	EPA	All	Mercury	Hg allowances

Most of these programs were established in response to Clean Air Act requirements to reduce emissions from the electric sector. They were either designed and authorized directly by EPA as part of the implementation of specific rules or were created by affected states as innovative approaches to reducing emissions. We briefly describe each of these programs below as a means of highlighting the many ways in which states are already cooperating to reduce emissions from the electric sector.

Multi-state trading programs that are currently in place include:

- **Cross State Air Pollution Rule (CSAPR).** This rule requires upwind states to reduce electric sector emissions of nitrogen oxides (NO_X) and sulfur dioxide (SO_2) that significantly contribute to a downwind state's particulate matter and ozone non-attainment problems. The mechanism EPA uses to reduce emissions under CSAPR is a cap-and-trade program that creates a market for NO_X and SO_2 by setting emissions limits—or budgets—for each pollutant in each state. EPA then allocates allowances to each covered power plant in those states (states may substitute their own allocations in place of EPA's default allocations). The budgets can be met in whatever way the state and covered sources see fit, including unlimited trading between sources in that state. Interstate trading of emission allowances is allowed, but the rule includes ''assurance provisions'' designed to ensure that individual states' emissions do not exceed the states' respective emissions budgets by more than specified ''variability limits.''

- **Regional Haze Backstop Trading Program.** The Regional Haze Rule, released in July 1999, requires states to develop plans for reducing emissions that impair visibility at pristine areas such as national parks. To comply with the rule, the Western Regional Air Partnership (WRAP) designed, and EPA approved, a voluntary regional compliance strategy that established regional milestones for SO_2—a major contributor to haze in the west. The milestones establish the level of emission reductions each state is expected to meet. WRAP also designed a backstop trading program that would take effect should any of the participating sources fail to meet the milestones through this voluntary program. In this case, the states trigger the backstop trading program. This backstop program would implement a regulatory emissions cap for the states, allocate emissions allowances to the affected sources based on the emissions cap, and require the sources to hold sufficient allowances to cover their emissions each year. So far, emissions have stayed well below the milestones and the backstop trading program has not been triggered.
- **Title IV Acid Rain Program.** This program requires the electric sector to significantly reduce emissions of SO_2 and NO_X, which are precursors to the formation of acid rain. The Acid Rain Program (ARP) included the first national cap and trade program in the country. The SO_2 program set a permanent cap on the total amount of SO_2 that may be emitted by electric generating units (EGUs) in the contiguous United States, and then allocated allowances based on historical fuel consumption and specific emission rates. Units that began operating in 1996 or later are not allocated allowances and must purchase allowances to cover their SO_2 emissions. Each allowance represents one ton of SO_2. Allowances may be bought, sold, and traded by any individual, corporation, or governing body, including brokers, municipalities, environmental groups, and private citizens. NO_X emissions are not capped under the ARP and reductions are achieved through a program that is closer to a traditional, rate-based regulatory system.
- **Regional Greenhouse Gas Initiative (RGGI)**. RGGI is a cap-and-trade program for greenhouse gases from power plants in the northeastern United States. Under RGGI, the participating states set a declining cap on greenhouse gas emissions and establish emissions budgets for each state. The Memorandum of Understanding signed by each participating state requires that at least 25 percent of the proceeds from the sale of allowances be reinvested into energy conservation or renewable energy. Most states sell nearly all their emission allowances through auctions and invest the proceeds back into consumer benefit programs.
- **Western Climate Initiative (WCI)**. The WCI started out as a collaboration of seven western states and four Canadian provinces working together to identify, evaluate, and implement

emissions trading policies to tackle climate change at a regional level. Six of the U.S. states dropped out of the WCI; however, California and the Canadian provinces of Québec, Manitoba, British Columbia, and Ontario continued working together to harmonize each of their emissions trading programs. In 2013, California's cap-and-trade program, which was established as part of the state's landmark legislation to reduce total greenhouse gas emissions in the state to 1990 levels by 2020, was linked with Québec's cap-and-trade system, which was established in December 2011 in order to meet the province's goal of reducing greenhouse gases by 20 percent below 1990 levels by 2020. California's program establishes an overall limit on greenhouse gas emissions from capped sectors and emission allowances are distributed by a mix of free allocation and quarterly auctions. The free allowances, which initially accounted for approximately 90 percent of a facility's overall emissions, decline over time. Unlike all other trading programs mentioned above, California's is the first cap-and-trade program to cover multiple sectors, including electric generators, industrial facilities, and fuel distributors. Québec's cap-and-trade program is very similar to California's. Allowances (called emission units) are distributed by a mix of free allocation and quarterly auctions, with free allowances declining by 1-2 percent a year. Electricity producers and fuel distributors do not receive any free allowances under Quebec's program. It does, however, allow offset credits from sectors not subject to the cap to be used for compliance.

Past multi-state efforts to reduce emissions through trading that may serve as examples of interstate coordination include:

- **Clean Air Interstate Rule (CAIR).** CAIR was the predecessor of the Cross State Air Pollution Rule and included a cap-and-trade policy to reduce the SO_2 and NO_X emissions of 27 eastern states and the District of Columbia. CAIR accomplished this by creating three separate trading programs for power plants: an annual NO_X program, an ozone season NO_X program, and an annual SO_2 program. Unlike CSAPR, however, CAIR allowed for the inclusion of non-EGU sources in the trading scheme. The U.S. Court of Appeals for the District of Columbia found CAIR to be legally deficient in 2008. One of the reasons for this finding was that it did not set state-specific emission requirements.

- **NO_x Budget Trading Program.** The NO_X Budget Trading Program (NBP), a precursor to CAIR, was a cap-and-trade program created to reduce the regional transport of NO_X emissions from power plants and other large combustion sources in the eastern United States. EPA designed a model trading program, including provisions for applicability, allocations, monitoring, banking, penalties, trading protocols, and program administration, which states could adopt. Under the NBP, EPA determined regional NO_X emission budgets and divided them among the states. States were free to choose how to meet their budget obligations and which sources would be covered. All states chose to include electric power generators and large industrial boilers in the trading program and many included additional sources as well. Many states also included set-asides for new units and energy efficiency and renewable programs in their trading rules. In most states, allowances were given away for free, but a few states in the NBP also auctioned a small portion of the allowances. One notable feature of the NBP is the compliance supplement pool. The compliance supplement pool was a store of allowances that each state could use if a source complied early or in the event that reliability was threatened.

- **Ozone Transport Commission (OTC) NO_x Budget Program.** The Ozone Transport Commission (OTC) NO_X Budget Program was implemented from 1999 to 2002 and was replaced by the NO_X Budget Trading Program in 2002. EPA helped the OTC design its Budget Program, which was an allowance trading program designed to reduce summertime NO_X emissions from electric utilities and large industrial boilers in the northeast United States. The OTC capped summertime NO_X emissions and each participating state was responsible for adopting regulations, allocating NO_X allowances, and ensuring compliance. EPA was responsible for approving states' regulations and tracking allowances and emissions.
- **Clean Air Mercury Rule (CAMR).** Under Section 111 of the Clean Air Act, EPA established standards of performance limiting mercury emissions from new and existing coal-fired power plants. It then created an optional market-based cap-and-trade program to reduce nationwide utility emissions of mercury. Under CAMR, EPA determined a national cap for mercury emissions and set emission reduction requirements for each state by distributing the national cap among the states in the form of mercury budgets. States were to determine how those budgets would be allocated. New sources, which also had to meet the New Source Performance Standards, were included under the national cap and therefore had to hold allowances equal to their emissions. Before it could be implemented, CAMR was struck down by the U.S. Court of Appeals for the District of Columbia for reasons unrelated to the design of the trading program.

The programs described above demonstrate a wide range of designs a group of states may choose for a trading program. Common to all of them is recognition of the importance of accurate and continuous emission monitoring. Robust monitoring and reporting requirements are prerequisites for flexibility and they are the cornerstone of accountability in any cap-and-trade program. Such requirements help ensure compliance, validate the integrity of the trading program, and facilitate program administration.

3.5. Multi-state collaboration and the Clean Power Plan

Several recent studies have addressed the potential costs and benefits associated with multi-state approaches to Clean Power Plan compliance. Some analyses, such as NERC's November 2014 study, *Potential Reliability Impacts of EPA's Proposed Clean Power Plan*, focus mainly on the two-year extension states receive if they use a multi-state approach to compliance.[3] Other studies are more similar to this report—modeling Clean Power Plan compliance with the goal of examining the costs and benefits related to multi-state collaboration.

[3] Available at http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/Potential_Reliability_Impacts_of_EPA_Proposed_CPP_Final.pdf.

An April 2015 follow-up to the NERC report cited above uses the AURORAxmp model to examine multi-state compliance across six regions of the United States in two scenarios of Clean Power Plan compliance: one in which states comply with their individual targets but allow interstate CO_2 allowance trading, and one in which states comply with aggregated regional targets and allow both interstate CO_2 allowance trading and regional CO_2 prices.[4] The April 2015 NERC study is mainly focused on potential reliability requirements associated with Clean Power Plan compliance and does not quantify the costs or advantages of pursuing one type of multi-state compliance over another or over solo compliance.

A March 2015 report by PJM, entitled *PJM Interconnection Economic Analysis of the EPA Clean Power Plan Proposal*, uses PROMOD to model states in the PJM interconnection under multiple scenarios of Clean Power Plan compliance.[5] Several of these scenarios assume multi-state compliance within the PJM region, while others examine these states' solo compliance. The PJM analysis found that solo compliance is typically more costly than multi-state compliance. These savings are associated with better utilization of least-cost options throughout the entire region under collaborative arrangements—largely a result of the extra costs of multiple single-state CO_2 price policies as compared to a regional, multi-state CO_2 price.

MISO has also released an analysis of multi-state Clean Power Plan compliance that is described in two separate reports: *GHG Regulation Impact Analysis – Initial Study Results* (September 2014) and *Analysis of EPA's Proposal to Reduce CO_2 Emissions from Existing Units* (November 2014).[6] The MISO study uses the EGEAS model to compare the total electric system costs in both scenarios under which Clean Power Plan compliance is achieved on a regional basis, and scenarios in which states comply with the Clean Power Plan using solo approaches. As with the PJM analysis, the MISO study finds significant savings through regional compliance approaches compared to solo approaches. Also, like the PJM study, these savings can largely be attributed to the efficiencies of using a regional CO_2 price versus a state-specific one.

Note that the cost savings attributable to using a regional CO_2 price versus a state-specific CO_2 price cannot be directly compared to any cost savings in our analysis—we assume that a state-specific CO_2 price mechanism will be infeasible for most states (see Section 4.3). We expect that—except for the largest or least interconnected states—single-state CO_2 prices will result in leakage of both generation and emissions out of state. This dynamic could result in one state's Clean Power Plan compliance through increased imports but would, at the same time, increase the CO_2 emissions of its neighbors, casting doubt on the likelihood that this compliance strategy would be approved by EPA.

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[4] Available at http://www.nerc.com/pa/RAPA/ra/Reliability%20Assessments%20DL/Potential%20Reliability%20Impacts%20of%20EPA%E2%80%99s%20Proposed%20Clean%20Power%20Plan%20-%20Phase%20I.pdf

[5] Available at http://www.pjm.com/~/media/4CDA71CBEC864593BC11E7F81241E019.ashx

[6] Available at http://www.eenews.net/assets/2014/09/18/document_ew_01.pdf and https://www.misoenergy.org/Library/Repository/Communication%20Material/EPA%20Regulations/AnalysisofEPAProposalReduceCO2Emissions.pdf

4. MULTI-STATE COLLABORATION FOR COMPLIANCE

Synapse evaluated compliance with the proposed Clean Power Plan using illustrative examples of three combinations of states—the Northwest, the Southwest, and Iowa and the Carolinas (see Table 4).[7]

Table 4. State combinations selected for analysis

Northwest	Southwest	Iowa + Carolinas
Idaho Montana Oregon Utah Washington Wyoming	Arizona New Mexico Navajo Tribe Fort Mojave Tribe	Iowa North Carolina South Carolina

For this analysis, Synapse used its Clean Power Plan Planning Tool ("CP3T"). CP3T is an Excel-based spreadsheet tool for performing first-pass planning of statewide compliance with EPA's Clean Power Plan. It is based on the unit-specific data assembled by EPA to create its "building blocks" for target-setting and compliance. CP3T users can adjust fossil unit capacity factors, renewable energy and energy efficiency projections, unit retirements, and 111(b) unit additions for each state. Users can then compare differences in generation, capacity, emissions, emission rates, and costs across created scenarios and EPA's base case.[8]

Our analysis finds that states may achieve limited savings by pursuing multi-state cooperation in their compliance strategies, either through joint compliance, trading REC-like certificates, participating in a "RGGI-like" initiative, or by using a combination of these strategies.

Note that every state and combination is unique in transmission constraints, power purchase agreements, and other complex arrangements not analyzed in our CP3T screening tool. These illustrative examples are intended to illuminate likely patterns in the benefits of different collaborative arrangements for Clean Power Plan compliance—not for use as definitive evidence of the best compliance strategy for any state. Note also that CP3T is not a substitute for electric-dispatch modeling. Best modeling practices for compliance planning require electric-dispatch modeling as well as correct assessment of current conditions in the electric sector, reasonable projections of future conditions, and representation of supply- and demand-side generating alternatives on an equal basis. See Synapse's

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[7] In most of our analyses, we examine North Carolina and South Carolina as states that file joint compliance plans with EPA. In one modeling run, we examine what happens if a joint Carolinas entity trades unbundled RECs with Iowa.

[8] CP3T is available for free at www.cp3t.com.

April 2015 report for NASUCA, *Best Practices in Planning for Clean Power Plan Compliance: A Guide for Consumer Advocates.*[9]

Our CP3T analysis examined compliance with the Clean Power Plan under a variety of circumstances, including several combinations of states, approaches to compliance, and variations in the states' ability to engage in interstate cooperation for emissions reduction. The combinations, and states making up each combination, were selected to portray a broad cross-section of issues including understanding the effects of multi-state compliance in: states with dissimilar renewable technical potentials; states with dissimilar existing resources; states that are major exporters; states that obtain large shares of electricity through imports; and states with utilities that cross state boundaries.

In our CP3T modeling of the Northwest, Southwest, and Iowa-Carolinas combinations, we analyzed states' solo compliance with the proposed Clean Power Plan along with several strategies for multi-state collaboration:

- Joint compliance
- Bilateral trading of REC-like certificates
- Integrated markets that combine joint compliance with "RGGI-like" allowance trading

We compared costs among these various strategies and found that the benefits of multi-state collaboration depend on the particular characteristics of the states involved. Some combinations of states would very likely benefit from one or more of the potential multi-state collaboration strategies. Other states are far less likely to see significant benefits but are unlikely to be harmed.

4.1. Are there benefits to joint submission?

Our analysis demonstrated that even without working together some states may benefit from submitting their Clean Power Plan compliance plans jointly with other states, through certificate trading or an allowance market.

Filing a Clean Power Plan compliance plan jointly may result in savings, depending on the states involved.

Potential cost savings result from:

- **Comparative cost advantage:** States filing jointly can take advantage of differences in the costs of renewables, energy efficiency and other potential compliance options—the larger the difference from one state to the next, the greater the potential cost savings. By taking advantage of resources wherever they are the cheapest, there is the potential for the state combination as a whole to benefit from lower costs in particular areas. For

[9] Wilson, et al. (2015). Available at: http://synapse-energy.com/project/clean-power-plan-reports-and-outreach-national-association-state-utility-consumer-advocates.

example, cost differences in renewables stem from capacity factors (how much of the time the resource is generating electricity), wind speeds, available insolation for solar PV units, siting opportunities, and political impediments.

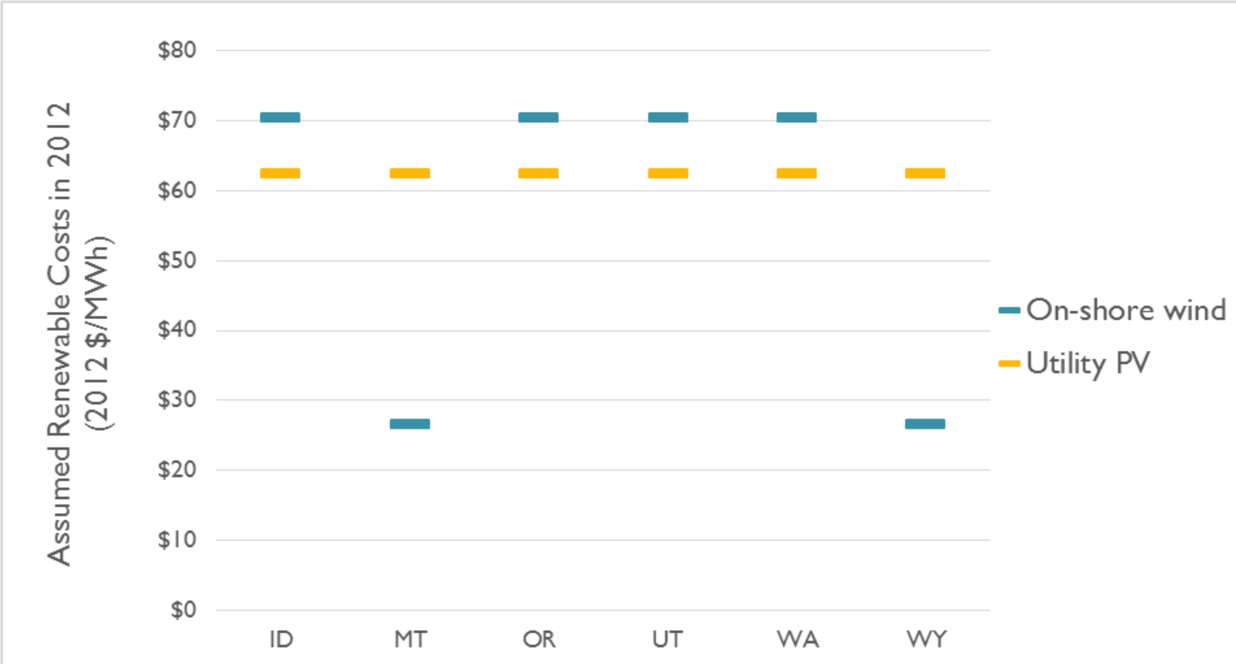
- **Capture of energy efficiency leakage:** Under the proposed Clean Power Plan, states may only count savings from energy efficiency in proportion to the share of electricity produced in state. For example, if a state imports 25 percent of its electricity, under the Clean Power Plan, it may count 75 percent of its savings from energy efficiency; the other 25 percent is assumed to be efficiency gain to the state producing the electricity for import. A state that is a net exporter of electricity can count 100 percent of its savings from energy efficiency towards Clean Power Plan compliance.

  Combinations of states can benefit from capturing this leakage by complying jointly if they: (1) include one or more net importers of electricity; (2) are—when considered jointly—either net neutral or net exporters of electricity; and (3) are electrically interconnected. Combinations with these three characteristics can apply more of the energy efficiency investments to their Clean Power Plan compliance efforts—thus reducing the need for other mechanisms.

- **Administrative efficiencies:** States may achieve some administrative efficiencies by joining together to model possible compliance pathways, submitting a joint compliance plan to EPA, or creating unified systems for compliance review. Note that it is also possible that states may see increased administrative costs by working with other states as air quality administrators, legislators, and other policy-makers from multiple states would be required to find consensus on a number of potentially controversial issues.

Among the three state combinations considered in this analysis, only the Northwest has a large enough diversity in renewables costs within the region to see appreciable benefits from strategic regional siting of renewable generation resources to make an impact on future costs (see Figure 10).

Figure 10. Renewable generation costs for on-shore wind and utility-scale solar in Northwest states in 2012



A joint plan in which Idaho, Oregon, Utah, and Washington count renewables sited in Montana and Wyoming towards their compliance could result in cost savings. In the context of our analysis, however, these savings are small in relation to total electric-system costs.

Savings to Northwest states from complying jointly are approximately 3 percent of total system costs by 2030; these savings include the effects both of advantageous renewables siting and capture of energy efficiency leakage. Because the Northwest consists of five net-electricity exporters and one state—Idaho—with small net imports relative to the size of the combination, any benefits from capturing energy efficiency leakage through joint compliance are likely to be minimal.

The Southwest also consists of three net-electricity exporters and one net importer—New Mexico, which, in 2012, generated 91 percent of its total sales in-state. As in the Northwest, because these states are already claiming all or most of their energy efficiency savings, the Southwest is unlikely to experience benefits from captured energy efficiency leakage by filing jointly.

The Carolinas are highly electrically interconnected and consist of one net-electric importer and one net exporter. In 2012, North Carolina had net imports of 21 TWh or 15 percent of total in-state electric sales, while South Carolina had net exports of 8 TWh, or 9 percent of total in-state electric sales. Filing jointly, the Carolinas would together be a net importer: North Carolina could count 91 percent of its efficiency savings towards compliance (up from 85 percent) but South Carolina could no longer count 100 percent of its savings. Unless combined with other benefits from joint compliance, this is unlikely to be an advantageous collaboration.

Overall, joint submission of compliance plans to EPA is most likely to result in savings when collaborating states: have very different resource potentials and costs; include electricity importing states but together are a net electricity exporter; and can find efficiencies in collaborative approaches to compliance administration.

4.2. Are there benefits to bilateral trading of REC-like certificates?

EPA's proposed rule leaves open the possibility that states may be able to take credit for the emissions reductions associated with REC-like certificates such as bundled or unbundled RECs, energy efficiency credits, or credits for another state's over-compliance with the Clean Power Plan.[10]

States achieve savings from purchasing RECs only when other compliance strategies are more expensive.

For the purposes of Clean Power Plan compliance, RECs, energy efficiency credits, and compliance credits are functionally equivalent—each is a certificate associated with either a MWh of zero-carbon electricity or a one-ton reduction in emissions, depending on the design of the certificate. Any state could potentially sell a maximum number of certificates equal to the difference between actual CO_2 emissions and EPA's mass-based Clean Power Plan target for the state in each year. The cost per certificate may range anywhere from a nominal fee of $1 per certificate to an amount slightly less than alternative compliance options. Actual certificate prices will depend on negotiations between states.

States would benefit from purchasing compliance credits if <u>any</u> of the following three conditions apply:

- In-state renewables are very expensive or renewable technical potential is very limited;[11]
- The state's public policy choices disfavor large investments in building renewable generation or energy efficiency; or
- The state's public policy choices favor types of renewables that are particularly costly, where other lower cost options exist.

In some states, the cost of renewables currently exceeds the cost of the next cheapest alternative. For example, the cost of in-state utility-scale solar systems in the Carolinas is currently about $62/MWh, while the cost of on-shore wind in Iowa is about $27/MWh. This would indicate that were the Clean Power Plan in effect today, the Carolinas would likely benefit from purchasing unbundled RECs from Iowa. However, Synapse's future cost projections based on National Renewable Energy Laboratory's (NREL's) ReEDS model estimate that the cost of in-state renewables in Carolina are expected to drop below that of the next-least expensive resource (e.g., coal and NGCCs) as the compliance period approaches. As a result, producing electricity from more-expensive fossil resources *combined with*

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[10] Bundled RECs are renewable credits that are associated with both deliverable electricity and a zero-carbon attribute. Unbundled RECs are renewable credits that represent the zero-carbon attribute alone.

[11] More specifically: If the cost per credit is less than the cost difference between (1) building renewable generation or energy efficiency in state and (2) the next cheapest alternative such as continuing to run fossil-fuel plants.

purchasing out-of-state RECs sufficient to comply with the Clean Power Plan would be more costly than building renewables in state that displace in-state fossil generation. Likewise, our analysis of the Northwest and Southwest combinations did not produce any clear examples of cost savings from bilateral trading of REC-like certificates benefiting states.

4.3. Are there benefits to bilateral trading of "RGGI-like" allowances?

The proposed rule also suggests that participation in CO_2 allowance trading schemes such as RGGI will be accepted as a compliance mechanism. States participating in a "RGGI-like" initiative could choose to comply on their own, or jointly with their partners in the allowance program. States that comply jointly could expect to receive the benefits of their participation in the allowance initiative as well as savings from advantageous renewables siting, capture of energy efficiency leakage, and administrative efficiencies. In this section we examine the advantages of allowance trading separately from those associated with joint compliance.

States may participate in "RGGI-like" allowance trading initiatives either with or without joint compliance with the Clean Power Plan.

By participating in a "RGGI-like" trading initiative, states can effectively set a price on CO_2. As a result, they alter the order in which electric generating units are displaced as new zero- or low-carbon resources come on line. With a large CO_2 price in place, new efficiency savings and renewables displace coal—even in regions where NGCC is currently more expensive than coal. At the same time, the allowance program sends a price signal to consumers that may reduce their electric usage—particularly to large commercial and industrial consumers that feel the effect of time-varying rates—and collects a pool of funds that may be invested in additional emission reduction measures or spent for other purposes. Successful allowance trading systems, like other CO_2 price mechanisms, may be incorporated into RTO market design but need not be.

A state could potentially set its own CO_2 price independently without forming a coalition with other states. States that take this course of action, however, will likely experience in-state generation prices that rise in relation to those of their neighbors. In this circumstance, out-of-state generators would be dispatched in preference to in-state generators. The result of this leakage of generation out of state might be Clean Power Plan compliance (replacing in-state generation with imports) but could potentially increase regional emissions if, for example, the CO_2 price makes in-state NGCC generation more expensive than out-of-state coal generation.

We did not perform modeling on bilateral trading of "RGGI-like" allowances in states submitting solo compliance plans to EPA.

4.4. Are there benefits to integrated markets?

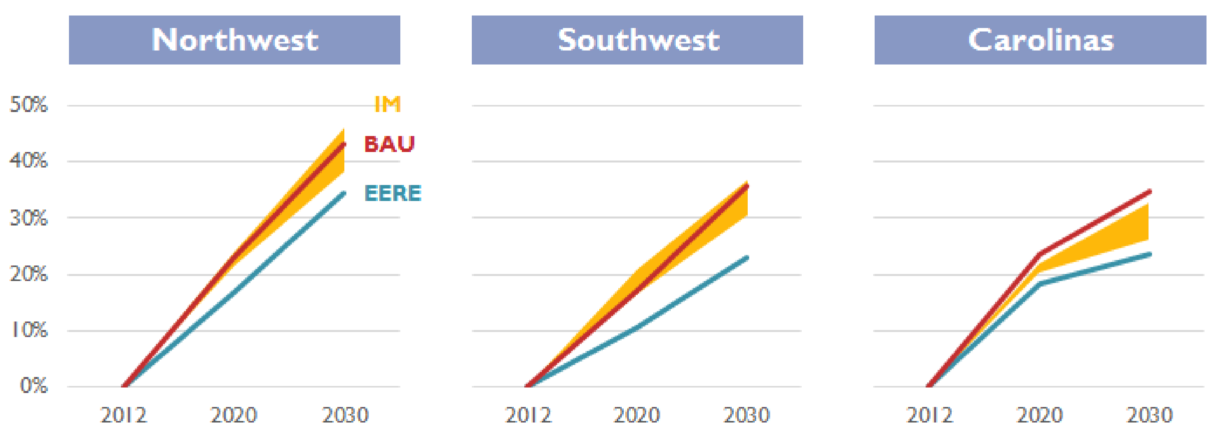
States collaborating through integrated markets jointly comply with the Clean Power Plan and also participate in a "RGGI-like" allowance trading initiative. These states take advantage of the benefits made possible through joint compliance (that is, capturing energy efficiency leakage and advantageous renewable siting) while simultaneously implementing a combination-wide CO_2 price.

With "RGGI-like" allowance trading and a high enough CO_2 allowance price, NGCC units displace coal generation. With coal on the margin, NGCC generation can be used as a Clean Power Plan compliance mechanism. When higher-emissions-intensity coal units are the resources being displaced by renewables, energy efficiency, and NGCC units (in contrast to a scenario in which NGCC units are on the margin), fewer zero-carbon resources are required to meet Clean Power Plan compliance. In states in which zero-carbon resources are the least-cost options in future years, putting coal on the margin and continuing to produce electricity from more expensive NGCCs has the potential to increase costs; for some states, the solution may be to build more zero-carbon resources, displacing *all* expensive fossil-fuel generation, and over-complying with the Clean Power Plan.

States using integrated markets to meet compliance will only see cost benefits if they continue to pursue least-cost resources.

State combinations that pursue compliance through an integrated market strategy will likely experience higher NGCC generation and lower coal generation than in the *Business-as-Usual* scenario: This is Building Block 2 in the Clean Power Plan—redispatch to NGCC units. The increase to NGCC generation will vary depending on the compliance strategy: regardless of whether or not a CO_2 price is in place, a combination may choose to invest in more or less energy efficiency and renewables. Figure 11 depicts the range of percent changes in total electric-system costs under the integrated markets compliance strategy (in yellow). The high end of the range represents states choosing natural gas to displace coal to achieve Clean Power Plan compliance, while the low end of the range represents states choosing a mix of natural gas, energy efficiency, and renewables for compliance.

Figure 11. Changes in total system costs for each arrangement with respect to 2012, including a range for integrated market ("IM") arrangements



Synapse modeling relies on cost projections from the NREL's ReEDS model, which aggregates data from public sources to make projections about future costs of renewables. According to these projections, renewable energy may be the least expensive form of compliance. Where that is the case, less zero-carbon resources are required to achieve compliance when coal is on the margin, and there is less of an opportunity for cost savings. Synapse's analysis shows integrated markets could result in 2030 total system costs that range from 26 to 46 percent above 2012 levels (compared to a range of 23 to 34 percent for the *EERE* scenarios, which increase investment in energy efficiency and renewables).

In the Northwest, integrated market costs may exceed *Business-as-Usual* costs in 2030 if the region adopts more high-cost NGCC generation as it displaces lower-cost coal generation. In the Carolinas, coal is relatively more expensive, and coal plants are older and generally require higher levels of retrofits to meet modern environmental regulations relative to the West. In this case, the integrated market strategy is less expensive than *Business-as-Usual*—but more expensive than *EERE*. These higher costs result not from the CO_2 price itself but from the reduced need for investment in zero-carbon resources to achieve compliance. State combinations participating in a "RGGI-like" initiative could lower costs by over-complying with the Clean Power Plan. In all of our integrated market scenarios, the increased costs associated with using higher levels of NGCC generation overwhelm any cost savings associated with joint compliance, including both preferential renewable siting and the capture of energy efficiency leakage.

Allowance trading initiatives do offer opportunities for cost savings that are not included in our quantitative analysis. In our CP3T modeling runs, we assume that the revenues collected from CO_2 auctions are spent within the electric system with no administrative losses, resulting in a cost-neutral regulatory program. The CO_2 price raises the cost of fossil generation—but the fees collected are assumed to return to the generators or ratepayers, or be invested by the state in energy efficiency and renewables measures with no net cost to the electric sector as a whole.

It is also possible that allowance revenues may be absorbed into state coffers or used outside of the electric-system in some other way, resulting in a net increase to electric-system costs. Currently, states participating in RGGI may choose to spend three-quarters of the revenues in any way they see fit, either inside or outside of the electric system; the remaining 25 percent of revenues is committed to investments in energy conservation and renewable energy. Most RGGI states reinvest part or all of these revenues in efficiency and renewables.

4.5. Strategic choices in multi-state collaboration

Multi-state collaboration for Clean Power Plan compliance has several potential advantages, at least for some states:

- Filing a Clean Power Plan compliance plan jointly may result in savings, depending on the states involved.
- States achieve savings from purchasing RECs only when other compliance strategies are more expensive.
- States may participate in "RGGI-like" allowance trading initiatives either with or without joint compliance with the Clean Power Plan.

- States using integrated markets to meet compliance will only see cost benefits if they continue to pursue least-cost resources.

To identify their least-cost compliance pathway, states must approach multi-state collaboration strategically. Benefits from working together with other states do exist—but not for every state. Multi-state compliance has the potential to result in some cost savings, especially for states that are joining with other states that have vastly different renewable potentials.

5. Challenges to Multi-State Collaboration

There are a number of important seams in the fabric of the Clean Power Plan—and the electric sector more generally—that present challenges for states exploring collaborative compliance arrangements. At the heart of many of these seams is the reality that electricity flows freely within a grid and across state boundaries; and while the Clean Power Plan is implemented at the state-level, the marketplaces for electricity and RECs do not obey rigid state boundaries. The structure of the electric sector need not be an obstacle to Clean Air Act implementation, but it does result in a handful of idiosyncratic challenges and opportunities that require clarification to avoid unnecessary confusion and iteration of state and multi-state compliance plans.

- **Rate- versus mass-based compliance:** States may choose either mass- or rate-based targets for compliance.
- **Out-of-state emission displacement:** New energy efficiency and renewable energy in one state may displace fossil-fuel generation and its associated emissions in another state.
- **Energy efficiency leakage:** States that import electricity only receive partial credit for their efficiency measures, but may "capture" more of this credit through compliance collaboration with other states.
- **Double-counting of emissions credits:** Compliance credits traded away to another state may not be counted towards the seller's Clean Power Plan compliance.

Rate- versus mass-based compliance options, out-of-state emission displacement, energy efficiency leakage, and double-counting are key considerations for states to integrate into their compliance planning. These challenges may also be intertwined, and their combined effects may have important impacts on the compliance decisions of states. Ultimately, compliance planning will require electricity dispatch and generation expansion modeling appropriately suited to each state's resources and goals. The modeling must also consider the likely collaborative compliance arrangements of other electrically interconnected states or regions. It is therefore important for states to understand the circumstances under which the following challenges arise, and what difficulties and opportunities they may present.

5.1. Rate- versus mass-based compliance

Throughout this study, we have approached the analysis of solo compliance, joint compliance, bilateral trading, and integrated market strategies for Clean Power Plan compliance from the perspective of meeting mass-based emissions targets. EPA's proposed Clean Power Plan, however, offers each state the flexibility to choose either mass- or rate-based targets for compliance. A state's decision to choose mass- or rate-based compliance may incorporate any number of assumptions about the future, including its unique underlying generation resource base, renewable energy potential, market characteristics, and expected growth in electricity demand. The mass- versus rate-based compliance decision of neighboring states will also factor into an individual state's decision to comply solo or join a multi-state group, and collaborating states can facilitate joint compliance by choosing a consistent form of target.

In this section, we examine our CP3T modeling runs to determine if and when there are compliance arrangements in which mass-based targets appear to be more easily achieved than rate-based targets, vice-versa, or neither (where compliance is always met for both). For each model run, we first determined the most cost-effective method of compliance towards the state or combination's mass-based target and then compared that to the Clean Power Plan emission rate from the model run to the rate-based target. Table 5 summarizes these results.

Table 5. Number of scenarios compliant with mass- and rate-based Clean Power Plan targets (2020-2030)

		Mass-based Target Status					
		Over-Compliant	%	Compliant	%	Non-Compliant	%
Rate-Based Target Status	Over-Compliant	7	*22%*	0	*0%*	0	*0%*
	Compliant	3	*9%*	6	*19%*	0	*0%*
	Switches During Regulatory Period	4	*13%*	2	*6%*	0	*0%*
	Non-Compliant	0	*0%*	7	*22%*	3	*9%*
	Total	**14**	***44%***	**15**	***47%***	**3**	***9%***

Of the 29 model runs in which mass-based compliance is achieved (i.e., not including the *Business-as-Usual* runs), 15 met mass-based targets within a small error term and 14 resulted in "over-compliance"—lower emissions than the required mass target.

- *Mass-based compliant runs*: 6 met the rate-based target, 2 had periods of both compliance and failure to comply, and 7 failed to comply with the rate-based target. No runs that were compliant with a mass-based target over-complied from a rate-based perspective.

- *Mass-based over-compliant runs*: 7 over-complied with an equivalent rate-based target, 3 met the rate-based target, 4 and had periods of both compliance and failure to comply.

Overall, these results show that in 50 percent of model runs where the mass-based target was either achieved or over-achieved, the rate-based target was also achieved or over-achieved. Our analysis, therefore, does not provide strong evidence that either the mass- or rate-based targets are more easily achieved. In addition, a given compliance strategy may prove to be compliant, over-compliant, or non-compliant with a mass-based target, but may prove more or less effective at achieving compliance with a rate-based target.

5.2. Out-of-state emission displacement

Energy efficiency and renewable energy are critical building blocks in Clean Power Plan target-setting for states. For a state complying with mass-based targets, these activities count towards compliance by displacing in-state emissions that would otherwise be released from fossil-fuel generators on the electric market's margin (that is, the most expensive generators operating in any time period and, therefore, the first generators to be displaced—ordered not to run—when new, lower cost generation is available). (For a detailed discussion of displacement of generation and emissions by efficiency and renewables see Synapse's recent report, *Air Emissions Displacement by Energy Efficiency and Renewable Energy: A Survey of Data, Methods, and Results.*[12]) For a state complying with rate-based targets, generation and emission displacement are the same. The difference is that energy efficiency and renewable energy count towards compliance through either an "avoided generation" (MWh) credit that enters in the denominator of the pounds per MWh target, or as an "avoided emissions" (pounds) credit that enters into the numerator of the target. Both methods lower the pounds per MWh emissions rate demonstrated by the state's compliance plan.

It is important to note that energy markets are highly interconnected across state boundaries. One state's efficiency and renewable energy measures may displace fossil-fuel generators within that state, just across state lines, or even hundreds of miles away, depending on where the marginal units are located. Mass-based emissions as demonstrated in compliance plans and measured in the compliance period will depend on the actual generation from fossil-fuels that takes place within state lines. If new energy efficiency and renewables in State A displace coal generation in State B, it is State B that will have lower emissions. In the compliance period State B benefits from State A's actions, but probably could not claim State A's expected future efficiency and renewables as a verifiable and quantifiable emission reduction measure when submitting a compliance plan to EPA.

[12] Biewald, B., J. Daniel, J. Fisher, P. Luckow, A. Napoleon, N.R. Santen, K. Takahashi. June 2015. Air Emissions Displacement by Energy Efficiency and Renewable Energy: A Survey of Data, Methods, and Results. Synapse Energy Economics. Available at: http://synapse-energy.com/project/air-emissions-displacement-energy-efficiency-and-renewable-energy.

Out-of-state emission displacement may be an important motive for electrically interconnected states to collaborate in a joint compliance plan or through trading. By pooling mass targets and working together towards compliance, states may be able to capture a much larger share of their combined emission reductions from displacing fossil-fuel generation with energy efficiency and renewables. With rate-based targets, in contrast, individual states can count the measured MWh from renewable energy and the measured MWh savings from energy efficiency, but may not experience less generation or emissions from fossil fuel units in their own state.

In most of the CP3T modeling presented in this report, all emission displacement from new efficiency and renewables are assumed to displace the marginal generators in their own state—in solo model runs—or in their own combination—in joint model runs. In the runs modeling the integrated market strategy, however, a CO_2 price puts coal on the margin. This results in electricity from coal being displaced before other types of generation. Tools that estimate out-of-state emissions displacement include electric dispatch models (as described in Synapse's April 2015 report for NASUCA entitled *Best Practices in Planning for Clean Power Plan Compliance: A Guide for Consumer Advocates*) and EPA's AVERT model, a tool designed by Synapse that analyzes the regional emission and generation impacts of implementing renewables and energy efficiency programs.[13]

5.3. Energy efficiency leakage

Building Block 4 of EPA's Clean Power Plan proposal involves the reduction of electricity demand and associated emissions using demand-side energy efficiency measures. EPA estimates that each state can cost-effectively 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.

In the proposal, net-electricity exporting states get credit for 100 percent of the savings associated with their energy efficiency programs, while net importing states may only take credit for a prorated amount of their energy efficiency savings, proportional to the percentage of in-state generation. This is because 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 in-state reductions in generation due to efficiency: the product of their cumulative energy efficiency savings and their share of in-state generation.

Energy efficiency programs reduce emissions from fossil-fueled generators because the demand for power from those generators is reduced. However, due to the highly interconnected nature of the electric system, a state's energy efficiency programs can reduce demand from many different generators across multiple states and regions. Attributing emission reductions from a state's energy efficiency programs to units solely in that state, therefore, likely does not reflect the real impact of these programs. This presents a challenge often referred to as leakage.

[13] Available at http://epa.gov/avert/.

For example, State A institutes significant energy efficiency programs, which reduce emissions at the marginal units in the region. In this example, most of the marginal units are located in neighboring States B and C. The emission reduction benefits of State A's energy efficiency programs have essentially *leaked* into states B and C. If State A is a net exporter, this does not present a problem for the state because the proposal allows a net exporter to take full credit for its energy efficiency savings. But if State A is a net importer of electricity, it will receive only a proportional percentage of the credit for its energy efficiency savings, even though it invested in the programs that led to the reductions. If State A teams up with States B and C to develop a multi-state compliance strategy, all the benefits from all three states' energy efficiency programs may be counted for compliance.

Assuming EPA maintains the same dynamic for crediting energy efficiency savings in its final rule, multi-state coordination presents significant opportunities to maximize the least-cost emission reduction strategies (specifically energy efficiency) and to minimize the leakage of energy efficiency savings outside of the implementing state.

5.4. Double counting of emission credits

States that choose to use RECs or other compliance credits purchased from out-of-state—or sell their own credits to other states—face an additional challenge: avoiding the double counting of emission reduction measures by buyers and sellers in the markets for these compliance commodities. Double counting describes an instance of a single emission reduction being counted twice—once towards compliance in the credit-producing state and once for compliance towards the credit-purchasing state. For example, State A generates a MWh of electricity from wind and with it, a REC. State A has a choice. It may either use the emission reductions associated with this REC—that is, the emission reduction from coal displacement—for its own compliance or sell the REC to State B without counting these displaced emissions towards its own compliance. State A may not do both.

Given the important differences across states in the existing generation fleets and potential for renewable development, some states may find benefits to trading in compliance commodities. This will depend on the relative prices of credits and the most cost-effective in-state emission reduction measure. In some cases, RECs or other compliance credits may be generated cost-effectively in one state, purchased by another state having less cost-effective means of emission reduction, and used by the purchasing state towards compliance with Clean Power Plan requirements.

Issues with rate- versus mass-based compliance add a layer of complexity to double counting. How does a credit generated in a mass-based state merge into the compliance accounting of a rate-based state? How many credits is a MWh of renewable energy that displaces coal generation worth? What is the meaning of a credit generated in a rate-based state? Assuming effective credit markets are set up to account for these differences, the trading of credits between states complying with a mix of rate- and mass-based targets could aggravate double counting.

Verification that such double counting will not occur is a key facet of multi-state trading and joint compliance arrangements. As with current systems that are set up to track RECs or other credits, a reliable Clean Power Plan credit tracking system will be essential to demonstrating compliance, both to receive EPA approval of compliance plans and to substantiate the emission rate or emissions achieved in the year of compliance. Left unresolved, double counting has the potential to result in a mismatch between U.S. electric-sector emissions and the emission levels intended by the Clean Power Plan. A reliable credit tracking system uses serial numbers to ensure that a single credit is only used once. It also ensures that credits maintain attributes such as avoided generation and emissions with the sale of each certificate so that they are properly accounted for by sellers and buyers in compliance demonstrations.[14] Assuring that the issue of double counting is addressed will be an important design feature for any new tracking regimes.

6. CONCLUSIONS

EPA's proposed Clean Power Plan gives states a wide range of options in emission reduction measures, type of compliance targets, and opportunities for collaboration with other states. Our analysis of these multi-state compliance strategies produced the following findings:

- ***Filing a Clean Power Plan compliance plan jointly may result in savings, depending on the states.*** Some states may achieve savings by complying jointly with other states. These savings stem from capturing energy efficiency "leakage", preferential renewable siting, or by avoiding duplication in administrative costs. However, savings attributable to joint compliance are likely to be small, and for some state combinations there may be no savings (but will also be no costs).
- ***States achieve savings from purchasing RECs only when other compliance strategies are more expensive.*** In some states, the trading of RECs or other compliance credits may be the least cost-compliance option. However, this is only likely to occur where energy efficiency and renewables are prohibitively expensive, or where they are disfavored by state policymakers.
- ***States may participate in "RGGI-like" allowance trading initiatives either with or without joint compliance with the Clean Power Plan.*** States that file singly could become involved in integrated markets with CO_2 allowance trading, but if they do, they forego the potential advantages of joint filing: energy efficiency "leakage" prevention, preferential renewable siting, and avoided administrative costs.
- ***States using integrated markets to meet compliance will only see cost benefits if they continue to pursue least-cost resources.*** Being involved in an integrated market with CO_2 allowance trading is an effective way to utilize existing natural gas generation for compliance and to generate revenues for energy efficiency programs and renewable generation. However, this

[14] Farnsworth, D. (2015). *Navigating EPA's Clean Power Plan for Compliance with Renewable Energy*. Regulatory Assistance Project and Center for Resource Solutions Report. February 11, 2015. Available at: http://www.resource-solutions.org/pub_pdfs/Navigating%20EPAs%20Clean%20Power%20Plan%20for%20Compliance%20with%20Renewable%20Energy.pdf.

strategy is unlikely to result in cost savings unless the lowest-cost resources are aggressively pursued.

There are clear efficiencies from collaborative compliance for some states—but not for all states. Careful analysis and strategic judgment is necessary for states to select compliance options that best meet their needs and objectives.

APPENDIX A: MODELING METHODOLOGY

Synapse used its CP3T (Clean Power Plan Planning Tool) to perform multi-state analysis of EPA's proposed Clean Power Plan to identify and explain a variety of challenges and opportunities related to compliance.[15] We modeled the following three combinations of states, as approved by NASUCA:

- **"Northwest"**—Idaho, Montana, Oregon, Utah, Washington, and Wyoming
- **"Southwest"**—Arizona, New Mexico, and the Navajo and Fort Mojave tribes
- **"Iowa and the Carolinas"**—Iowa, North Carolina, and South Carolina[16]

In our multi-state analysis, North Carolina and South Carolina are analyzed as states that jointly comply, whereas Iowa is used to provide an example of an unrelated state from which trading certificates could be obtained for the joint Carolinas entity.

Below, we discuss the methodology used to model the three state combinations in five key steps:

Step 1. Formulate compliance scenarios

Step 2. Model states complying singly with the Clean Power Plan

Step 3. Model states complying jointly with the Clean Power Plan

Step 4. Model states complying with the Clean Power Plan by trading with other states

Step 5. Compare and contrast the differences between the results of Steps 2, 3, and 4

This methodology sets out an overview of the steps taken in modeling for this report. For detailed CP3T methodology see the CP3T User Manual.[17]

Step 1: Formulate Compliance Scenarios

Our analysis investigates how the three combinations of states comply with the Clean Power Plan under a variety of scenarios and approaches to collaboration. While "combination" refers to the specific set of states that are pursuing multi-state compliance, "scenarios" are defined by the choice of resource investments and retirements. Scenarios modeled in this report are:

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[15] Clean Power Plan Planning Tool ("CP3T"). Version 1.4. Available at: http://synapse-energy.com/cp3t.

[16] Initially, we explored Kentucky as another state in this combination. In the course of our analysis we discovered that Kentucky's relatively modest emission reduction requirements in the proposed Clean Power Plan, low anticipated growth rate, and expected coal plant retirements are likely to result in Kentucky inexpensively achieving compliance in virtually any scenario. We removed Kentucky from the analysis because it is unlikely to gain cost savings from multi-state compliance unless it engages in selling over-compliance credits to other states. Detailed information on the Kentucky runs can be found in Appendix C.

[17] CP3T User Manual Version 1.4 available at http://synapse-energy.com/sites/default/files/tools/CP3T-User-Manual.pdf.

- ***"High Gas"*—**This scenario models Clean Power Plan compliance using increased generation from existing NGCC units and new NGCC units.
- ***"EERE"*—**This scenario models Clean Power Plan compliance using additional energy efficiency (EE) and new renewable energy (RE) resources.
- ***"High EERE"***—This scenario models a future with very high levels of renewable energy penetration.
- ***"Business-as-Usual"***—This scenario models a future in which Clean Power Plan compliance is not attained and resources investment decisions remain consistent over time. Most states do not comply under this scenario.

For each combination, we modeled different strategies for collaboration: states complying singly, states complying jointly, states complying using bilateral trading, and states participating in integrated markets. Note that not all scenarios were modeled for all arrangements:

		Scenario			
		High Gas	*EERE*	*High EERE*	*Business-as-Usual*
Collaboration Strategy	*Solo*		X		
	Joint		X	X	X
	Bilateral Trading		X		
	Integrated Markets	X	X		

The assumptions used to model all scenarios are described in Appendix B; scenario-specific assumptions and modeling results are reported in Appendix C.

Step 2: Model solo compliance

We first used CP3T to model each state or tribe included in the three state combinations under solo compliance with the Clean Power Plan in the *EERE* scenario, for a total of fourteen solo state model runs:

	EERE
Northwest	Idaho, Montana, Oregon, Utah, Washington, and Wyoming
Southwest	Arizona, New Mexico, Navajo tribe, and Fort Mojave tribe
Iowa and the Carolinas	Iowa, North Carolina, and South Carolina

For these runs, we assumed the only pathway for solo state compliance was through expanding energy efficiency and renewables; we assumed that that CO_2 pricing would be ineffective for reducing carbon when applied on a state-by-state basis (see section 4.3 for more information). As a result, states complying singly would not be able to implement re-dispatch of NGCCs over coal as a compliance mechanism.

CP3T is an iterative model. Modeling each state in each scenario required careful, hands-on attention from our modeling team to make sure constraints such as peak demand, generation, emissions rates, and emissions are met for every year in our 2012-2030 study period. In order to establish a level ground for comparison, we optimize CP3T with respect to mass-based compliance in each modeling run. However, because CP3T simultaneously reports outputs for emissions and emissions rates, we were able to use this information to draw conclusions about what it means for states and combinations to comply either through mass- or rate-based compliance, and how this could affect least-cost compliance (see Section 5).

For each model run we recorded generation, emissions, and cost outputs from CP3T in charts and tables (see Section 3.5 and Appendix C). We also used EIA Form 861 data and Annual Energy Outlook 2014 cost data to translate costs and generation into dollars per MWh, which were then used to create year-by-year comparisons relative to 2012 electric system costs.[18] This allowed us to create a single metric that can easily be compared across years, scenarios, states, and combinations.

Step 3: Model states complying jointly

In Step 3, we analyzed "joint compliance" in the three combinations under the assumption that all states and tribes within each combination join together to file a single compliance plan with EPA. This pathway to compliance is complicated by the necessity for multiple states to align their political, regulatory, and stakeholder viewpoints to the degree required for creating a single compliance plan. However, this analysis provides an important upper bound that illustrates one extreme in states' potential integration for multi-state compliance and may illuminate efficiencies gained by this high level of integration. In CP3T, states in each combination are treated as a single compliance unit. For each combination of states, we analyzed joint compliance under three separate scenarios: the first assuming states use increased energy efficiency and renewables to achieve compliance, the second assuming states use even higher levels of renewable penetration, and the third assuming states do not comply with the Clean Power Plan, and instead meet future sales requirements by expanding the use of in-state NGCCs.

	EERE	High EERE	Business-as-Usual
Northwest	Northwest as a single 6-state group	Northwest as a single 6-state group	Northwest as a single, noncompliant 6-state group
Southwest	Southwest as a single 4-"state" group	Southwest as a single 4-"state" group	Southwest as a single, noncompliant 4-"state" group
The Carolinas	Carolinas as a single 2-state group	Carolinas as a single 2-state group	Carolinas as a single, noncompliant 2-state group

[18] EIA Form 861 2012 available at http://www.eia.gov/electricity/data/eia861/zip/f8612012.zip. Annual Energy Outlook 2014 available at http://www.eia.gov/forecasts/archive/aeo14/. Detail on the specific assumptions used in each model run are the CP3T defaults and can be found in CP3T itself.

As with Step 2, we recorded outputs on capacity, generation, emissions, emission rates, and costs.

Step 4: Model states complying by trading with other states

Next, we used CP3T to explore compliance in each scenario using two types of trading. The first type of trading, interstate credit trading, examines compliance through the exchange of several different kinds of emission-free commodities. States can trade renewable energy generation bundled together with renewable generation certificates (RECs); unbundled RECs that are attributed, but unconnected, to actual generation; energy efficiency credits; or allowances for CO_2 emissions. We explored several examples of trading with unbundled RECs, energy efficiency credits, and credits for over-compliance with the Clean Power Plan.[19] As with solo compliance, we assumed that in bilateral trading, states still largely comply with the Clean Power Plan using in-state mechanisms, and thus cannot use CO_2 pricing to force in-state NGCC units to displace in-state coal.

	EERE
Northwest	Washington sells CO_2 credits Wyoming buys CO_2 credits
Southwest	New Mexico sells CO_2 credits Arizona buys CO_2 credits
Iowa and the Carolinas	Iowa sells unbundled RECs Carolinas jointly buy unbundled RECs

The second type of trading we examined, integrated markets, assumes states (a) file joint compliance plans with EPA and (b) use intrastate cap-and-trade systems to achieve compliance. In these scenarios, states may use CO_2 pricing to force in-state NGCC units to displace in-state coal, which allows us to examine scenarios in which increased use of NGCCs is a viable compliance strategy.

	EERE	High Gas
Northwest	Northwest as a single 6-state group	Northwest as a single 6-state group
Southwest	Southwest as a single 4-"state" group	Southwest as a single 4-"state" group
The Carolinas	Carolinas as a single 2-state group	Carolinas as a single 2-state group

Note that we did not examine an arrangement in which states participate in integrated markets but do not file a joint compliance plan.

As in Step 3 and Step 4, we recorded outputs on capacity, generation, emissions, emission rates, and costs for each example.

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[19] As discussed in Section 4, we treated energy efficiency credits and credits for over-compliance as functionally equivalent

Step 5: Compare and contrast the differences between the results of Steps 2, 3, and 4

Finally, we used the outputs from Step 2, Step 3, and Step 4 to draw conclusions about what it means for states in each combination to comply singly, to comply jointly, or to comply through the use of different types of interstate trading. In this step we examine patterns in modeling results across combinations and across scenarios. In addition, we ask what these patterns can contribute to answering the following questions:

- Are there benefits to joint submission?
- Are there benefits to bilateral trading of REC-like certificates?
- Are there benefits to bilateral trading of “RGGI-like” allowances?
- Are there benefits to integrated markets?

We discuss how our assumptions in each scenario impact the unique components of each state’s electric system and will attempt to identify the least-cost compliance options and arrangements, given the scenarios analyzed. Examples of components that are analyzed include placement of renewables in states that have more advantageous resources compared to the rest of the combination, and flexibility of generation from fossil resources in one state versus another.

APPENDIX B: KEY ASSUMPTIONS USED FOR ALL SCENARIOS

For all scenarios, we assumed retirements at fossil-fuel power plants consistent with announced retirements to date. Electric-generating units were retired if utilities had reported a retirement date to the federal government via EIA Form 860 2013, or if they had announced a retirement date publicly in another venue.[20] Retirements by state are listed in the table below:

Combination	State	Unit Type	Plant	Unit	Nameplate Capacity (MW)	Retirement Year
Northwest	MT	COALST	J E Corette Plant	1	173	2016
Northwest	OR	COALST	Boardman	1	643	2021
Northwest	UT	COALST	Carbon	1	75	2016
Northwest	UT	COALST	Carbon	2	114	2016
Southwest	AZ	OGST	Saguaro	1	125	2014
Southwest	AZ	OGST	Saguaro	2	125	2014
Southwest	NM	COALST	San Juan	2	369	2018
Southwest	NM	COALST	San Juan	3	555	2018
Southwest	NM	OGST	Rio Grande	6	50	2015
Southwest	NM	OGST	Rio Grande	7	50	2018
Iowa and the Carolinas	IA	COALST	Lansing	3	38	2014
Iowa and the Carolinas	IA	COALST	Walter Scott Jr Energy Center	1	49	2017
Iowa and the Carolinas	IA	COALST	Walter Scott Jr Energy Center	2	82	2017
Iowa and the Carolinas	IA	COALST	George Neal North	1	147	2017
Iowa and the Carolinas	IA	COALST	George Neal North	2	350	2017
Iowa and the Carolinas	IA	COALST	Pella	6	27	2013
Iowa and the Carolinas	IA	COALST	Fair Station	1	25	2014
Iowa and the Carolinas	IA	COALST	Fair Station	2	38	2014
Iowa and the Carolinas	IA	OGST	Dubuque	3	29	2015
Iowa and the Carolinas	IA	OGST	Dubuque	4	38	2015
Iowa and the Carolinas	IA	OGST	Sutherland	1	38	2017
Iowa and the Carolinas	IA	OGST	Sutherland	3	82	2017
Iowa and the Carolinas	KY	COALST	Big Sandy	1	281	2016
Iowa and the Carolinas	KY	COALST	Big Sandy	2	816	2016
Iowa and the Carolinas	KY	COALST	Green River	3	75	2016
Iowa and the Carolinas	KY	COALST	Green River	4	114	2016
Iowa and the Carolinas	KY	COALST	Tyrone	3	75	2014
Iowa and the Carolinas	KY	COALST	Cane Run	4	163	2017
Iowa and the Carolinas	KY	COALST	Cane Run	5	209	2017
Iowa and the Carolinas	KY	COALST	Cane Run	6	272	2017
Iowa and the Carolinas	KY	COALST	Kenneth C Coleman	1	205	2015
Iowa and the Carolinas	KY	COALST	Kenneth C Coleman	2	205	2015
Iowa and the Carolinas	KY	COALST	Kenneth C Coleman	3	192	2015
Iowa and the Carolinas	KY	COALST	Dale	1	27	2016
Iowa and the Carolinas	KY	COALST	Dale	2	27	2016
Iowa and the Carolinas	KY	COALST	Dale	3	81	2016

[20] EIA Form 860 2013 available at http://www.eia.gov/electricity/data/eia860/xls/eia8602013.zip. Information on power plant retirements otherwise publicly released was assembled by Synapse from numerous sources.

Combination	State	Unit Type	Plant	Unit	Nameplate Capacity (MW)	Retirement Year
Iowa and the Carolinas	KY	COALST	Dale	4	81	2016
Iowa and the Carolinas	KY	COALST	D B Wilson	1	566	2015
Iowa and the Carolinas	NC	COALST	Cape Fear	5	141	2013
Iowa and the Carolinas	NC	COALST	Cape Fear	6	188	2013
Iowa and the Carolinas	NC	COALST	HF Lee Plant	1	75	2013
Iowa and the Carolinas	NC	COALST	HF Lee Plant	2	75	2013
Iowa and the Carolinas	NC	COALST	HF Lee Plant	3	252	2013
Iowa and the Carolinas	NC	COALST	L V Sutton Steam	1	113	2014
Iowa and the Carolinas	NC	COALST	L V Sutton Steam	2	113	2014
Iowa and the Carolinas	NC	COALST	L V Sutton Steam	3	447	2014
Iowa and the Carolinas	NC	COALST	Buck	5	125	2014
Iowa and the Carolinas	NC	COALST	Buck	6	125	2014
Iowa and the Carolinas	NC	COALST	Dan River	1	70	2013
Iowa and the Carolinas	NC	COALST	Dan River	2	70	2013
Iowa and the Carolinas	NC	COALST	Dan River	3	150	2013
Iowa and the Carolinas	NC	COALST	Riverbend	4	100	2014
Iowa and the Carolinas	NC	COALST	Riverbend	5	100	2014
Iowa and the Carolinas	NC	COALST	Riverbend	6	133	2014
Iowa and the Carolinas	NC	COALST	Riverbend	7	133	2014
Iowa and the Carolinas	SC	COALST	H B Robinson	1	207	2013
Iowa and the Carolinas	SC	COALST	W S Lee	1	90	2017
Iowa and the Carolinas	SC	COALST	W S Lee	2	90	2017
Iowa and the Carolinas	SC	COALST	W S Lee	3	175	2016
Iowa and the Carolinas	SC	COALST	Canadys Steam	1	136	2013
Iowa and the Carolinas	SC	COALST	Canadys Steam	2	136	2019
Iowa and the Carolinas	SC	COALST	Canadys Steam	3	218	2019
Iowa and the Carolinas	SC	COALST	McMeekin	1	147	2019
Iowa and the Carolinas	SC	COALST	McMeekin	2	147	2019
Iowa and the Carolinas	SC	COALST	Dolphus M Grainger	1	82	2013
Iowa and the Carolinas	SC	COALST	Dolphus M Grainger	2	82	2013
Iowa and the Carolinas	SC	COALST	Jefferies	3	173	2013
Iowa and the Carolinas	SC	COALST	Jefferies	4	173	2013

For each scenario modeled, the same order of operations and assumptions were applied in CP3T. For detailed CP3T methodology see the CP3T User Manual; scenario-specific assumptions and modeling results are reported in Appendix C.[21] For all scenarios except the *Business-as-Usual* and *High Gas* scenarios, it was assumed the displacement order for resources was oil and gas steam units, existing NGCCs, then coal units. Effectively, this means as more "must-take" renewable generation and energy efficiency comes online, generation from oil and gas steam units is the first to be avoided, then existing NGCC, then coal. For the *Business-as-Usual* and *High Gas* scenarios, this sequence was changed to: oil and gas steam, coal units, then existing NGCCs, reflecting the switch in dispatch that would result from CO_2 pricing.

[21] CP3T User Manual Version 1.4 available at http://synapse-energy.com/sites/default/files/tools/CP3T-User-Manual.pdf.

For all scenarios:

1. The individual state (solo, bilateral trading) or combination of states (joint, integrated markets) was selected in CP3T.
2. For each year, for solo and bilateral trading model runs the incremental MWh required or implied by the state RPS was entered; for joint and integrated market model runs, the sum of MWh for all states' RPS requirements was entered. For states that do not have an RPS, this value was entered as zero.
3. The location of the renewables was specified. For solo model runs, 100 percent of renewables was located within state boundaries. For joint and integrated market model runs, the allocation of renewables to states was made proportional to each state's RPS requirements. For the bilateral trading runs in the Carolinas, 100 percent of renewables (after satisfying any in-state RPS requirements) were met through the use of unbundled RECs. For the bilateral trading runs in the Northwest and Southwest, 100 percent of renewables was located within state boundaries.
4. Total renewable generation was allocated across each type of renewable energy resource in accordance with states' RPSs. Where renewable energy resources are not explicitly specified in the RPS, the lowest cost option in levelized dollars per MWh is chosen, excluding geothermal and non-zero carbon sources;
5. For each year, energy efficiency GWh were specified in accordance with existing state efficiency standards. For states that do not have an energy efficiency standard, these values were held constant at 2012 levels.

EERE scenarios only:

6. NGCC capacity factors were not adjusted from 2012 levels.
7. For each year, a high energy efficiency trend was developed using EPA's Clean Power Plan technical support document for energy efficiency savings.[22] In this high energy efficiency trend, annual incremental energy efficiency is assumed to remain constant from 2012 to 2015 then rise annually to achieve an incremental savings level of 2.0 percent savings as a percent of in-state sales by 2019 and 2.5 percent savings by 2025. These savings were used as inputs in CP3T. In some states with an existing energy efficiency standard, the existing standard exceeded the savings implied by this high energy efficiency trend in some or all years. In these cases, we used the greater of the two savings trends.
8. Generation requirements were evaluated for 2012 through 2030 and, if not satisfied, new renewable energy resources were added to meet generation requirements.

[22] Available at http://www2.epa.gov/sites/production/files/2014-06/20140602tsd-ghg-abatement-measures-scenario1.xlsx

9. Mass-based emission requirements were then evaluated for 2020 through 2030. If the emission requirements were not satisfied, further new renewable energy resources were added sufficient to meet emission requirements.

High Gas scenarios only:

6. For each year starting in 2020, statewide average NGCC capacity factors were increased to the level necessary to meet generation requirements or to a 70-percent maximum.
7. For net importing arrangements, for each year prior to 2018, generation requirements were evaluated in CP3T and, if not satisfied, imports were increased sufficient to meet generation requirements. For net exporting states, for each year prior to 2018, if generation requirements were not satisfied, exports were reduced sufficient to meet generation requirements.
8. For years 2018 through 2030, generation requirements were evaluated in CP3T and, if not satisfied, new NGCC capacity was added in 250 MW increments sufficient to meet generation requirements.
9. Mass-based emission requirements were evaluated in CP3T and, if not satisfied, new NGCC capacity was added in 250 MW increments sufficient to meet emission requirements.

Specific detail on the assumptions used for fuel prices, energy efficiency costs, renewable costs, renewable capacity factors and other inputs can be found by downloading CP3T.[23] In all our runs, we used CP3T defaults including:

- Unit-specific data from EPA's Clean Power Plan technical support documents[24]
- Regional-specific electric sales forecasts from the AEO 2014 Reference Case
- Regional-specific fuel prices from the AEO 2014 Reference Case (including a nationwide average cost of natural gas delivered to the electric sector of $5.07/MMBtu in 2020 and $6.49/MMBtu in 2030 in 2012 dollars)
- Coal, NGCC, natural gas combustion turbine, and nuclear capital, variable and fixed operating and maintenance costs, and heat rates from the AEO 2014 Reference Case Electric Market Module Table 8.2[25]
- Energy efficiency costs from internal Synapse research[26]

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[23] Available at www.cp3t.com.

[24] Available at http://www2.epa.gov/carbon-pollution-standards/clean-power-plan-proposed-rule-technical-documents.

[25] Available at http://www.eia.gov/forecasts/aeo/assumptions/pdf/electricity.pdf.

- Wind and solar PV cost assumptions from LBNL[27]
- Wind and solar capacity factor assumptions from EPA's AVERT model[28]

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[26] Stanton, E. A., S. Jackson, B. Biewald, M. Whited. November 2014. *Final Report: Implications of EPA's Proposed "Clean Power Plan."* Synapse Energy Economics for NASUCA. Available at http://synapse-energy.com/project/clean-power-plan-reports-and-outreach-national-association-state-utility-consumer-advocates.

[27] Available at http://emp.lbl.gov/sites/all/files/2013-data-file.xls.xls and http://emp.lbl.gov/sites/all/files/LBNL_Utility-Scale_Solar_2013_report.pdf.

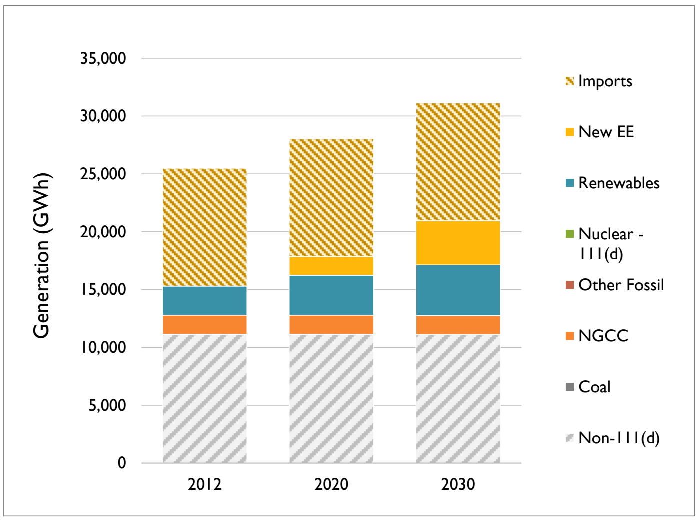
[28] Available at http://epa.gov/avert.

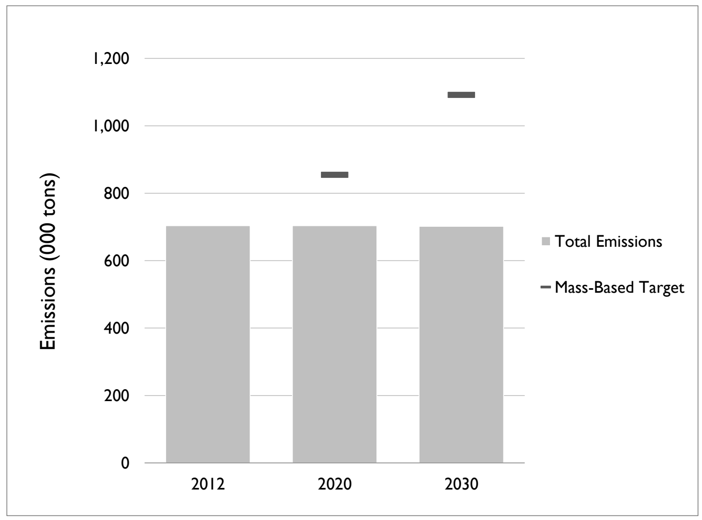
APPENDIX C: SCENARIO ASSUMPTIONS AND RESULTS

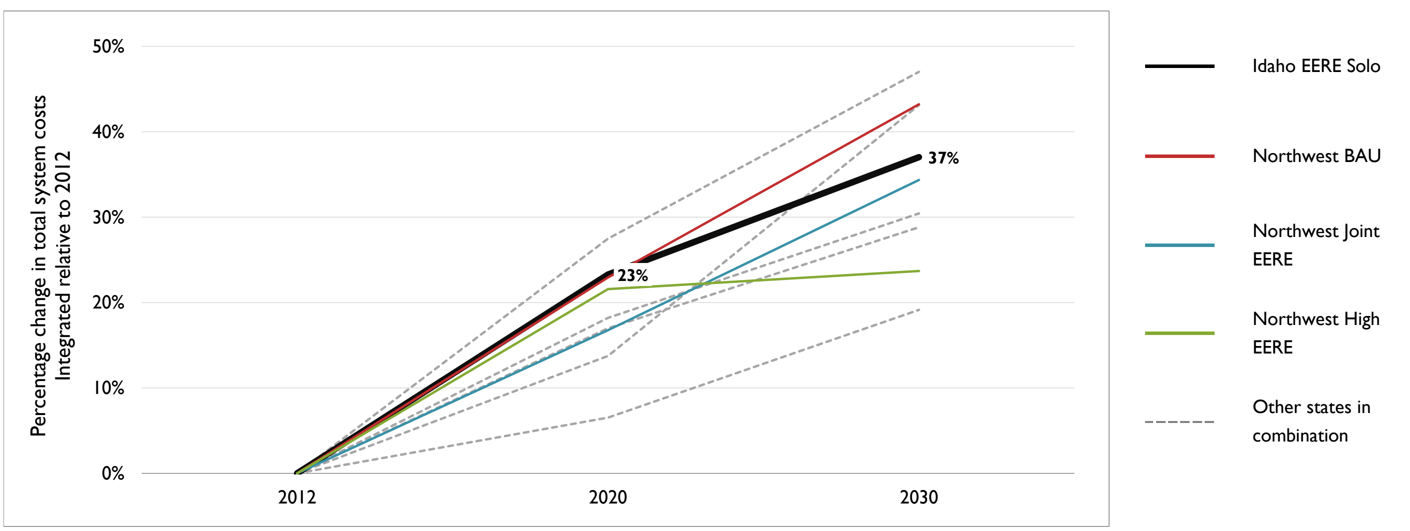
The following 32 pages provide detail on inputs and key findings for each model run in our analysis.

Idaho EERE Solo

Key Findings	ID over-complies by meeting its generation requirements with additional efficiency and renewables.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	540 MW of solar PV capacity are added by 2020, and an additional 500 MW of PV by 2030.
Existing NGCC	2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	ID has no existing coal capacity.
Imports/Exports	Net imports remain constant at 2012 levels from 2020 through 2030.
Other	-

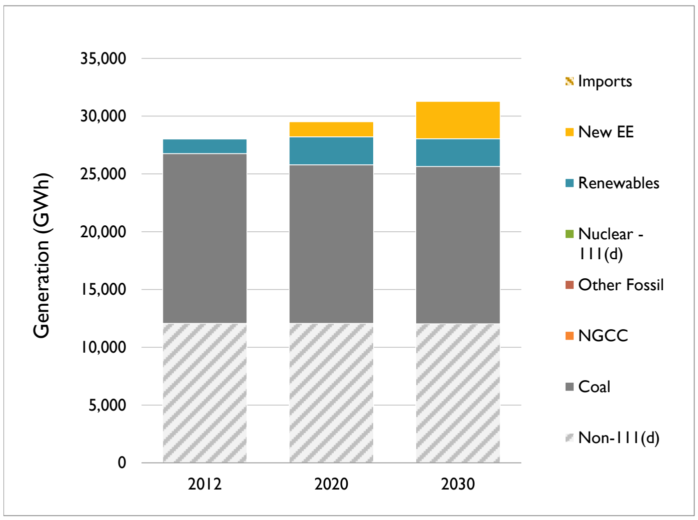


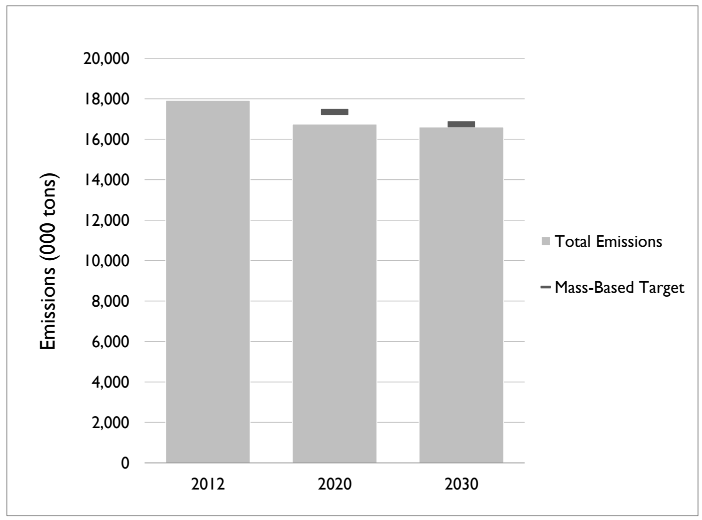


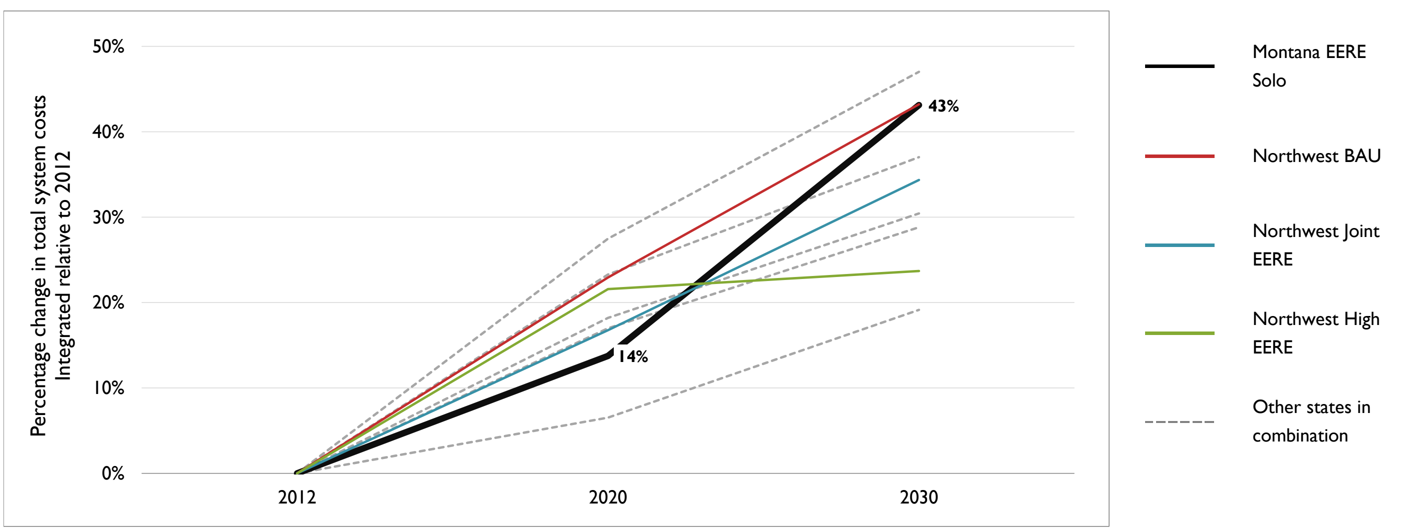


Montana EERE Solo

Key Findings	MT complies by doubling its 2012 renewable generation by 2030 thereby displacing 1 million MWh of coal generation.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	550 MW of wind added by 2030.
Existing NGCC	There is no NGCC capacity in Montana.
New NGCC	No new NGCC capacity is added.
Coal	173 MW of coal capacity retires in 2016.
Imports/Exports	Net exports remain constant at 2012 levels from 2020 through 2030.
Other	-

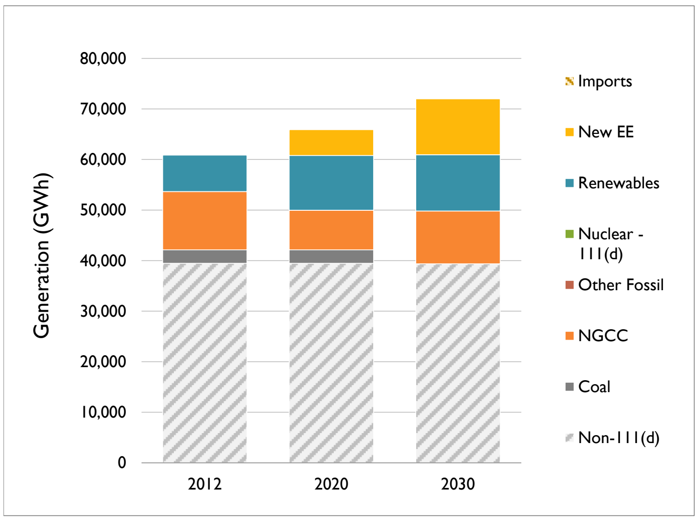


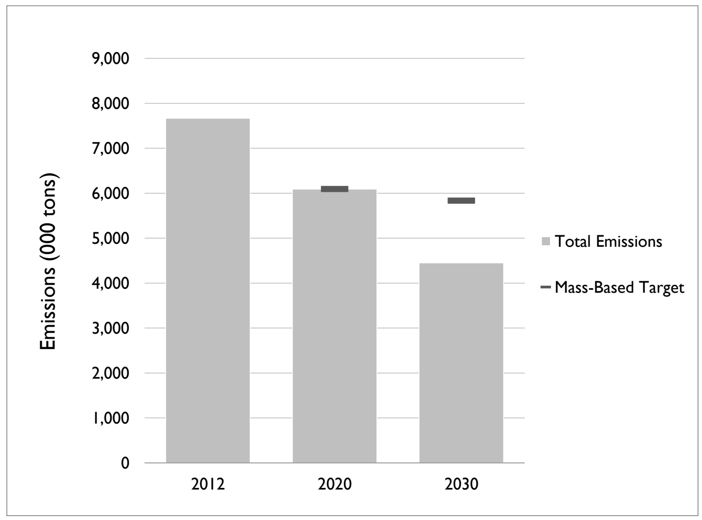


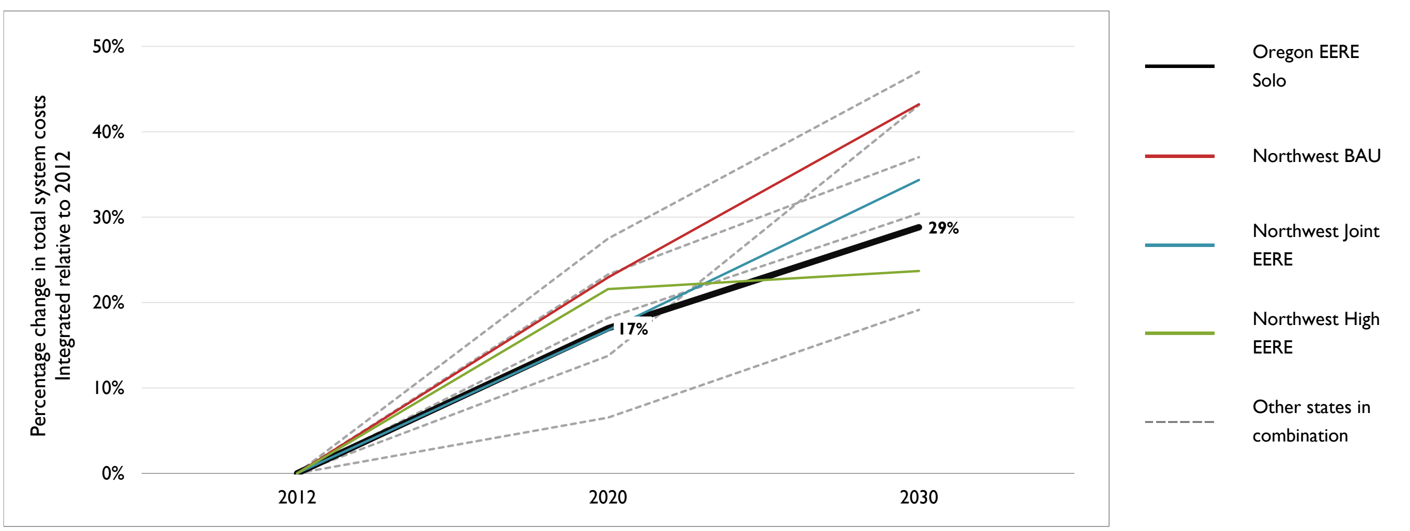


Oregon EERE Solo

Key Findings	OR over-complies by retiring Boardman in 2021, increasing efficiency measures, and meeting state RPS requirements.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	2.3 GW of solar PV are added by 2030.
Existing NGCC	Existing NGCC average capacity factor falls from 38% in 2012 to 35% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	642 MW of coal capacity retires in 2021.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

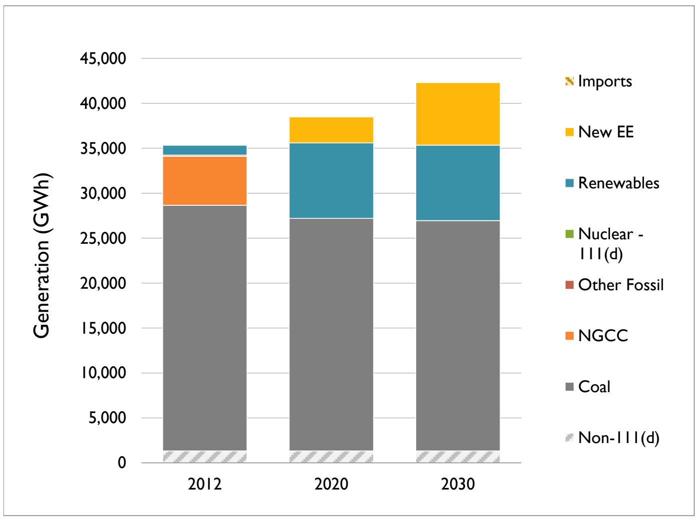


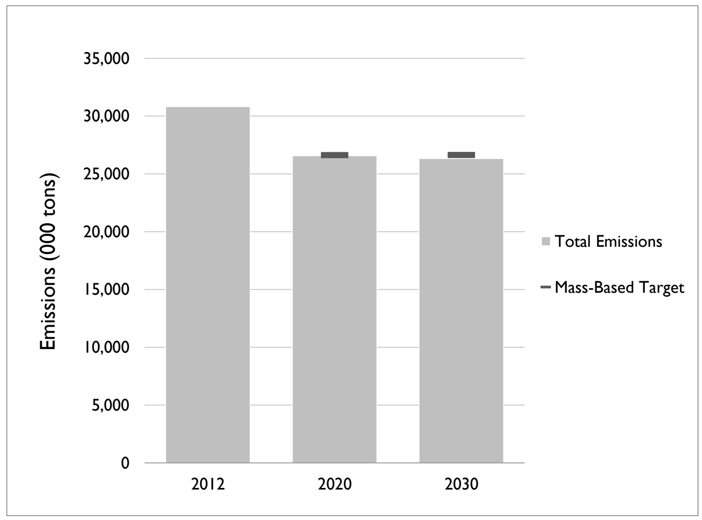


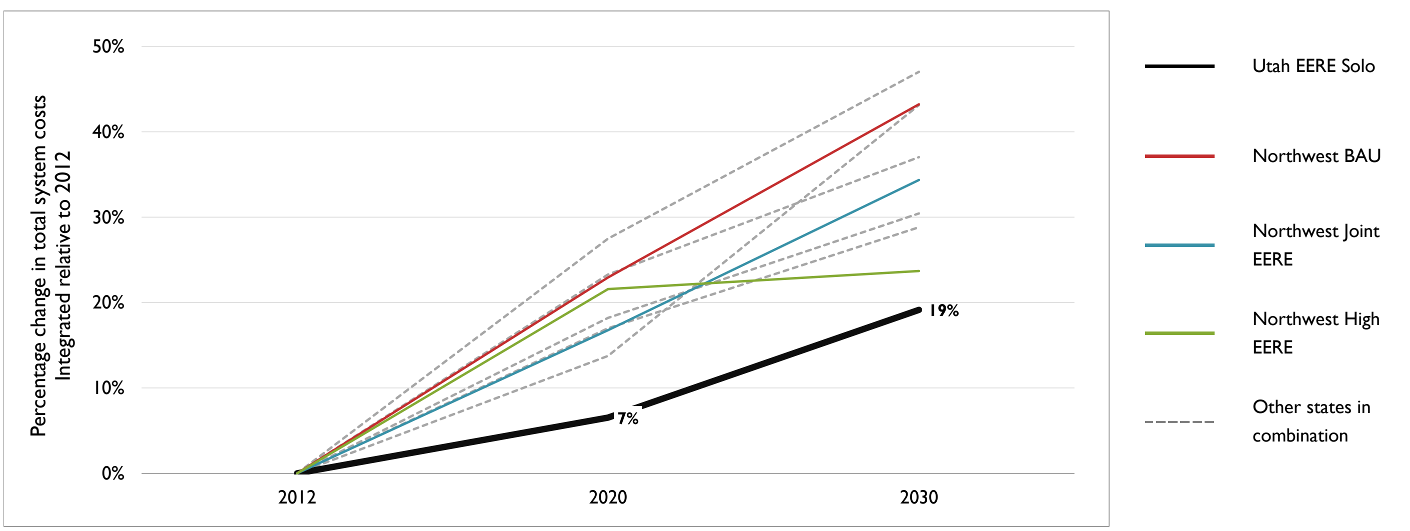


Utah EERE Solo

Key Findings	UT complies by building new renewables equal to four times its current renewable generation by 2020.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	4.2 GW of solar PV added by 2020.
Existing NGCC	NGCC generation is completely displaced by new EE and RE.
New NGCC	No new NGCC capacity is added.
Coal	200 MW of coal capacity retires in 2016.
Imports/Exports	Net exports remain constant at 2012 levels from 2020 through 2030.
Other	-

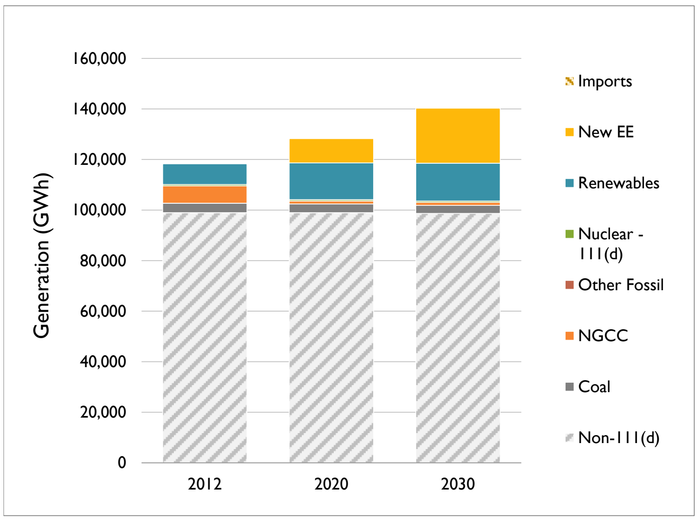


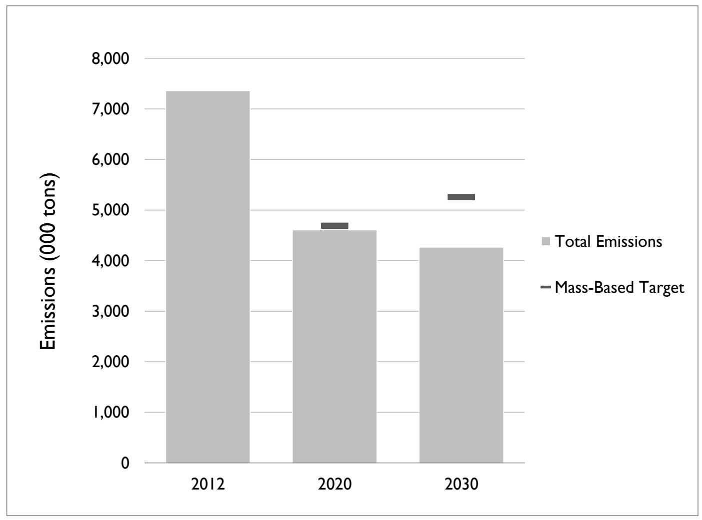


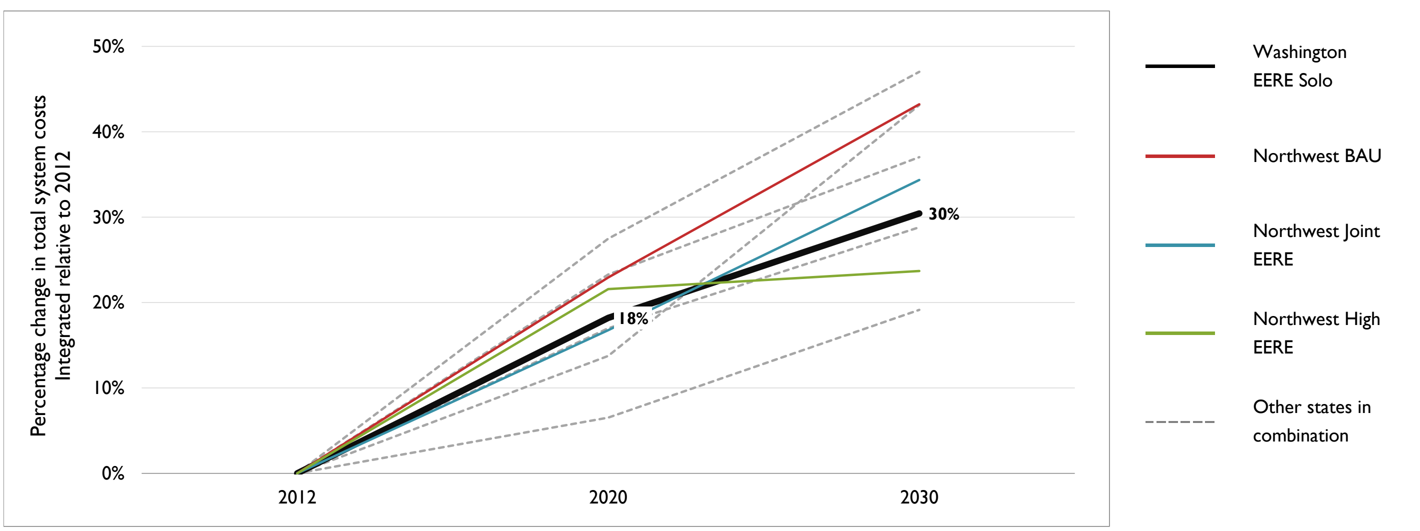


Washington EERE Solo

Key Findings	WA over-complies displacing most of its NGCC generation and meeting growing sales with new efficiency and
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	WA meets its RPS requirements: 15% of sales covered by the RPS by 2020.
Existing NGCC	NGCC average capacity factor falls from 22% in 2012 to 3% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant.
Imports/Exports	Net exports remain constant at 2012 levels from 2020 through 2030.
Other	-

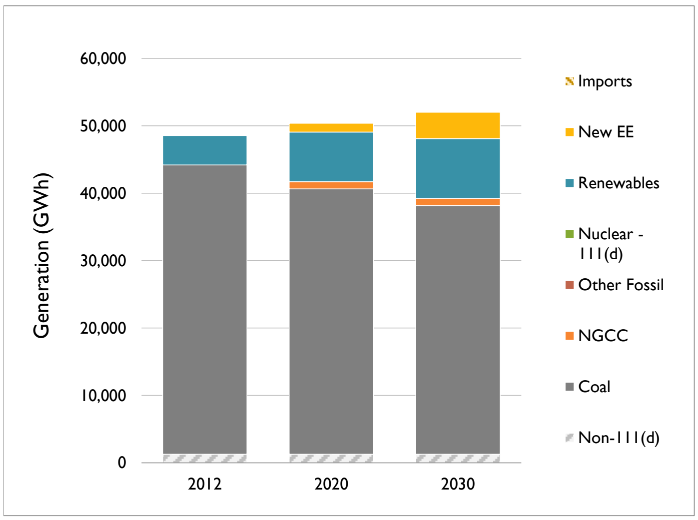


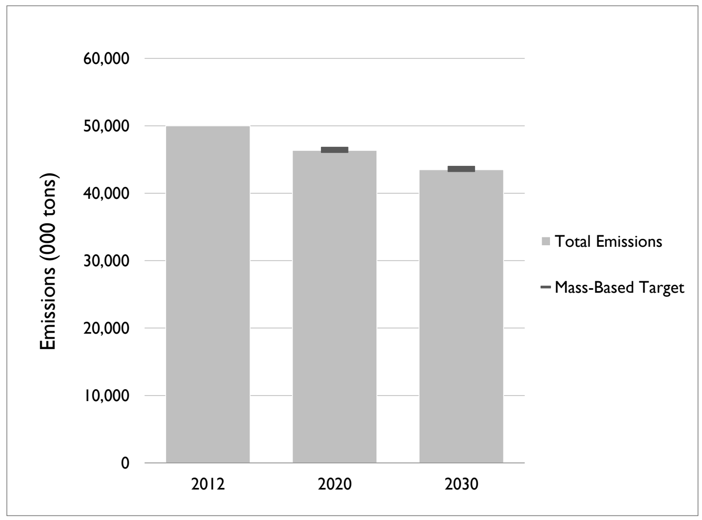


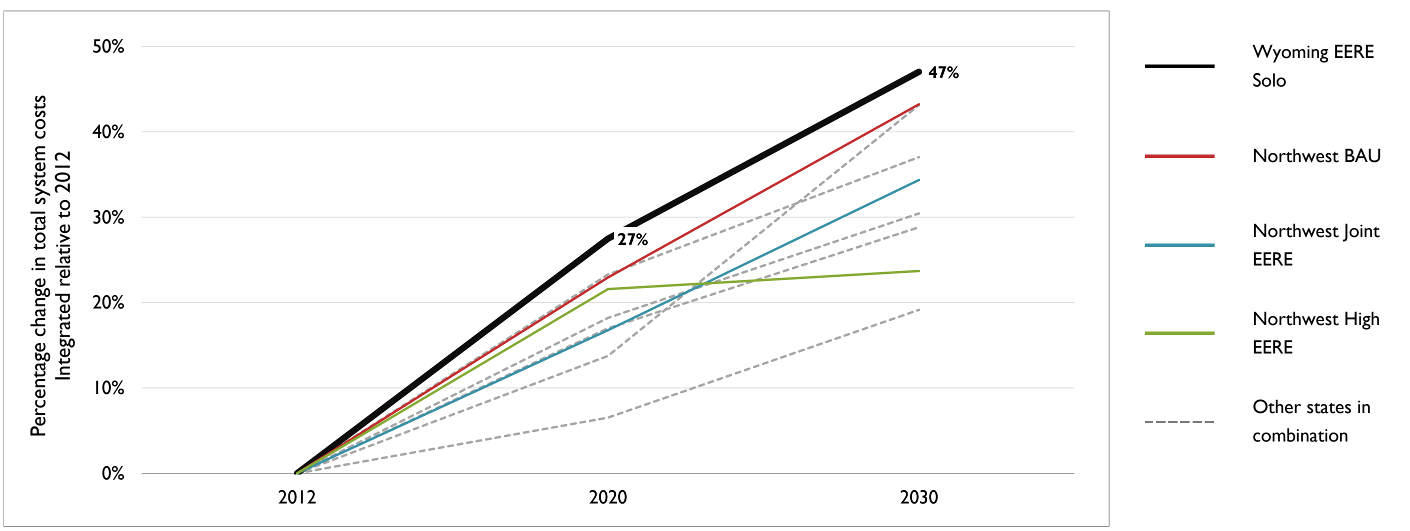


Wyoming EERE Solo

Key Findings	WY complies by building 1.7 GW of renewables, partially displacing coal generation.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	1.7 GW of wind added by 2030.
Existing NGCC	2012 NGCC generation increases as Cheyenne Generation Station comes online in 2013.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

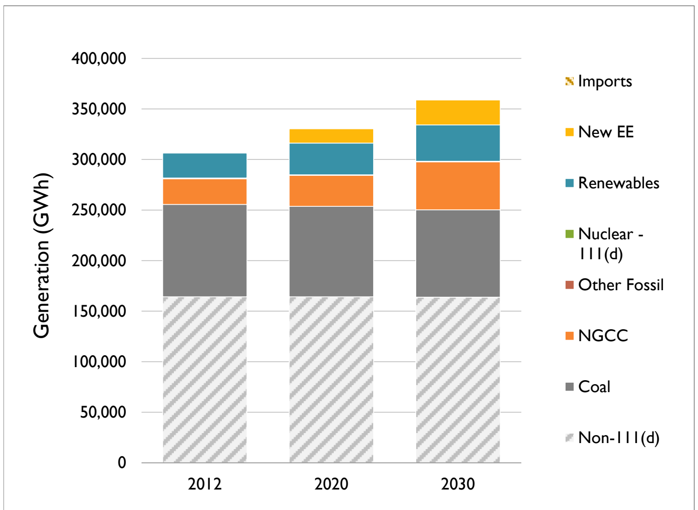


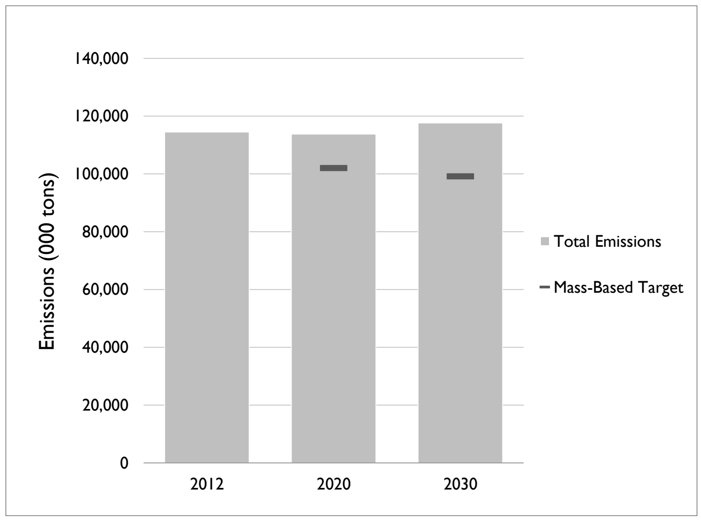


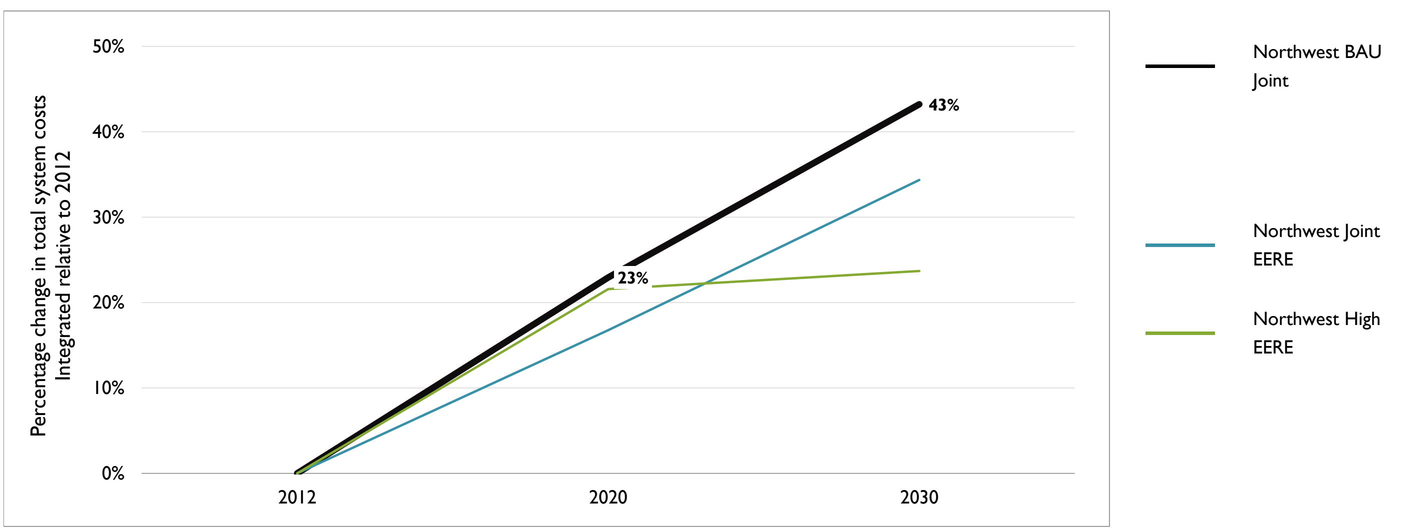


Northwest BAU Joint

Key Findings	This scenario is non-compliant. Existing NGCC generation is increased to meet sales requirements.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	MT, OR, and WA meet their RPS requirements.
Existing NGCC	Existing NGCC capacity factors increase from 31% in 2012 to 55% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	2 GW of coal capacity retires by 2021.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

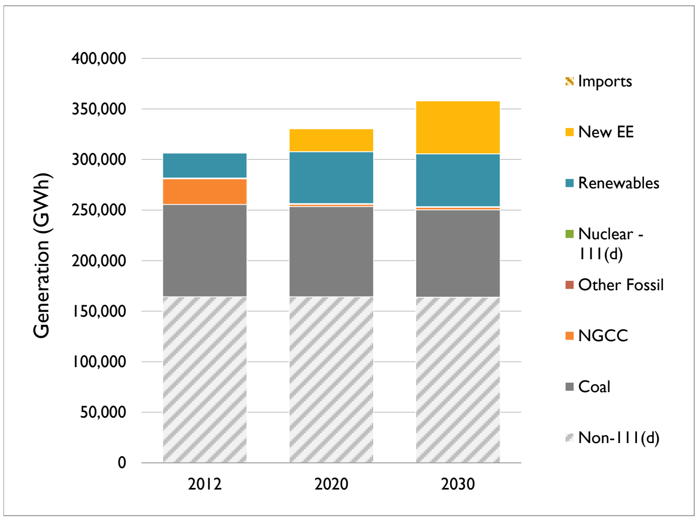


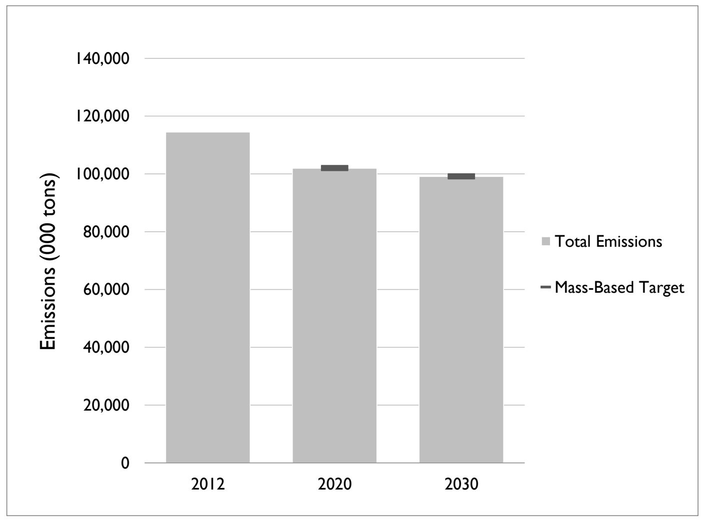


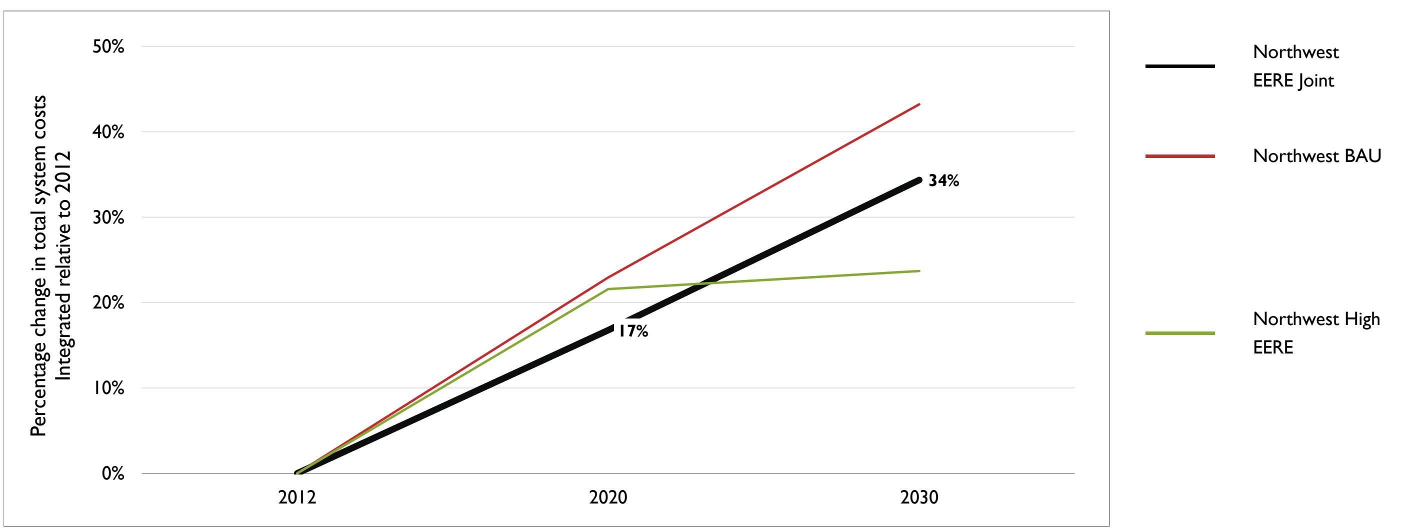


Northwest EERE Joint

Key Findings	The Northwest complies by meeting state RPS requirements early and exceeding these requirements by 44%.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	MT, OR, and WA meet their RPS requirements; 13.1 GW of renewables added by 2030.
Existing NGCC	NGCC generation is almost completely displaced by new EE and RE.
New NGCC	No new NGCC capacity is added.
Coal	2 GW of coal capacity retires by 2021.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

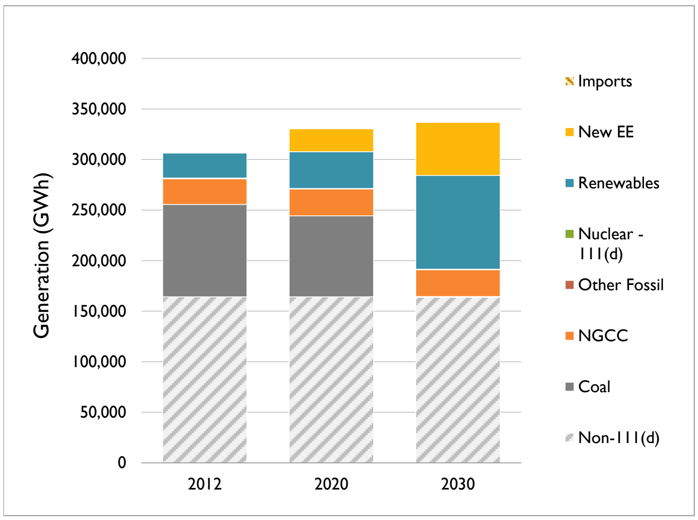


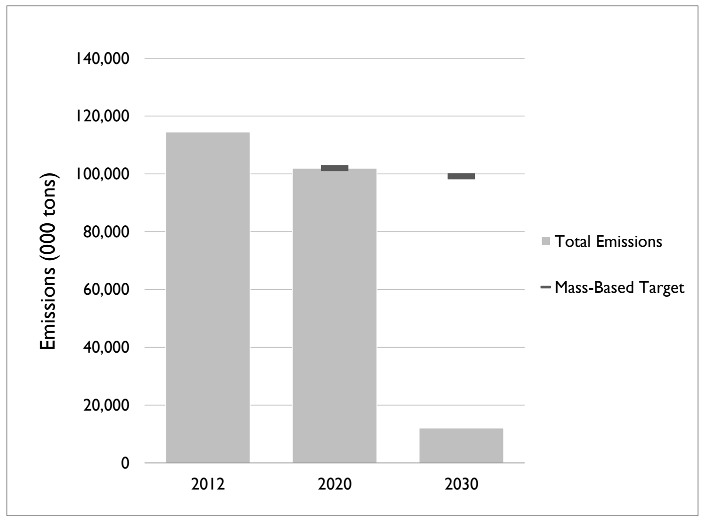


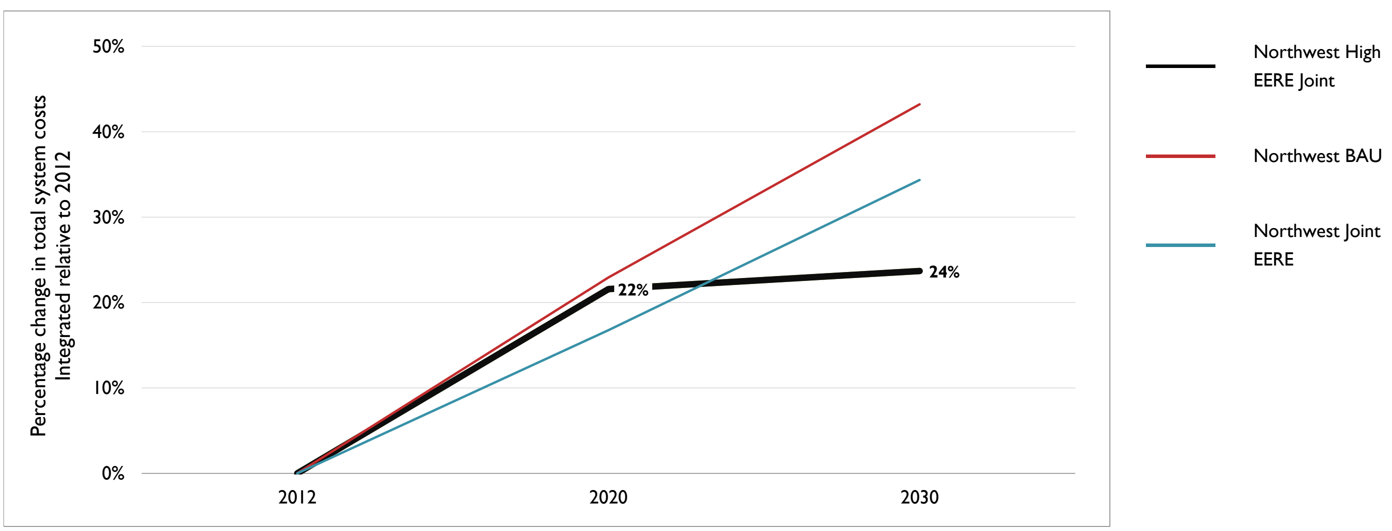


Northwest High EERE Joint

Key Findings	Renewable generation is increased to a level sufficient to displace coal generation.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	41 GW of new renewables added by 2030.
Existing NGCC	2012 NGCC generation increases as Cheyenne Generation Station comes online in 2013.
New NGCC	No new NGCC capacity is added.
Coal	2 GW of coal capacity retires by 2021. Coal generation completely displaced by 2030.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

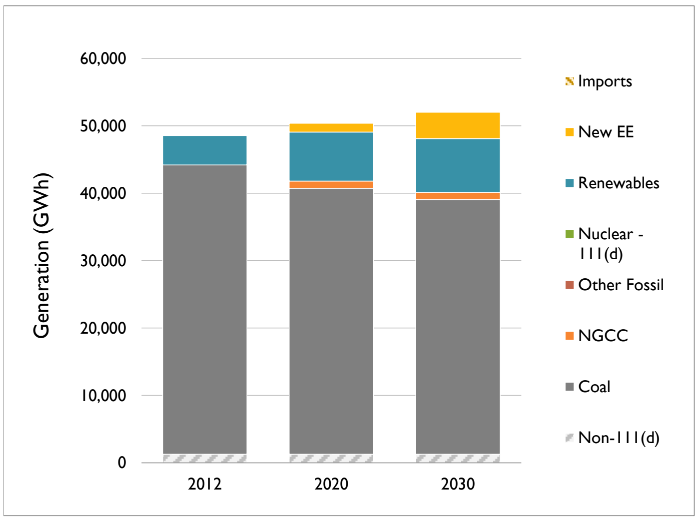


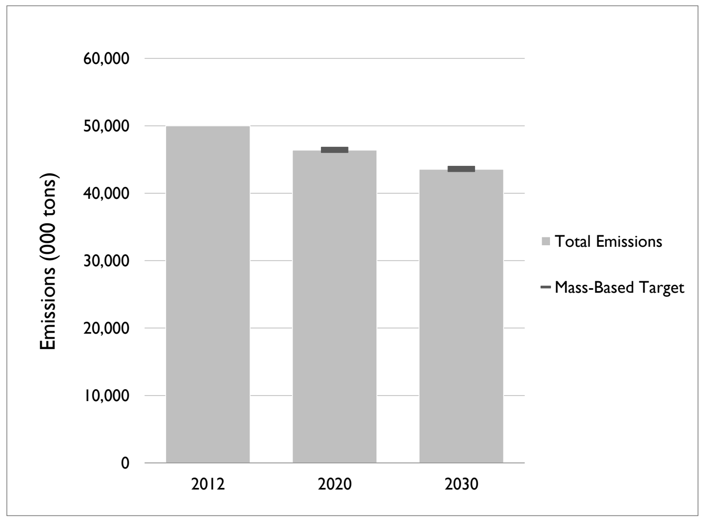


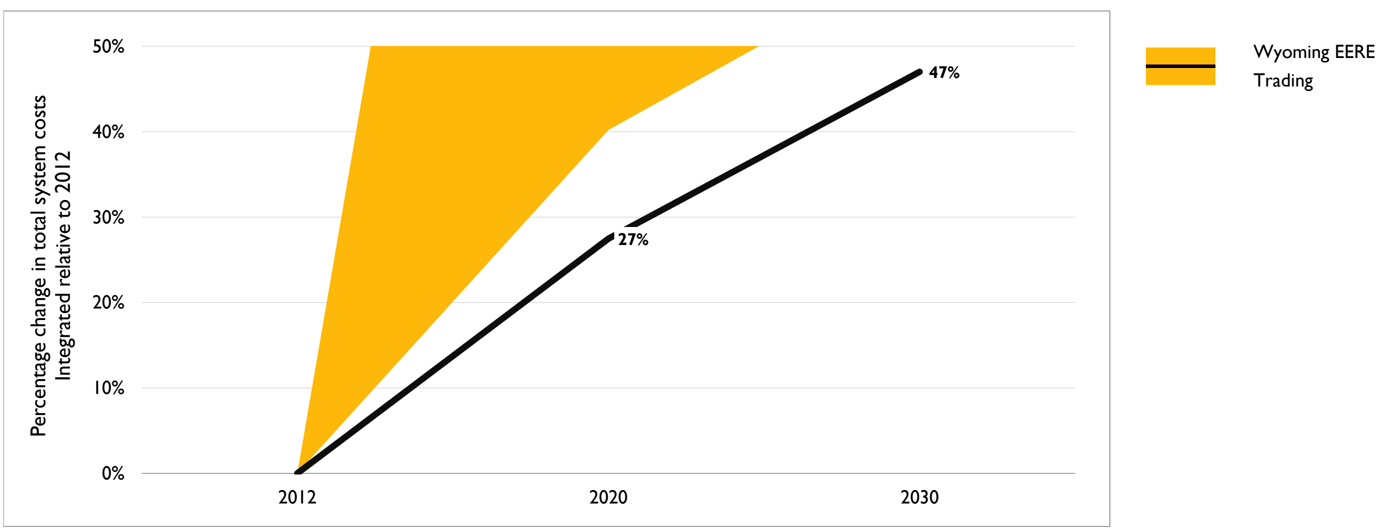


Wyoming EERE Trading

Key Findings	WY complies by purchasing compliance credits from WA and building renewables.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	1.4 GW of wind added by 2030.
Existing NGCC	2012 NGCC generation increases as Cheyenne Generation Station comes online in 2013.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	WY purchases all available compliance credits from WA.

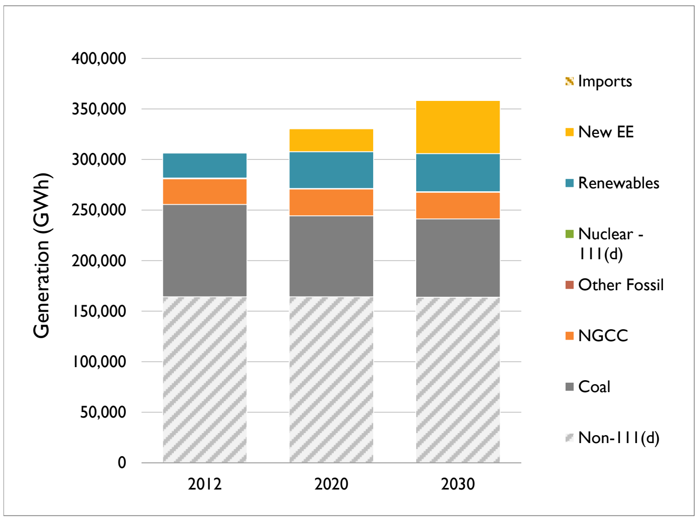


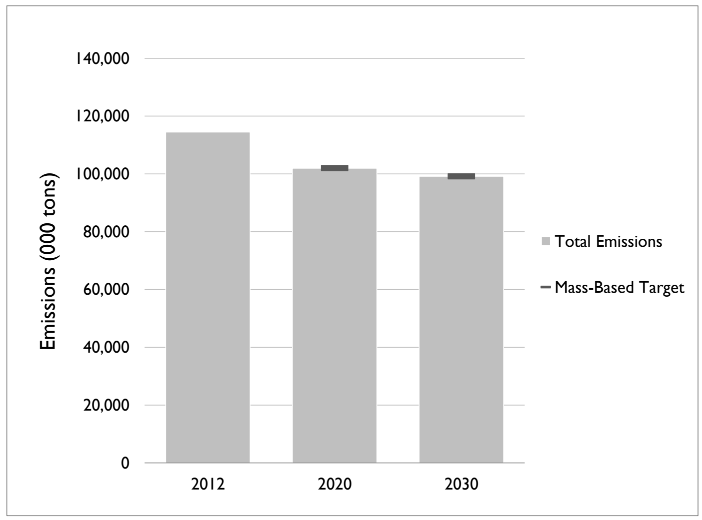


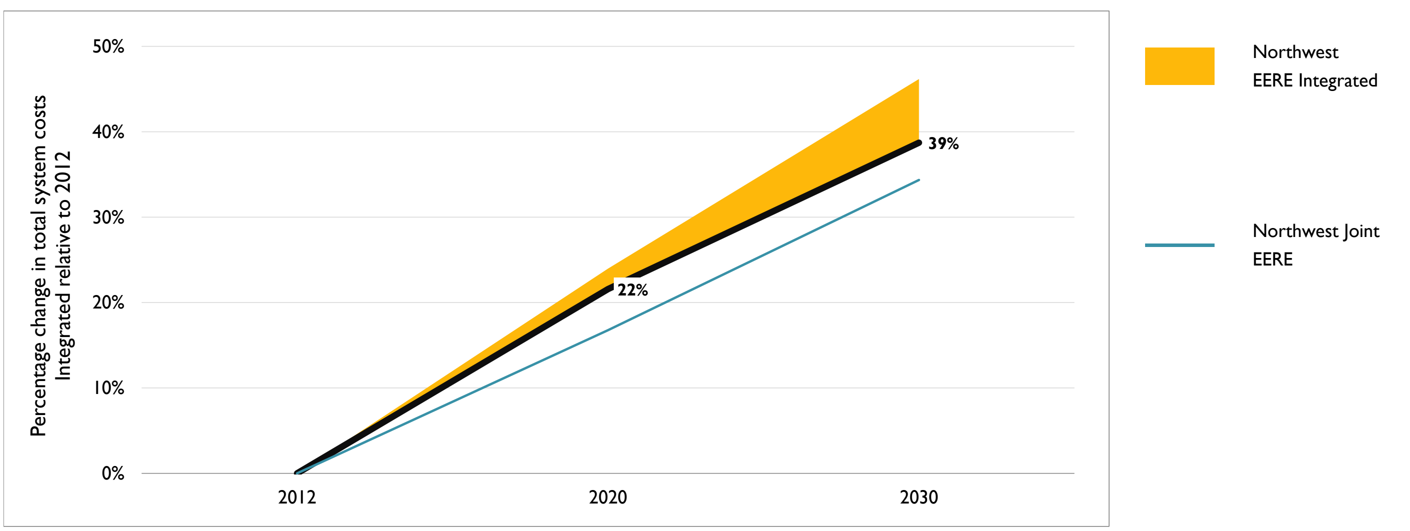


Northwest EERE Integrated

Key Findings	The Northwest complies by meeting state RPS requirements early and exceeding these requirements by 19%.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	MT, OR, and WA meet their RPS requirements; 6.4 GW of renewables added by 2030.
Existing NGCC	2012 NGCC generation increases as Cheyenne Generation Station comes online in 2013.
New NGCC	No new NGCC capacity is added.
Coal	2 GW of coal capacity retires by 2021.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

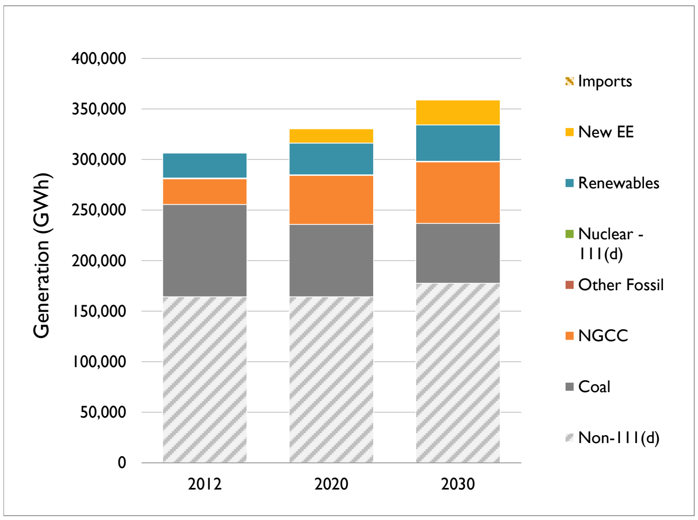


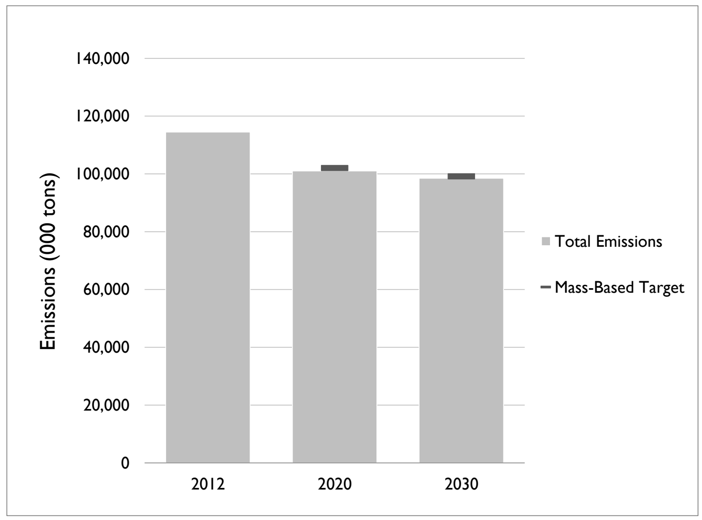


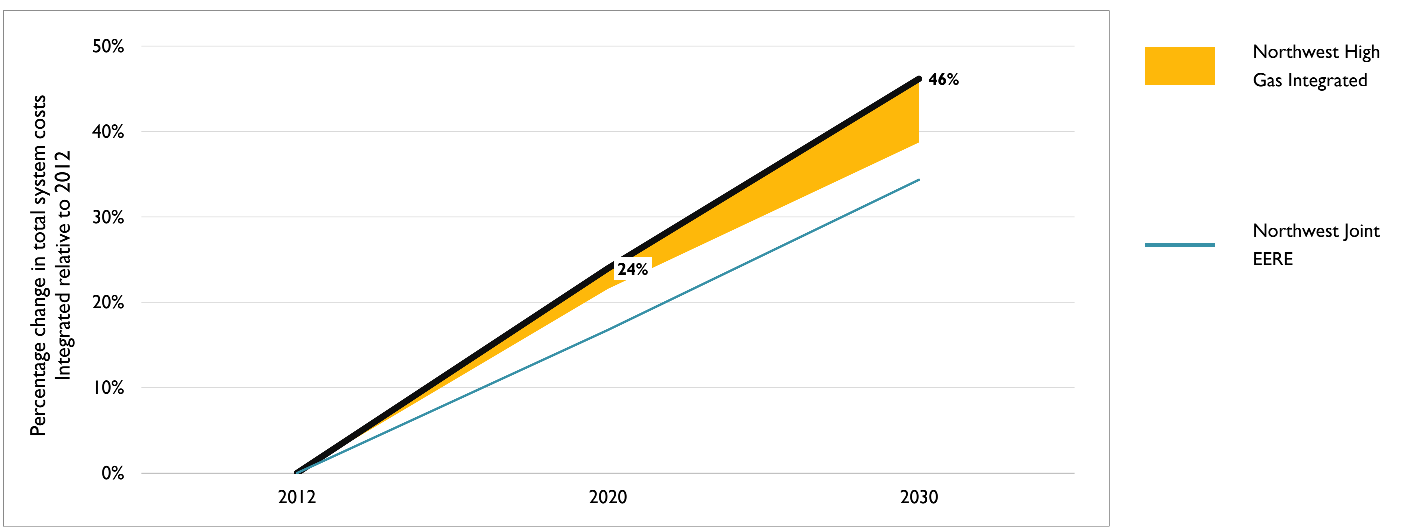


Northwest High Gas Integrated

Key Findings	The Northwest complies by displacing existing coal with existing NGCCs.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	MT, OR, and WA meet their RPS requirements.
Existing NGCC	Existing NGCC capacity factors increase from 31% in 2012 to 72% in 2030.
New NGCC	2.3 GW of new NGCC is added by 2030.
Coal	2 GW of coal capacity retires by 2021.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

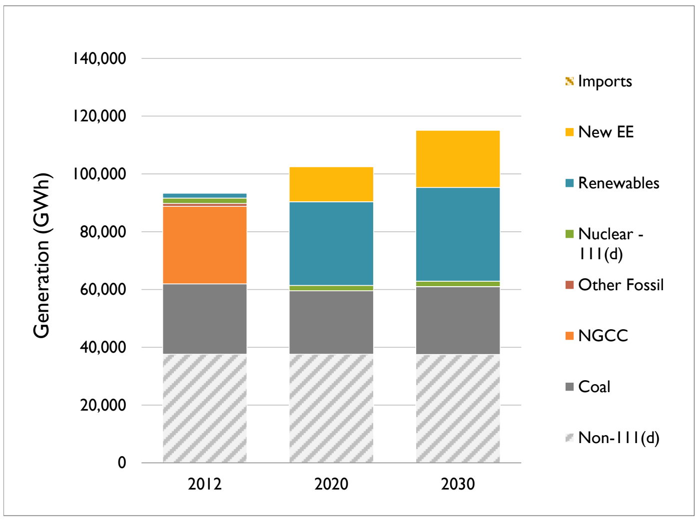


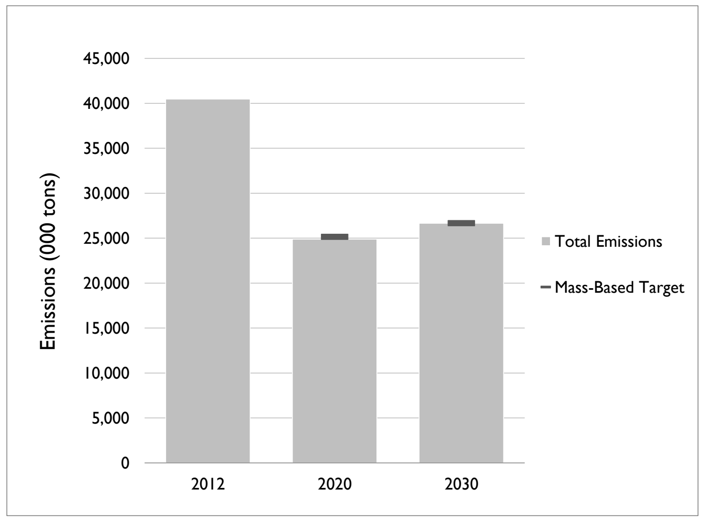


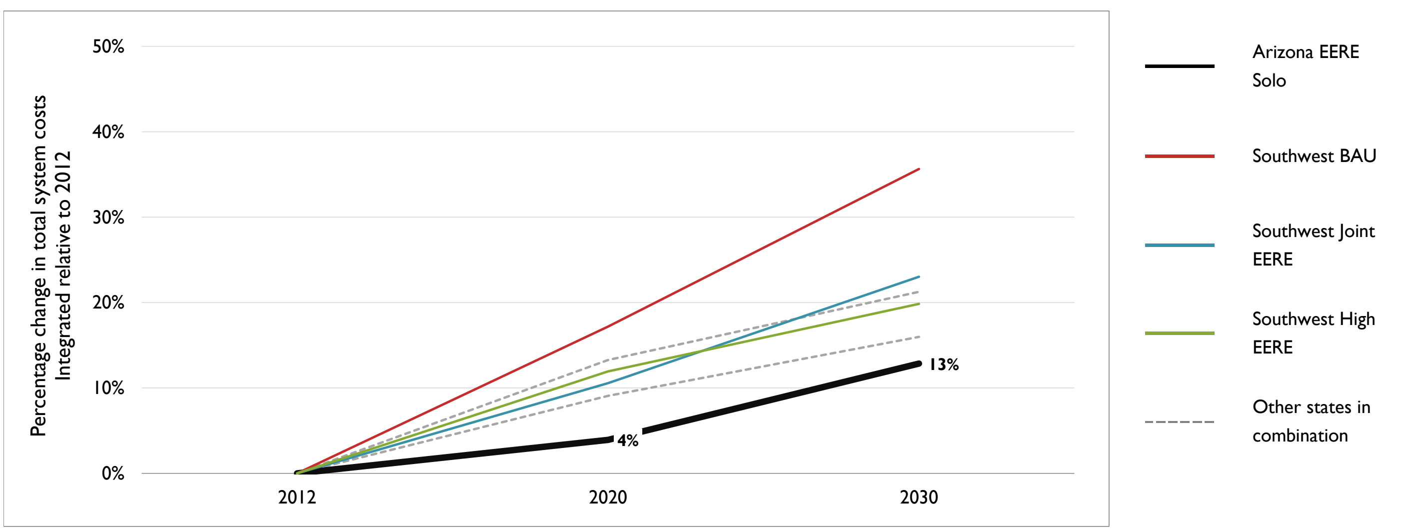


Arizona EERE Solo

Key Findings	Arizona complies by displacing existing NGCCs with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	AZ meets its RPS requirements (15% of sales by 2025) and builds 11.8 GW of additional renewables.
Existing NGCC	NGCC generation is completely displaced by new EE and RE.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant at 2012 levels.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-



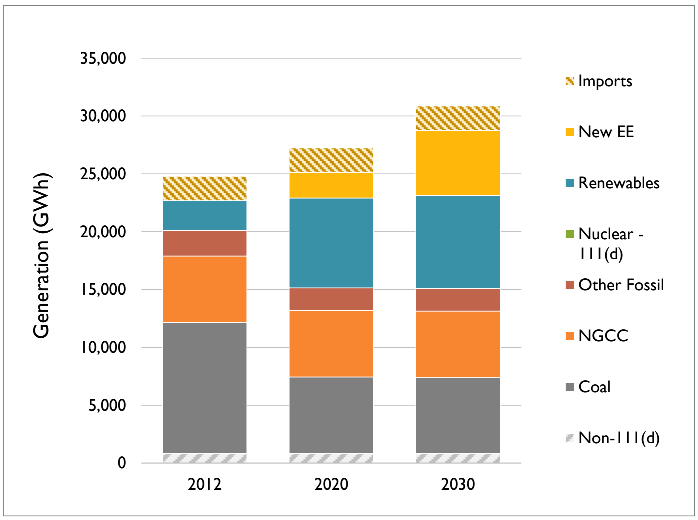


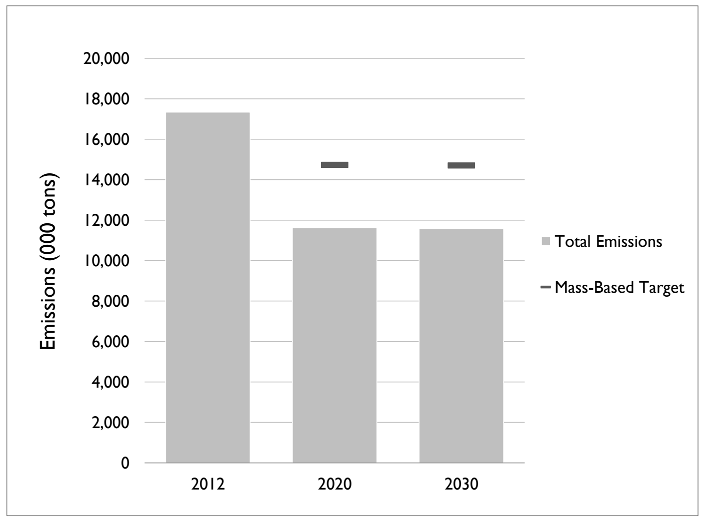


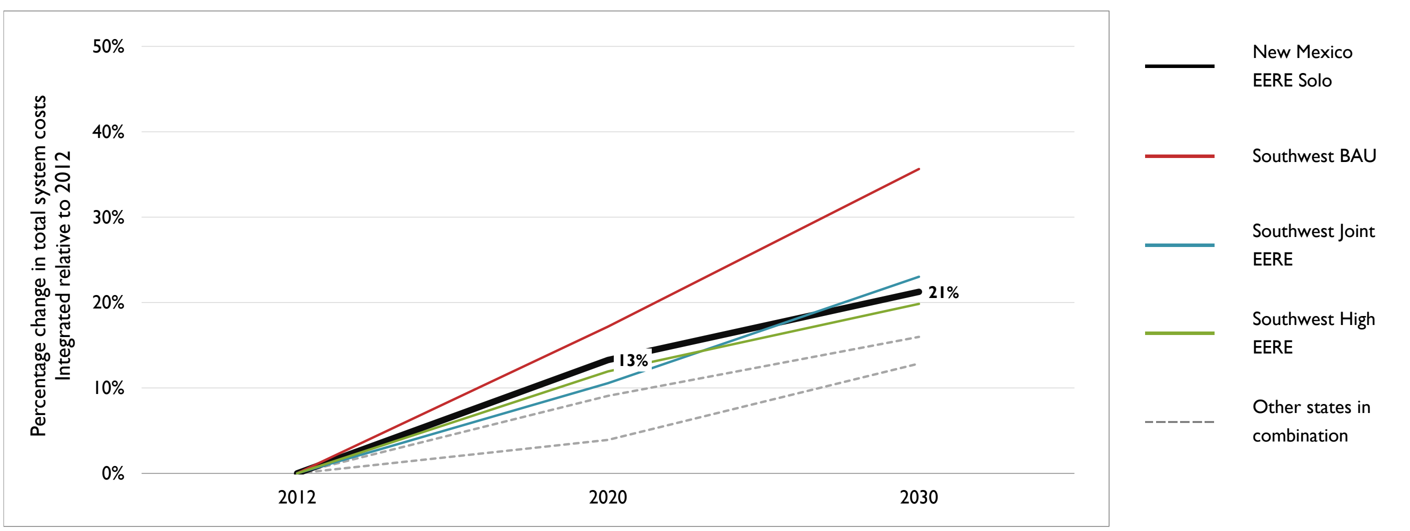
Percentage change in total system costs for Navajo not shown; Navajo is expected to have costs lower than 2012 in all years and runs.

New Mexico EERE Solo

Key Findings	NM over-complies by meeting its generation requirements with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	NM meets its RPS requirements (20% of sales by 2020) and builds 2.8 GW of additional renewables.
Existing NGCC	2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018.
Imports/Exports	Net imports remain constant at 2012 levels in all years.
Other	-



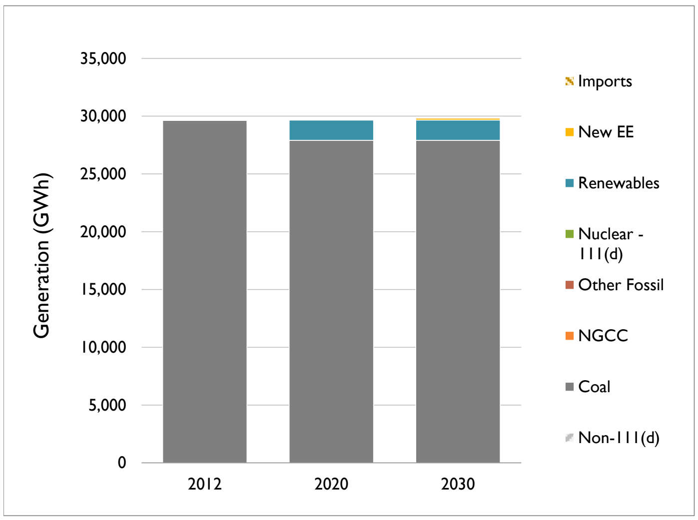


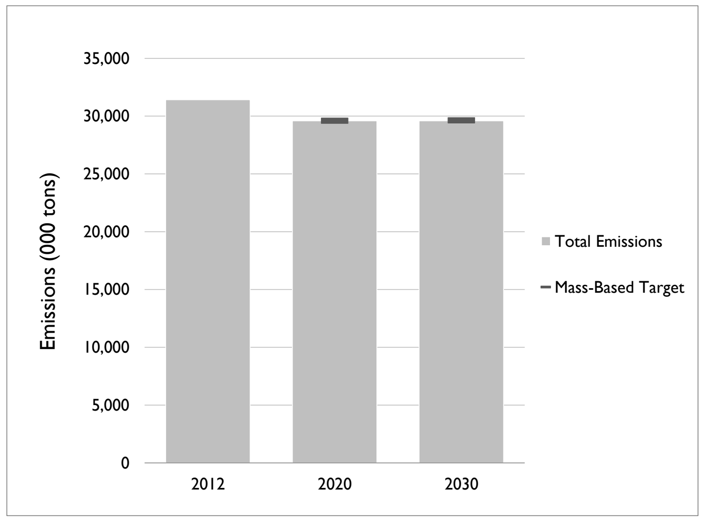


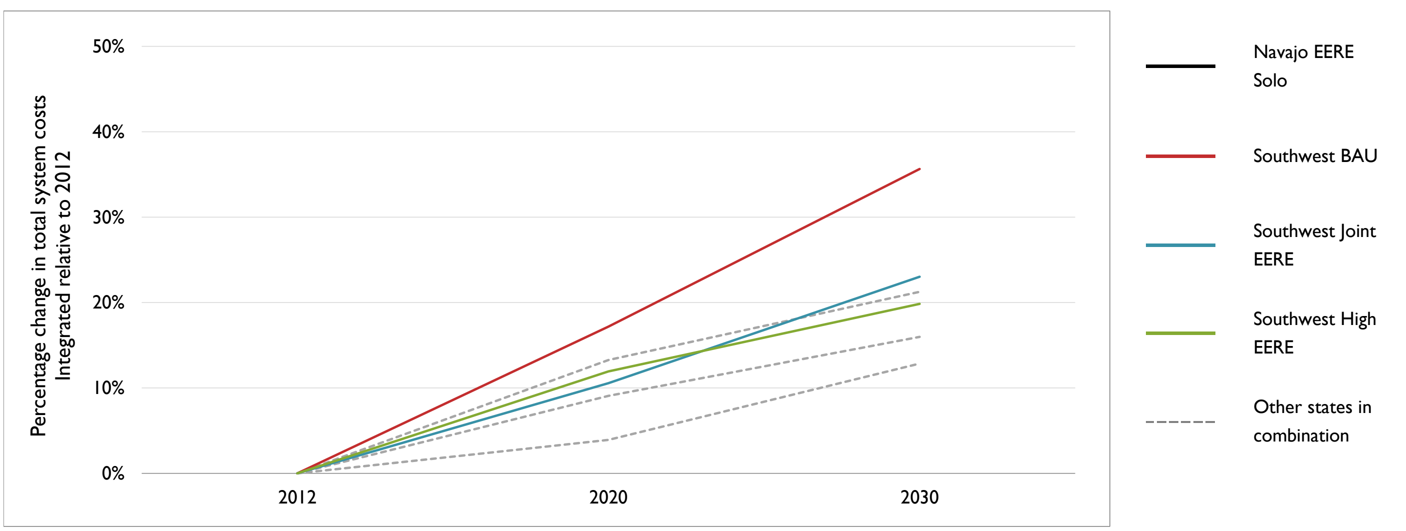
Percentage change in total system costs for Navajo not shown; Navajo is expected to have costs lower than 2012 in all years and runs.

Navajo EERE Solo

Key Findings	Navajo complies by displacing coal with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	0.8 GW of utility solar added by 2030.
Existing NGCC	Navajo has no existing NGCC capacity.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant at 2012 levels.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-



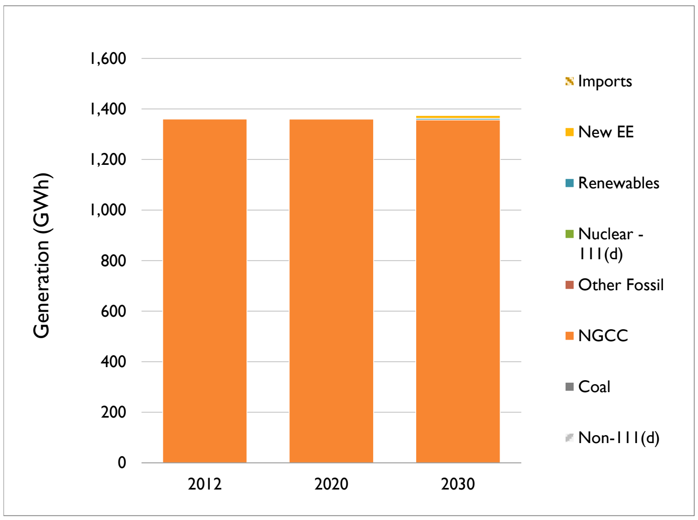


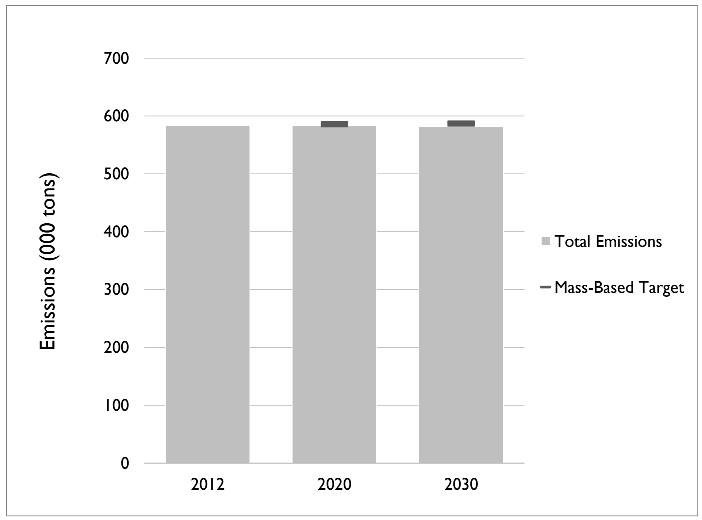


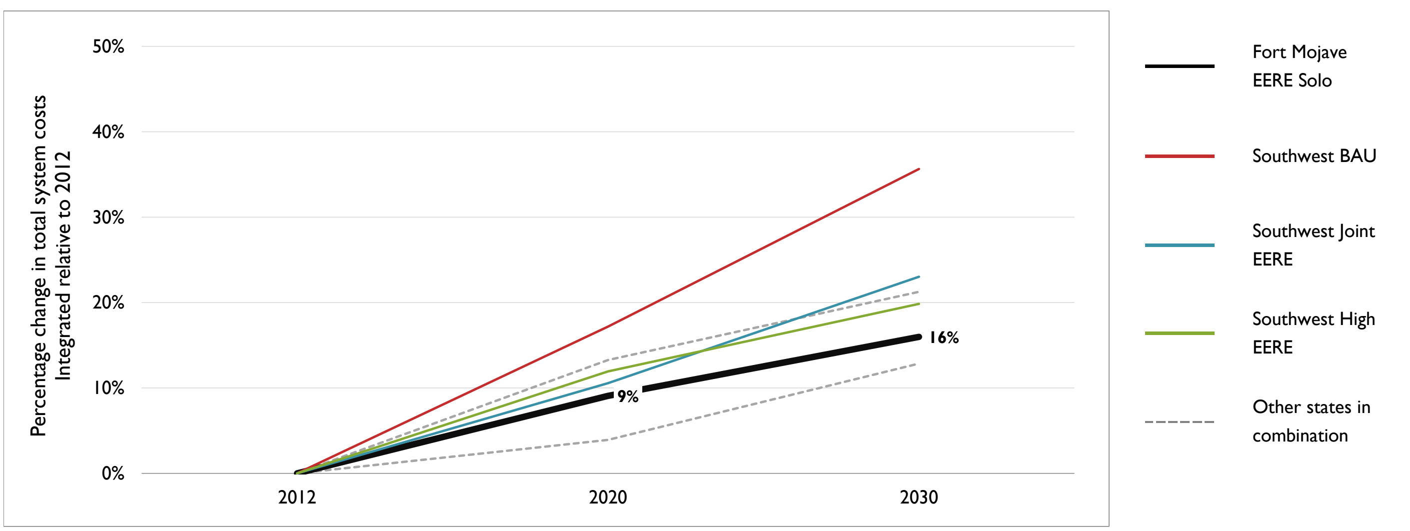
Percentage change in total system costs for Navajo not shown; Navajo is expected to have costs lower than 2012 in all years and runs.

Fort Mojave EERE Solo

Key Findings	Fort Mojave complies by displacing natural gas with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	3 MW of utility solar added by 2030.
Existing NGCC	2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	Fort Mojave has no existing coal capacity.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-



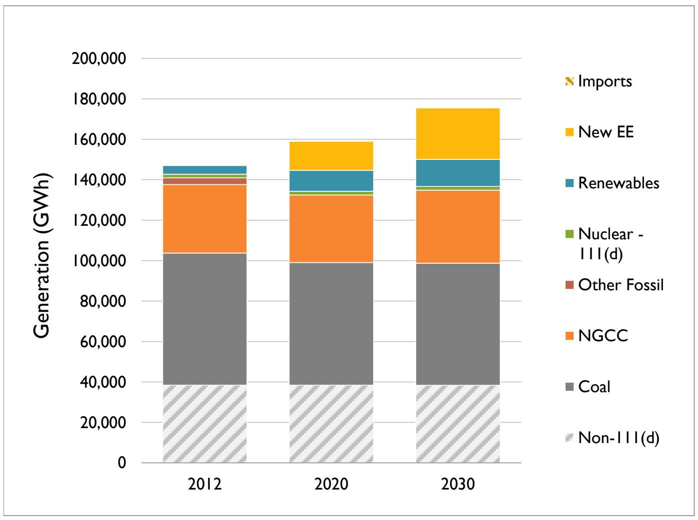


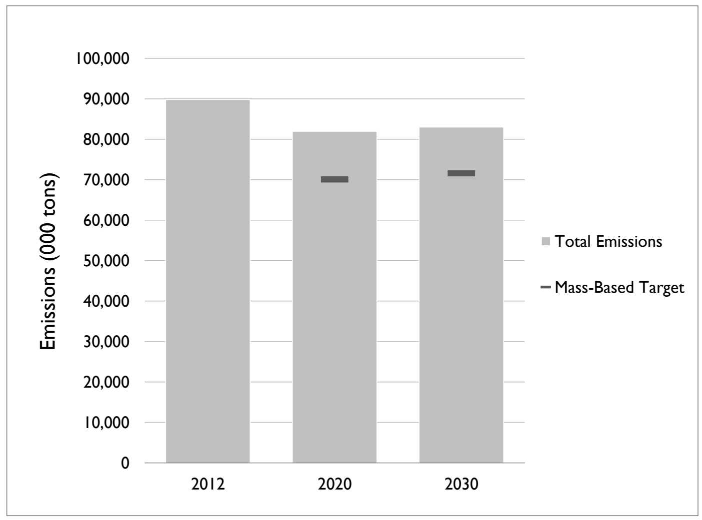


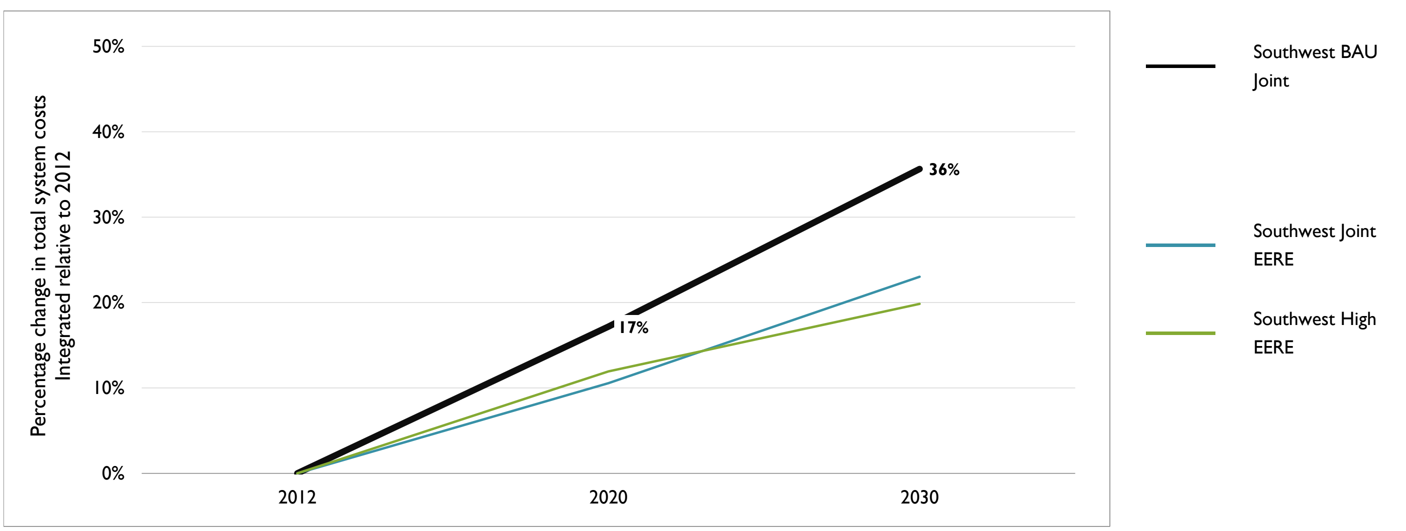
Percentage change in total system costs for Navajo not shown; Navajo is expected to have costs lower than 2012 in all years and runs.

Southwest BAU Joint

Key Findings	This scenario is non-compliant. Existing NGCC generation is increased to meet sales requirements.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	AZ and NM meet their RPS requirements.
Existing NGCC	NGCC average capacity factor increases from 29% in 2012 to 31% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

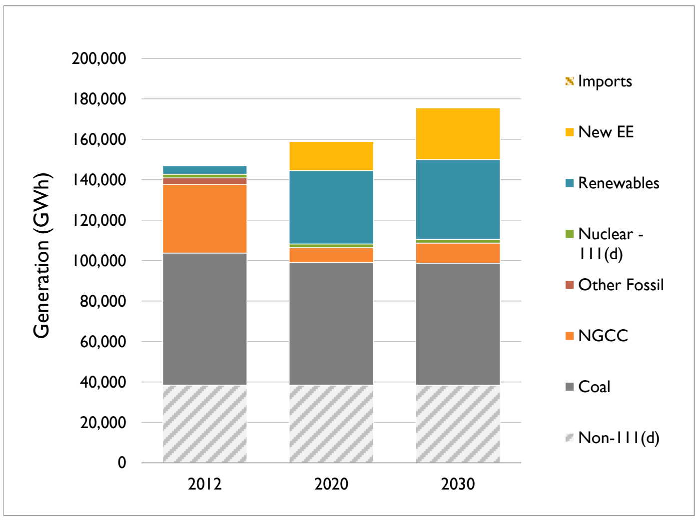


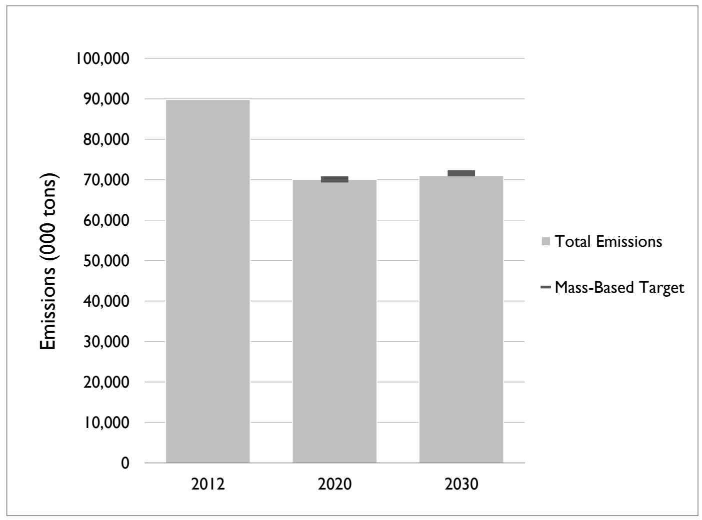


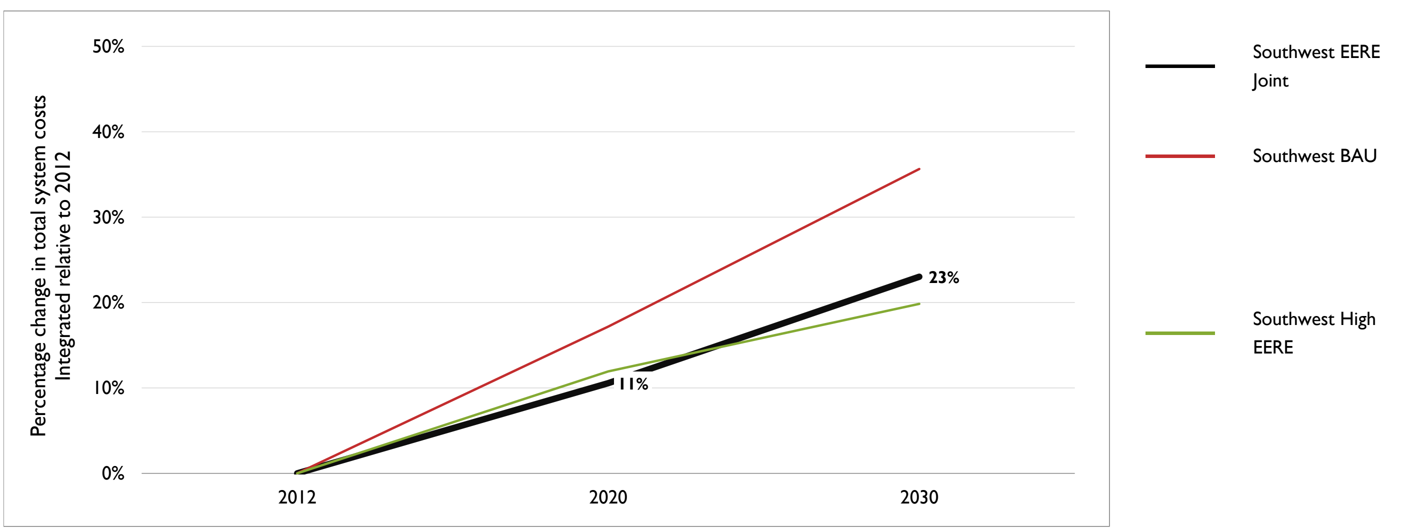


Southwest EERE Joint

Key Findings	The Southwest complies by displacing existing NGCC generation with renewables and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	AZ and NM meet their RPS requirements; 16 GW of new renewables added by 2030.
Existing NGCC	NGCC average capacity factor falls from 29% in 2012 to 8% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

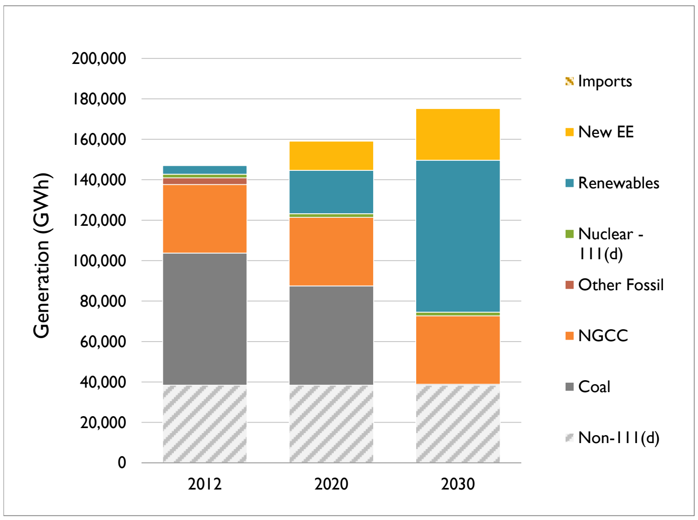


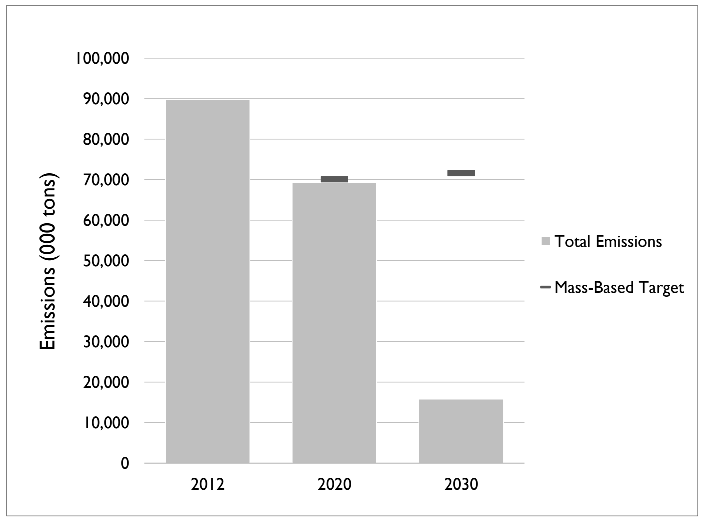


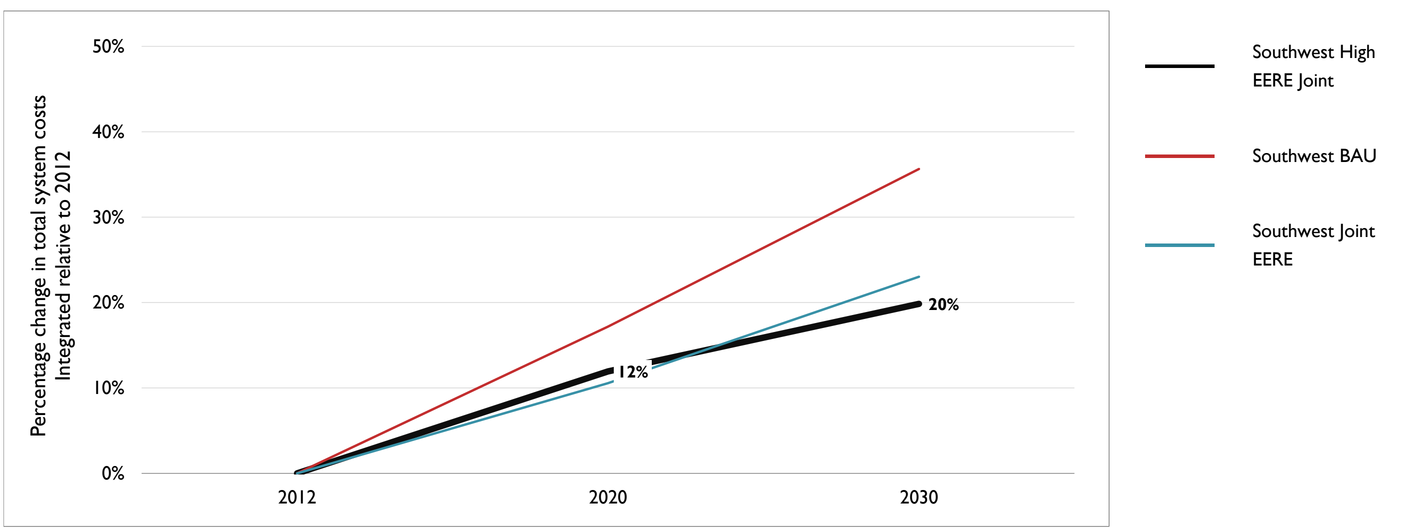


Southwest High EERE Joint

Key Findings	Renewable generation is increased to a level sufficient to displace coal generation.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	32 GW of new renewables added by 2030.
Existing NGCC	2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018. Coal generation completely displaced by 2030.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

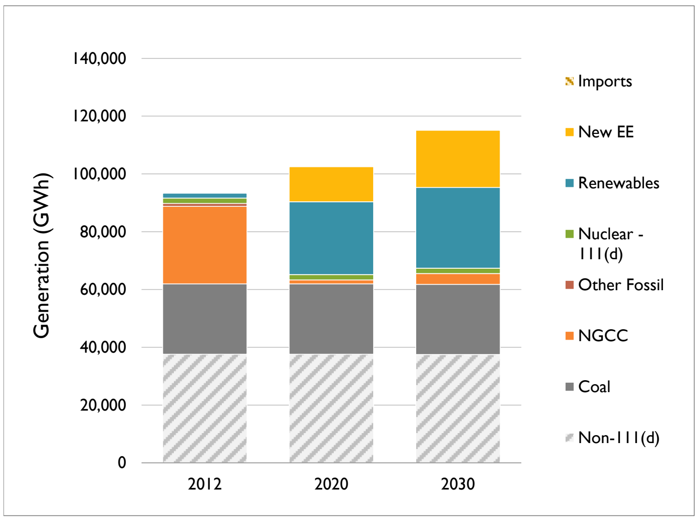


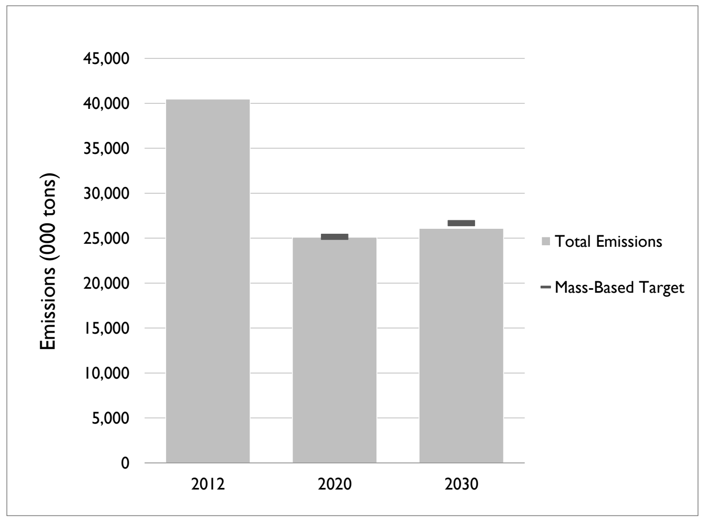


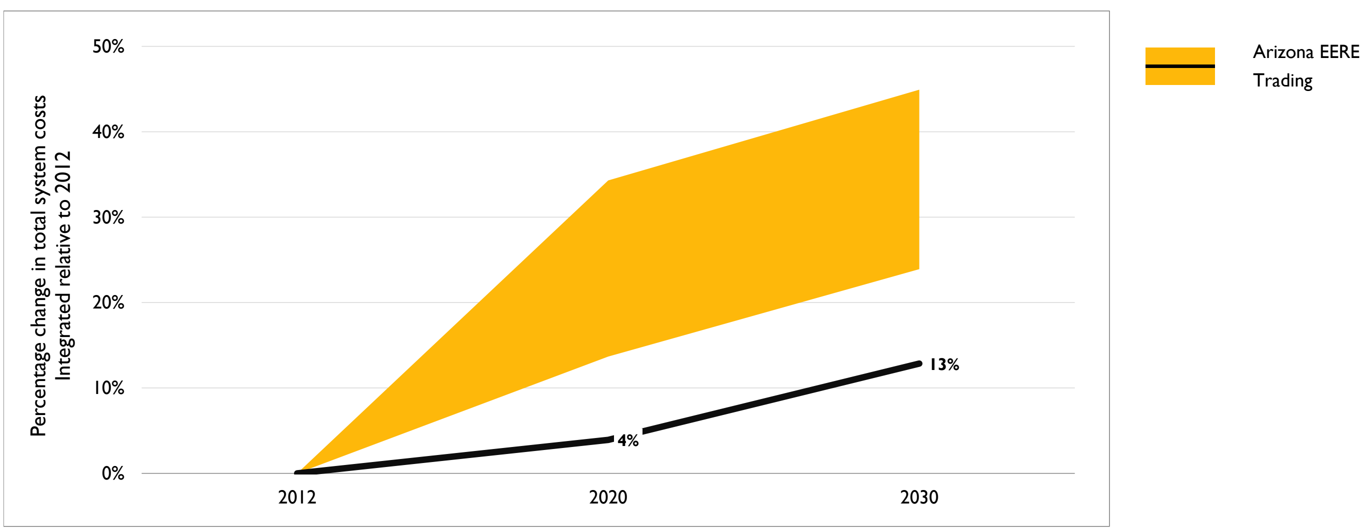


Arizona EERE Trading

Key Findings	WY complies by purchasing compliance credits from NM and building renewables.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	AZ meets its RPS requirements (15% of sales by 2025) and builds 9.5 GW of additional renewables.
Existing NGCC	NGCC generation is almost completely displaced by new EE and RE.
New NGCC	No new NGCC capacity is added.
Coal	Coal capacity remains constant at 2012 levels.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	AZ purchases all available compliance credits from NM.

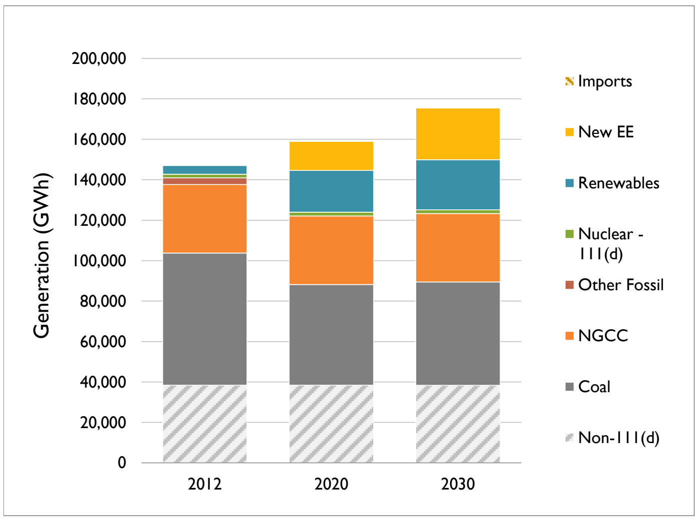


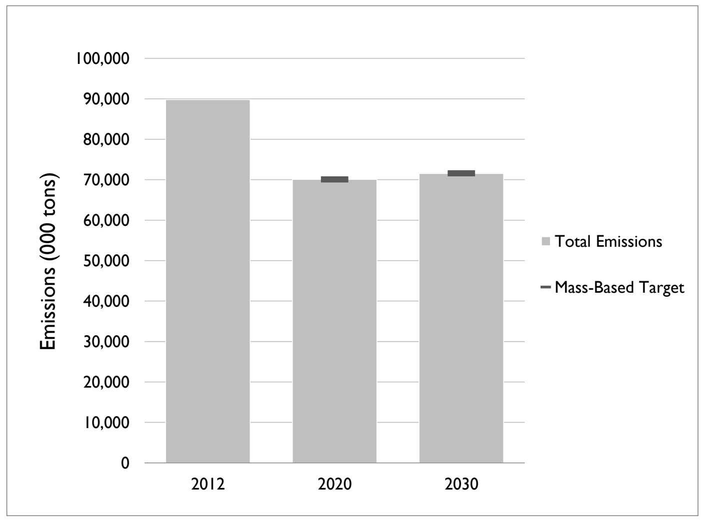


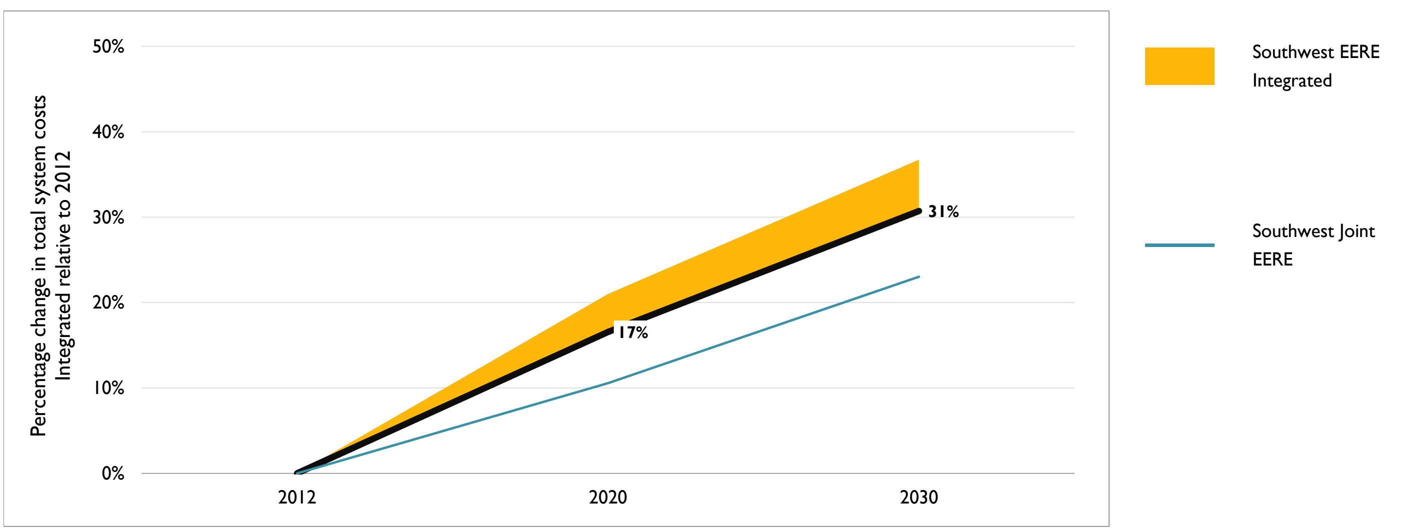


Southwest EERE Integrated

Key Findings	The Southwest complies by meeting state RPS requirements early and exceeding these requirements by 120%.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	AZ and NM meet their RPS requirements; 9.5 GW of new renewables added by 2030.
Existing NGCC	2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

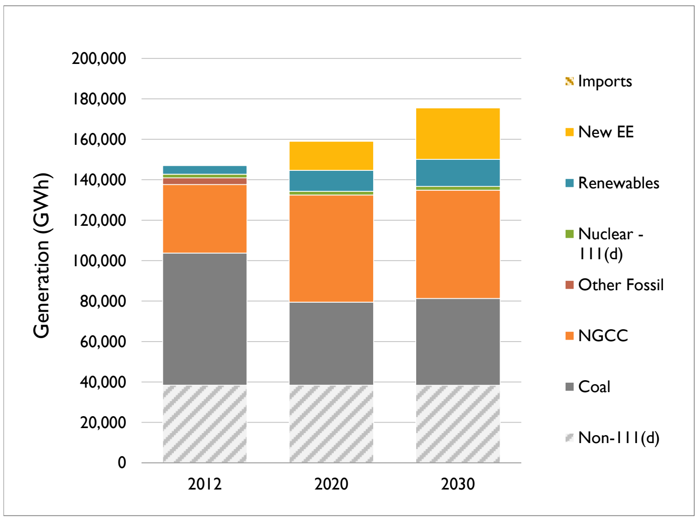


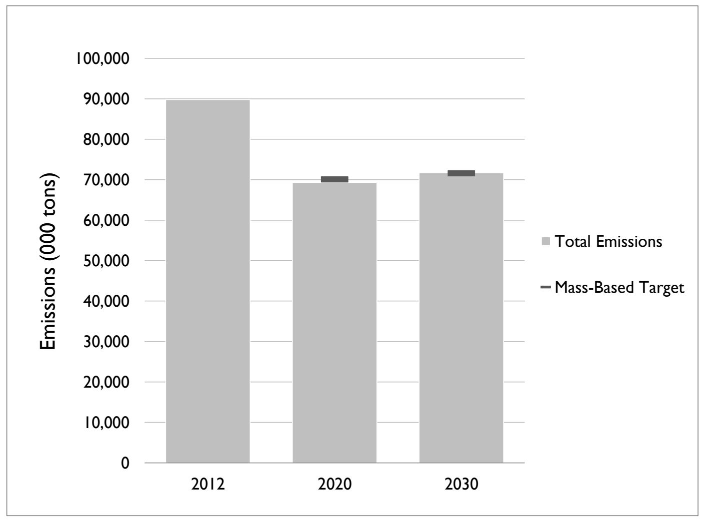


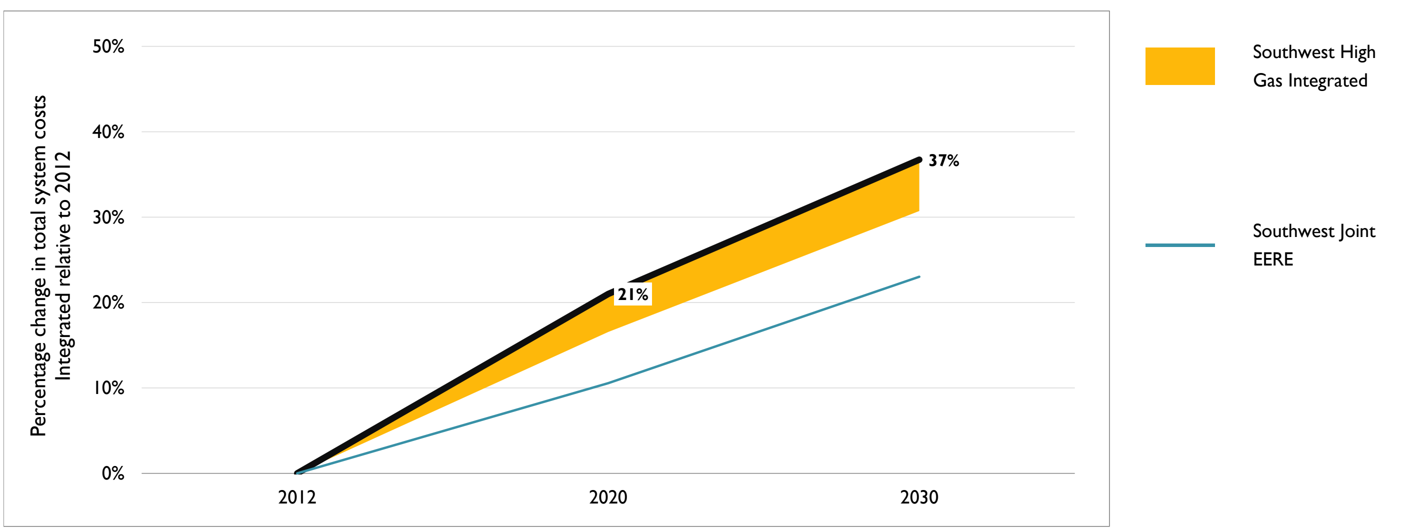


Southwest High Gas Integrated

Key Findings	The Southwest complies by displacing existing coal with existing NGCCs.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	AZ and NM meet their RPS requirements.
Existing NGCC	NGCC average capacity factor increases from 29% in 2012 to 45% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	924 MW retired in 2018.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

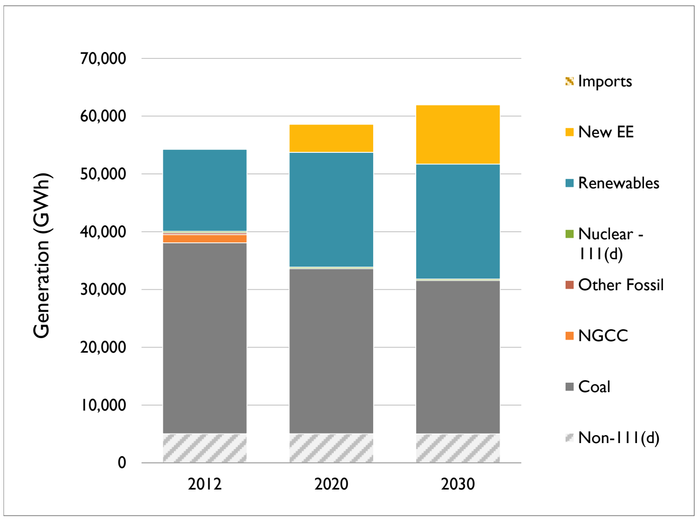


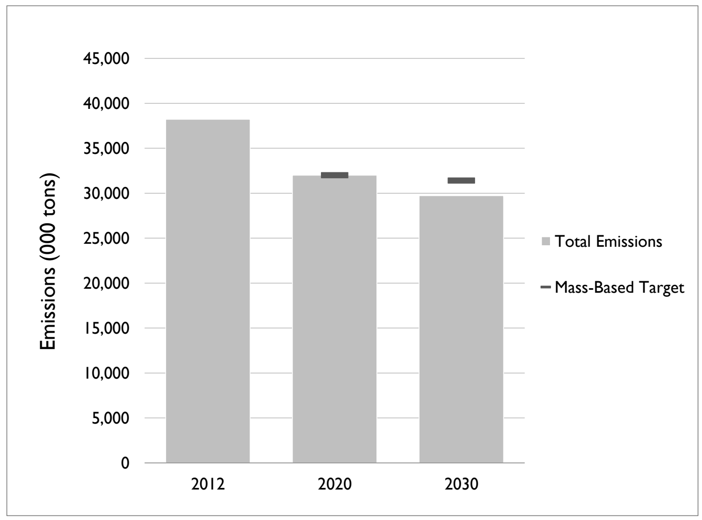


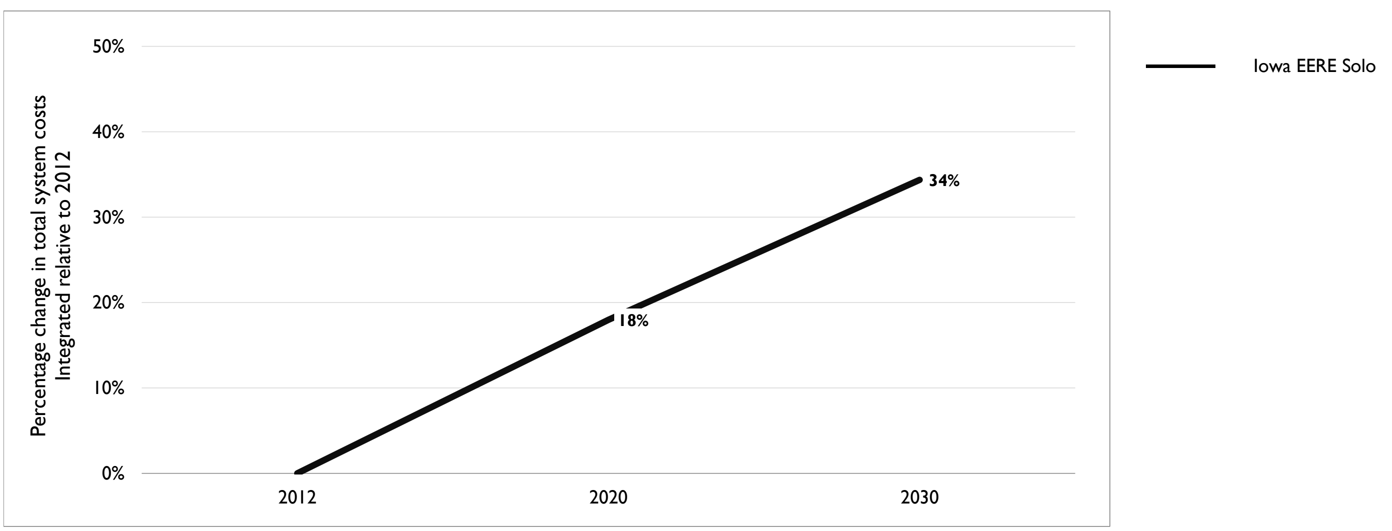


Iowa EERE Solo

Key Findings	IA complies by displacing NGCCs and coal with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	1.6 GW of additional wind required by 2030.
Existing NGCC	NGCC generation is completely displaced by new EE and RE.
New NGCC	No new NGCC capacity is added.
Coal	753 MW retired by 2017.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	185 MW of oil/gas steam capacity is retired by 2017.

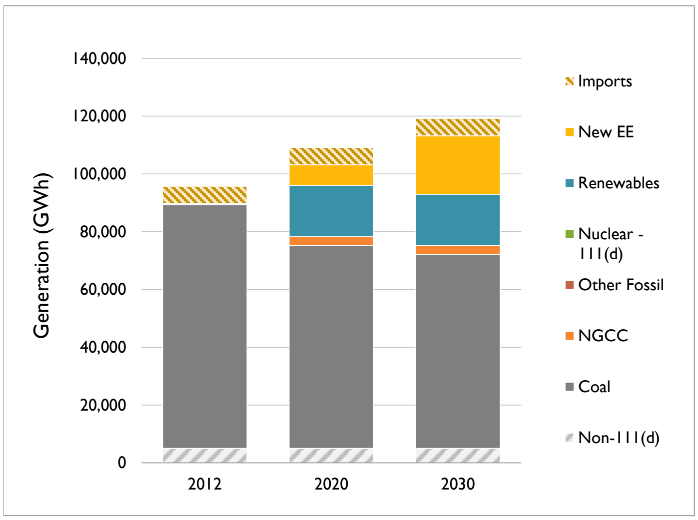


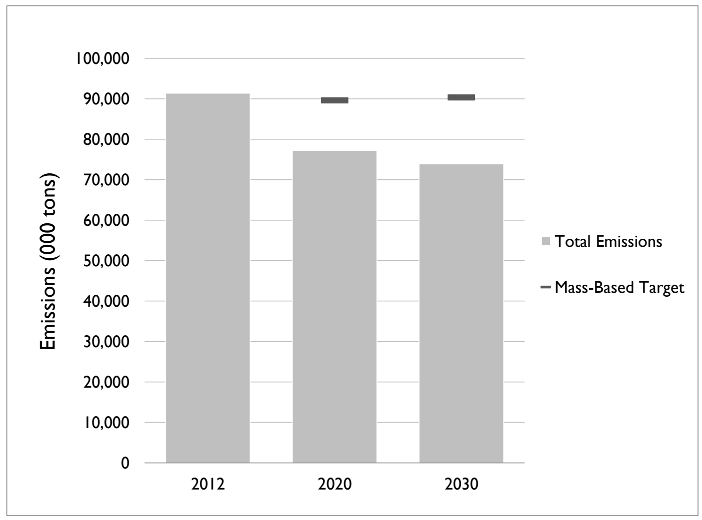


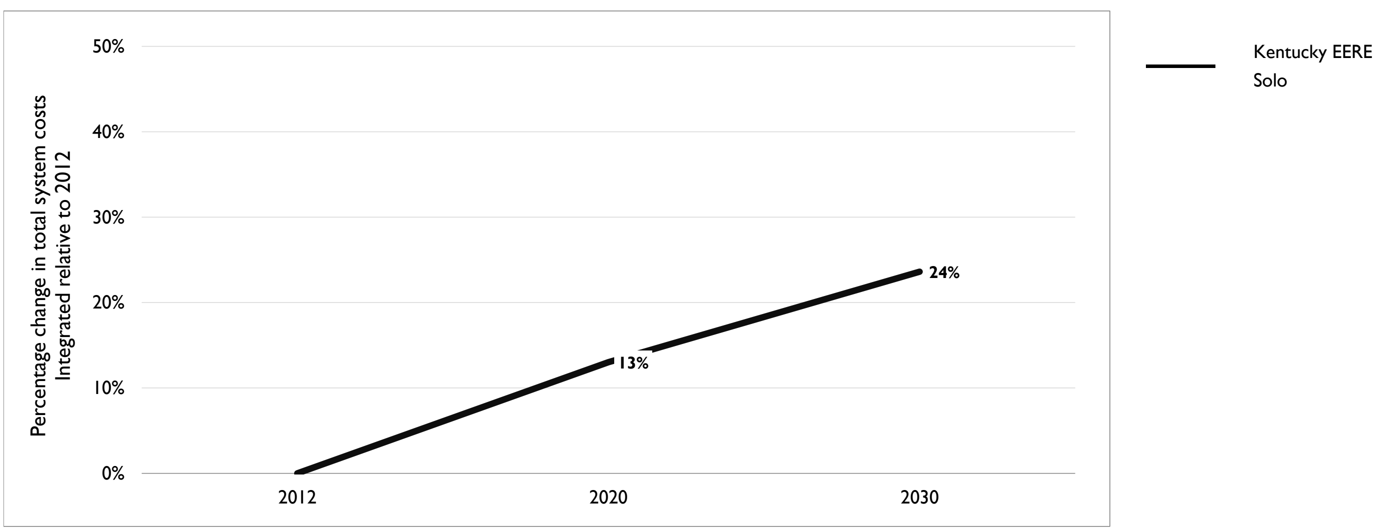


Kentucky EERE Solo

Key Findings	KY complies through currently-announced coal retirements and increased energy efficiency and renewables.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	10.3 GW renewables added by 2030.
Existing NGCC	2012 NGCC generation increases as Cane Run comes online in 2013.
New NGCC	No new NGCC capacity is added.
Coal	3.4 GW retired by 2017.
Imports/Exports	Net imports remain constant at 2012 levels from 2020 through 2030.
Other	-

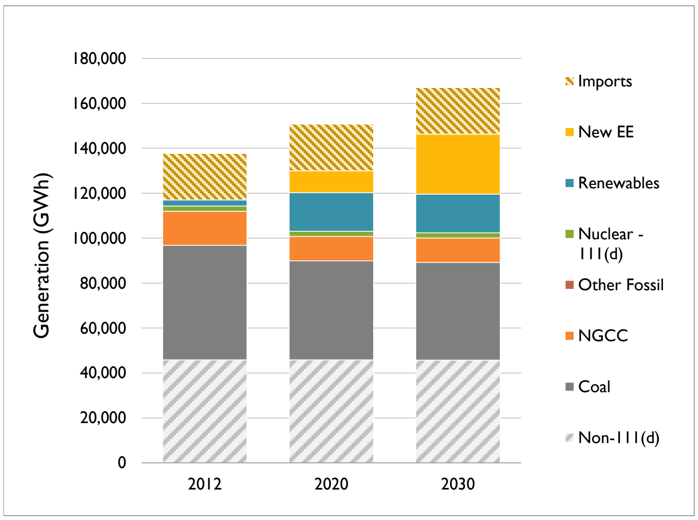


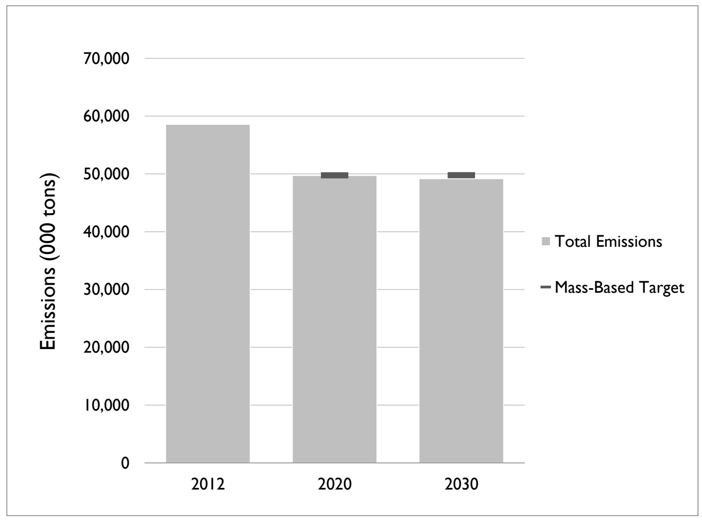


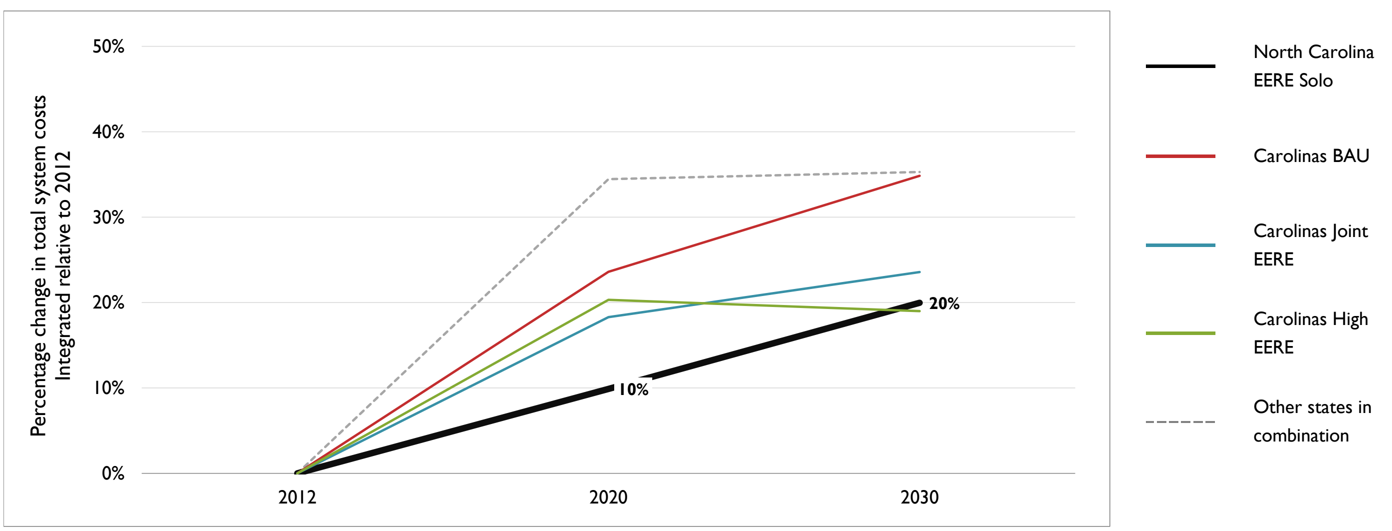


North Carolina EERE Solo

Key Findings	NC complies by displacing NGCCs and coal with new renewable energy and energy efficiency.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	NC meets its RPS requirements (12.5% of sales by 2021) and by building an additional 0.5 GW of solar.
Existing NGCC	NGCC average capacity factor falls from 37% in 2012 to 18% by 2030.
New NGCC	No new NGCC capacity is added.
Coal	2.4 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

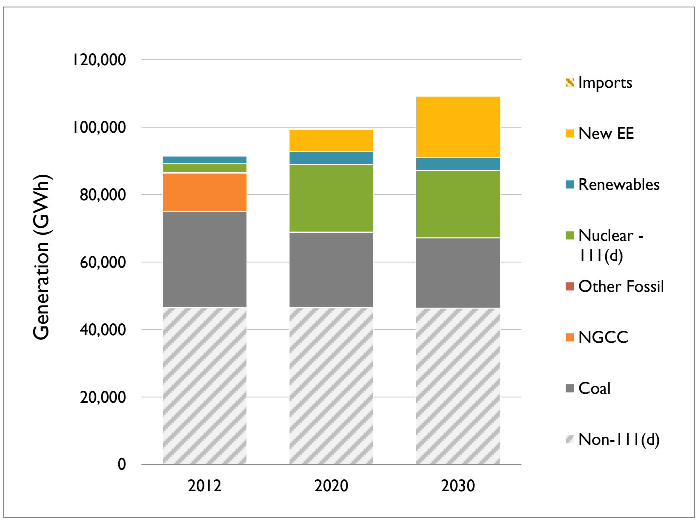


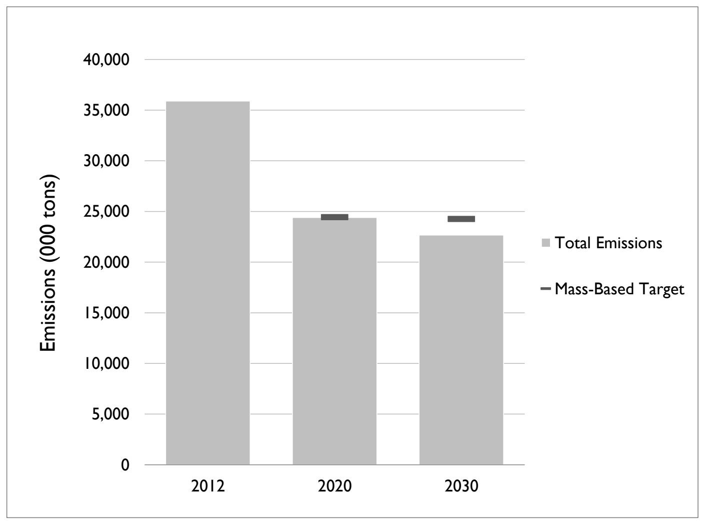


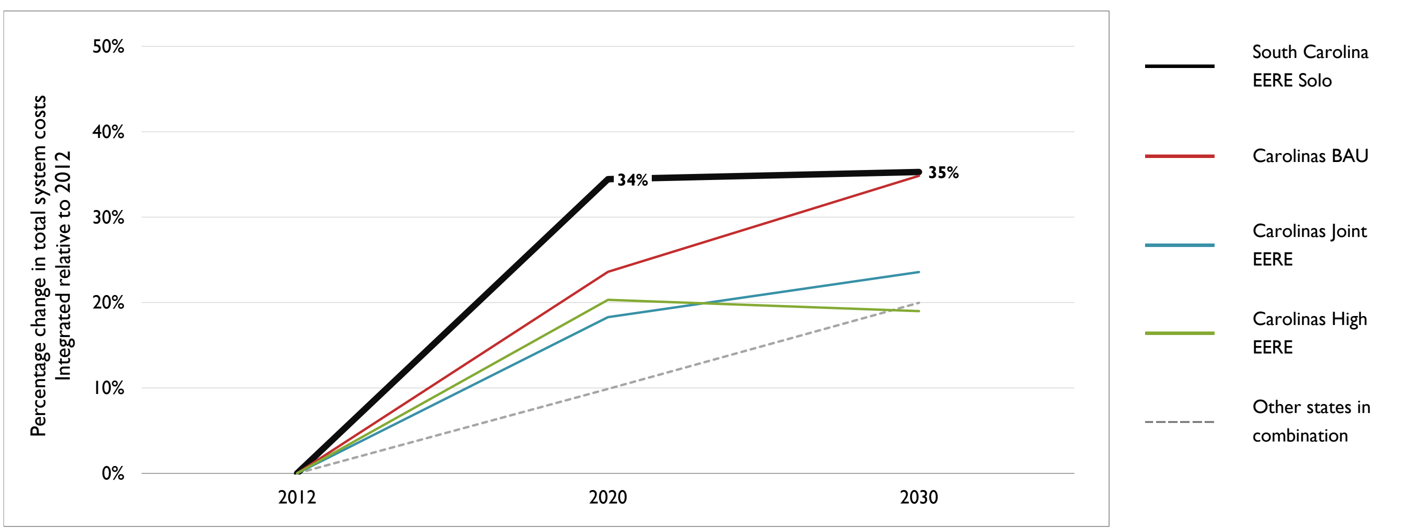


South Carolina EERE Solo

Key Findings	SC complies by achieving 2.5% annual incremental efficiency saving and adding 2.2 GW of new nuclear capacity.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	0.9 GW of utility solar added by 2030.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. NGCC generation is completely displaced by new EE, RE, and new
New NGCC	No new NGCC capacity is added.
Coal	1.8 GW retired by 2019.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

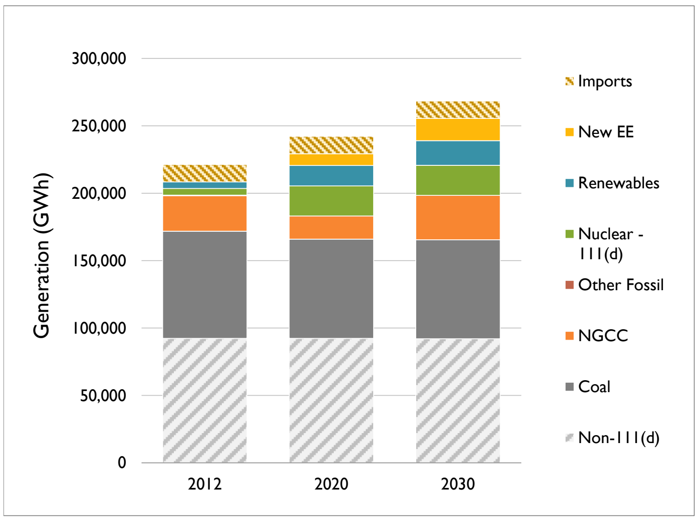


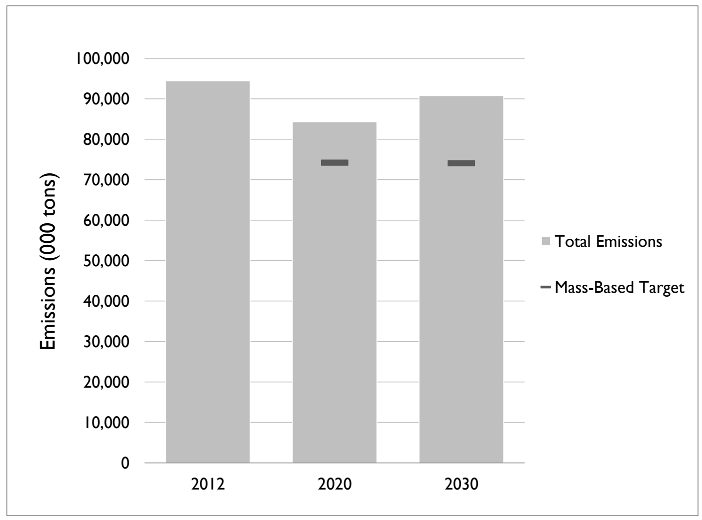


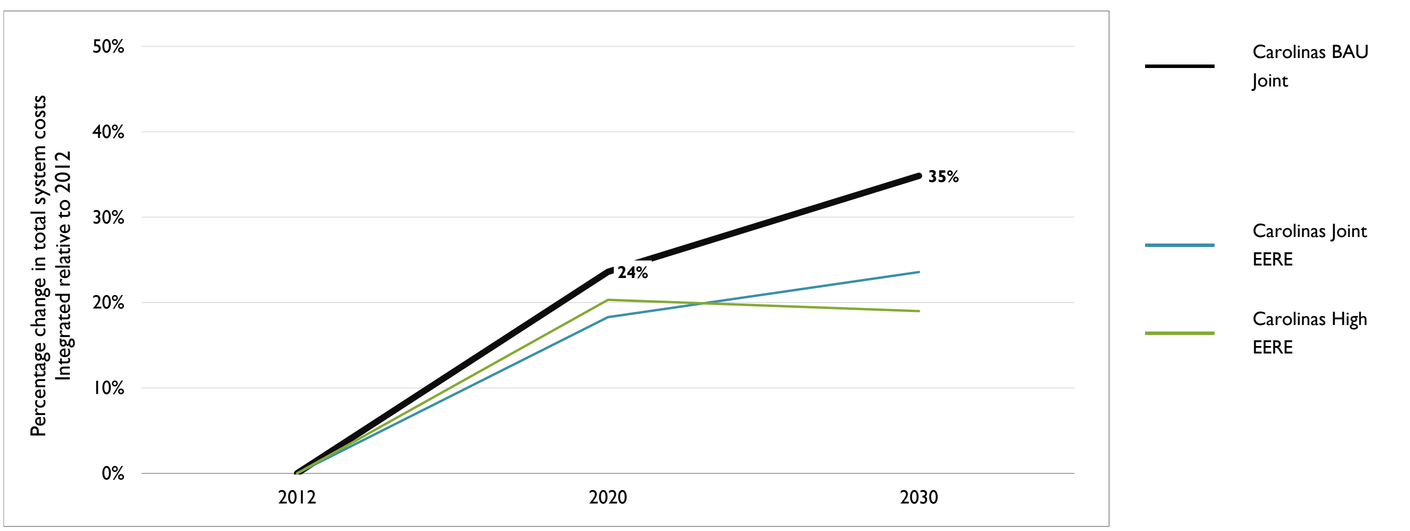


Carolinas BAU Joint

Key Findings	This scenario is non-compliant. Sales requirements are met through NC RPS and new nuclear.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	NC meets its RPS requirements (12.5% of sales by 2021) and by building an additional 0.5 GW of solar.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. 2012 NGCC generation remains constant.
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

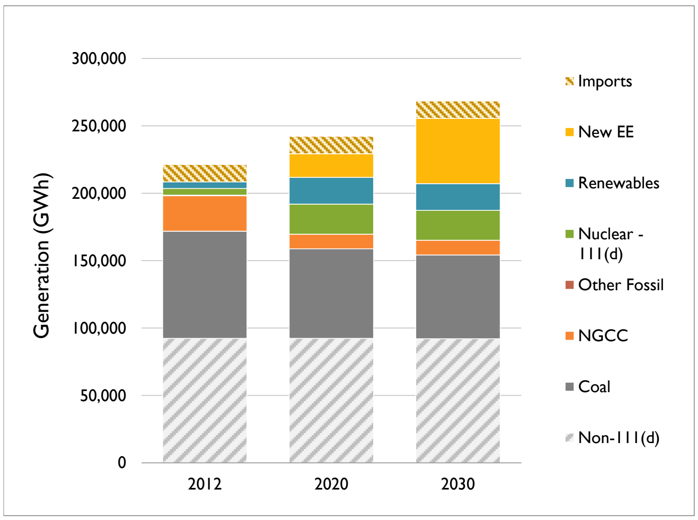


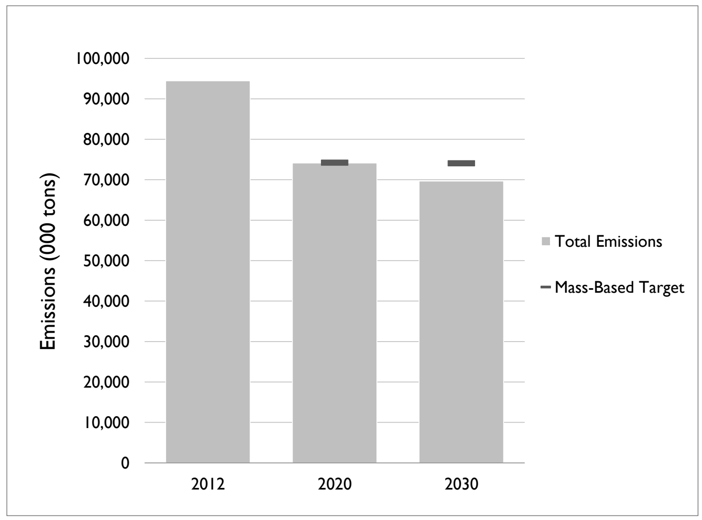


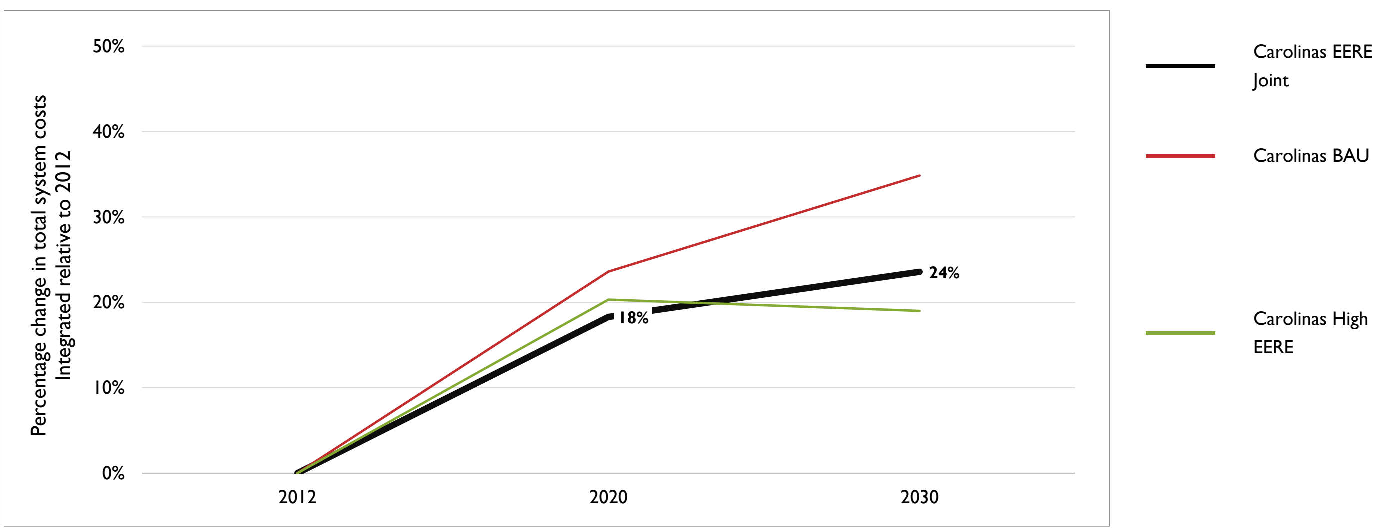


Carolinas EERE Joint

Key Findings	The Carolinas comply through increased energy efficiency and renewables.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	8.9 GW of renewables added by 2030.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. NGCC average capacity factor falls from 40% in 2012 to 13% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

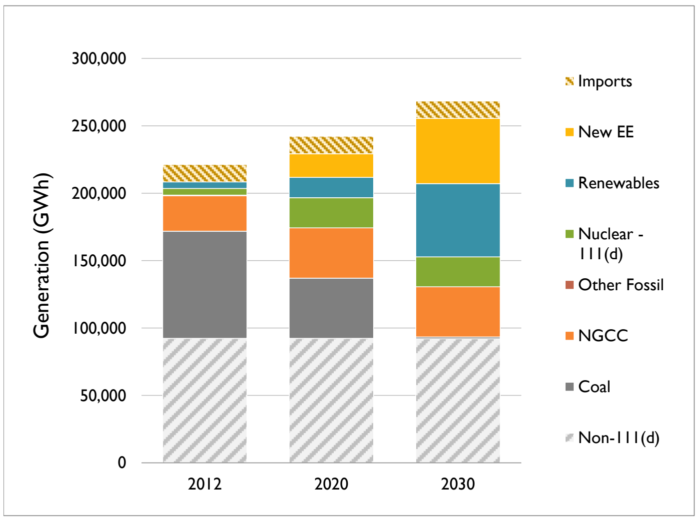


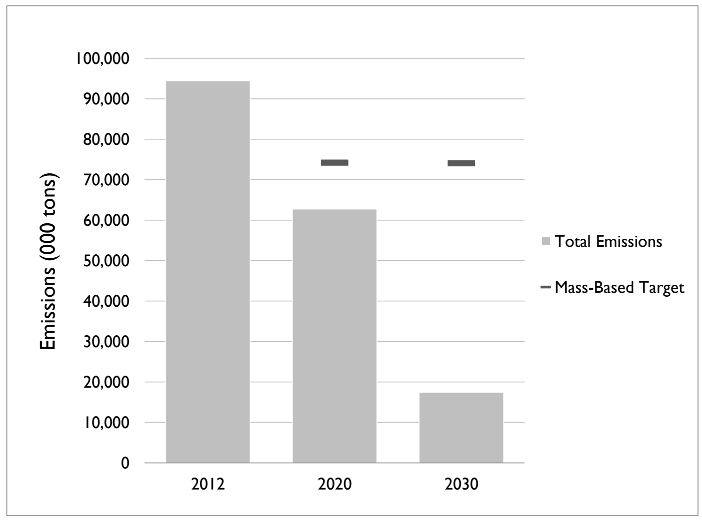


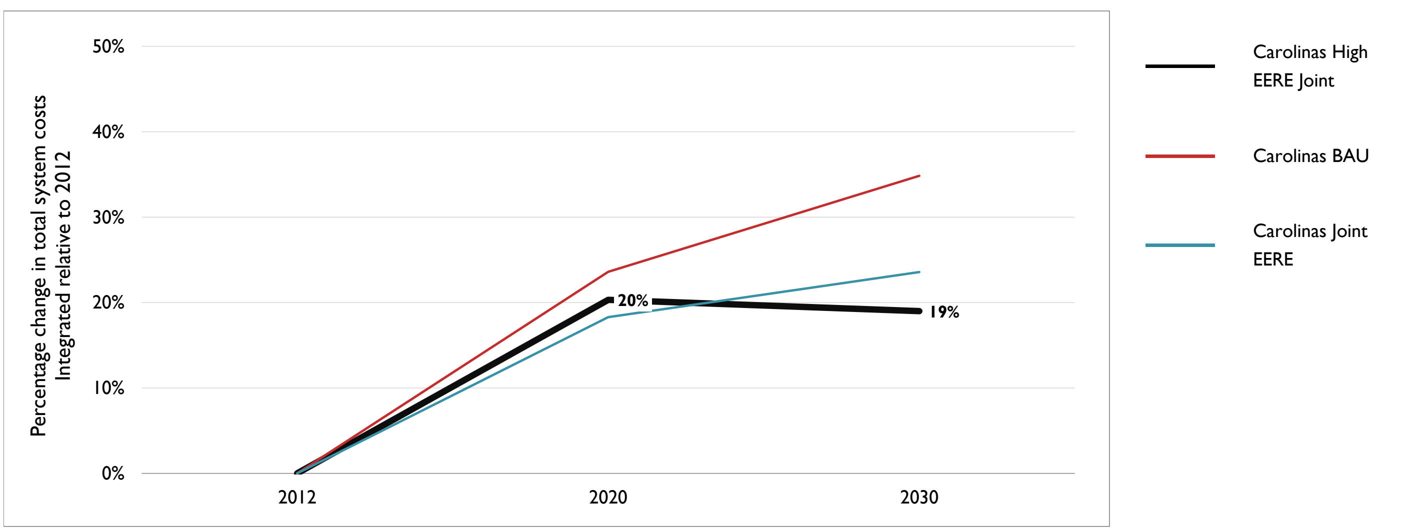


Carolinas High EERE Joint

Key Findings	Renewable generation is increased to a level sufficient to displace coal generation.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	29 GW of new renewables added by 2030.
Existing NGCC	2.2 GW NGCC plant comes online in 2015.
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014. Coal generation completely displaced by 2030.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

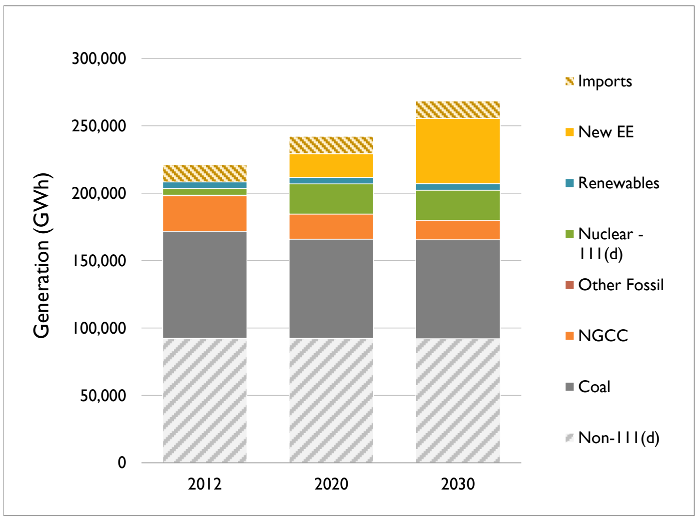


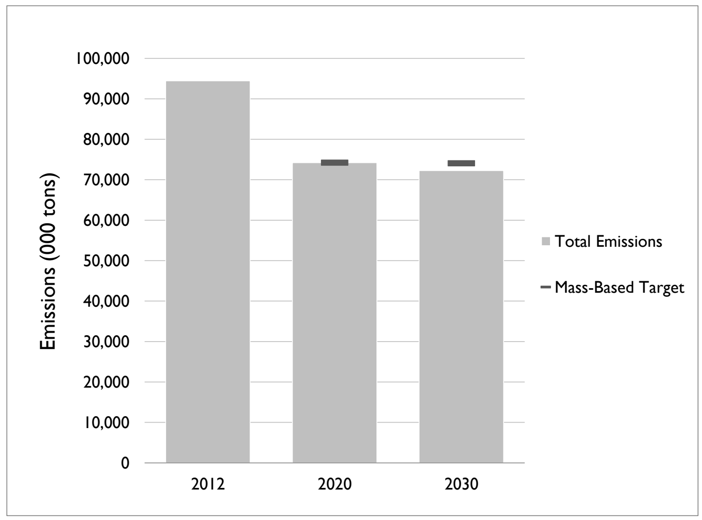


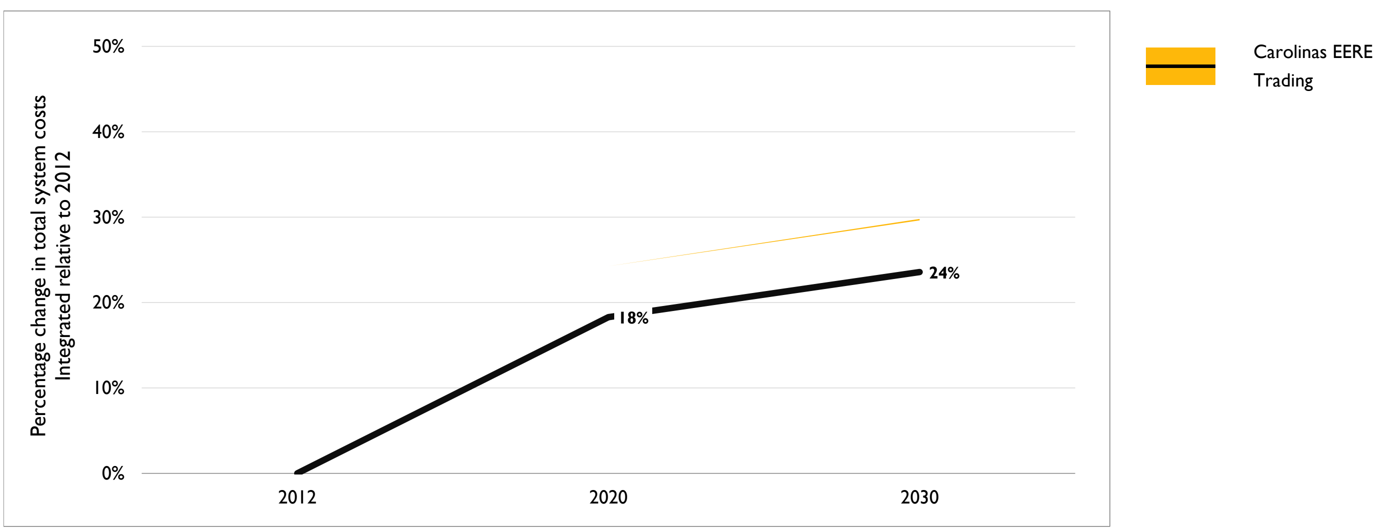


Carolinas EERE Trading

Key Findings	The Carolinas comply through increased energy efficiency and by purchasing RECs from IA.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	The Carolinas purchase 23 TWh of RECs from IA by 2030.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. NGCC average capacity factor falls from 40% in 2012 to 17% in 2030.
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-

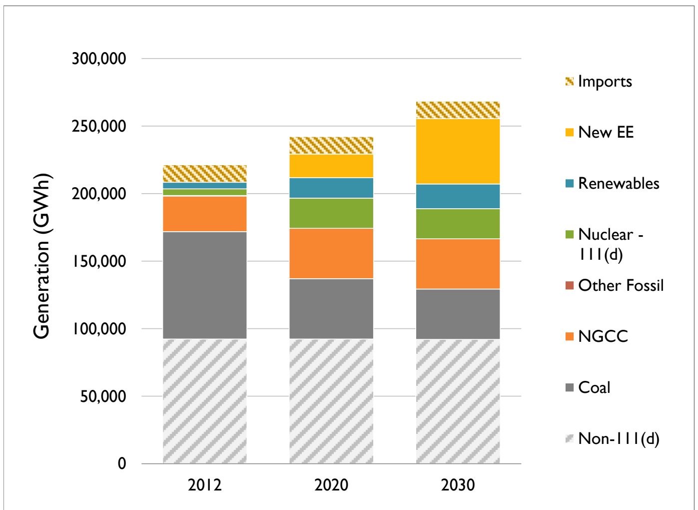


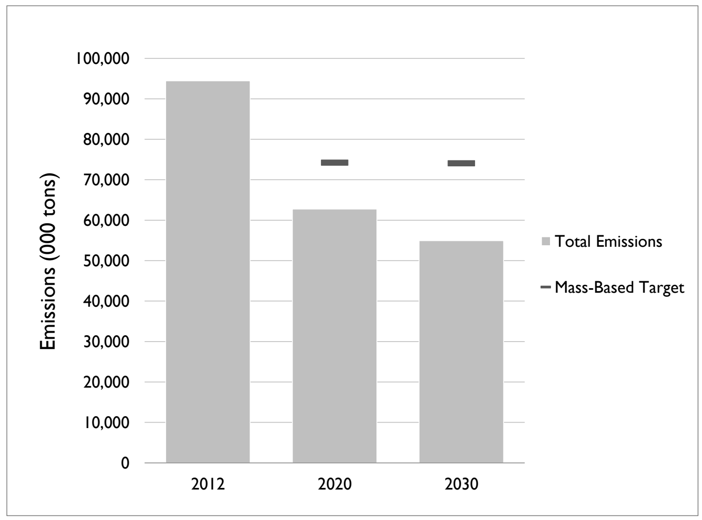


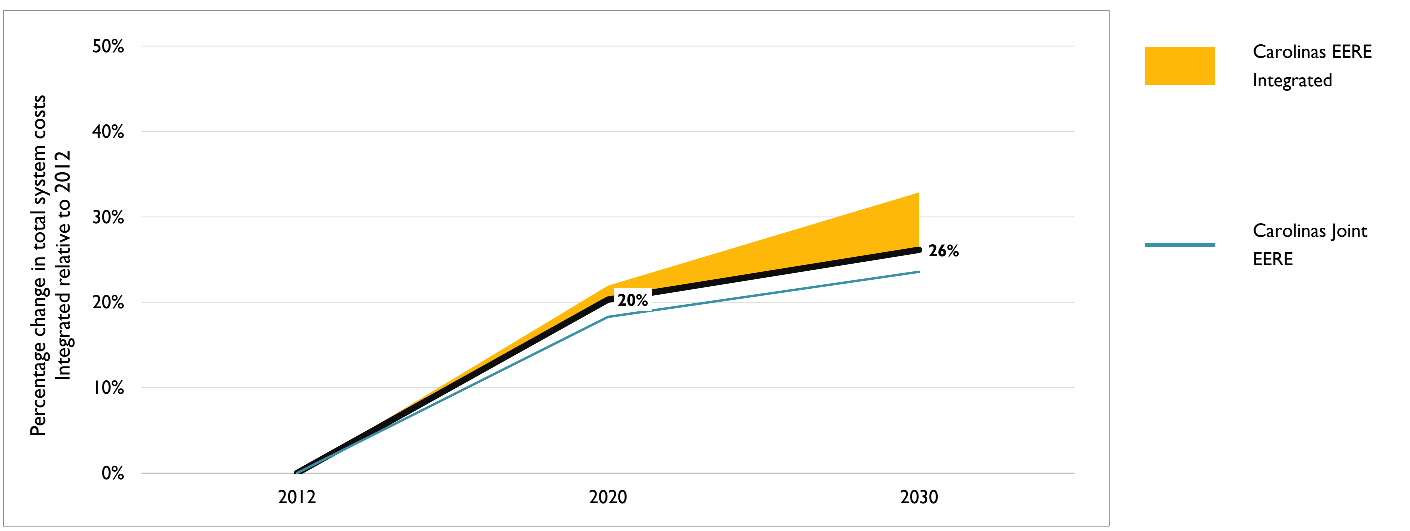


Carolinas EERE Integrated

Key Findings	The Carolinas comply by displacing existing coal with existing NGCCs.
Displacement Order	[1] O/G Steam, [2] existing NGCC, [3] coal
Energy Efficiency	Incremental energy efficiency savings reach 2.5% per year by 2025, then remain constant to 2030.
Renewables	NC meets its RPS requirements (12.5% of sales by 2021) and by building an additional 0.5 GW of solar.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. NGCC average capacity factor increases from 40% in 2012 to 43% in
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-







Carolinas High Gas Integrated

Key Findings	The Carolinas comply by displacing existing coal with existing NGCCs.
Displacement Order	[1] O/G Steam, [2] coal, [3] existing NGCC
Energy Efficiency	2012 levels of energy efficiency savings kept constant through 2030.
Renewables	NC meets its RPS requirements (12.5% of sales by 2021) and by building an additional 0.5 GW of solar.
Existing NGCC	2.2 GW NGCC plant comes online in 2015. NGCC average capacity factor increases from 40% in 2012 to 66% in
New NGCC	No new NGCC capacity is added.
Coal	4.2 GW retired by 2014.
Imports/Exports	Net exports remain constant at 2012 levels in all years.
Other	-