# Mission Attainment: Incorporating Pollution Reductions from Energy Efficiency in State Implementation Plans

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## Executive Summary

The US Environmental Protection Agency's (EPA's) National Ambient Air Quality Standards (NAAQS) set limits on six criteria pollutants that are harmful to public health and welfare. States are required to develop state implementation plans (SIPs) to maintain or achieve these standards. EPA designates states with air pollutant concentrations above the NAAQS limits as "nonattainment" areas. These states must meet added stringency requirements through their SIPs to reduce air pollutant emissions in specific geographic regions. States that meet the standards are in "attainment" and must take steps to maintain this status.

Energy efficiency is a least-cost strategy for reducing multiple pollutants simultaneously by reducing the need for power generation from power plants. States can use energy efficiency as a strategy to help reach or maintain attainment with NAAQS or to proactively reduce emissions to avoid initial nonattainment designations. EPA recognizes the multiple benefits of energy efficiency and supports its use as an air quality strategy. Yet, even though energy efficiency policies and utility programs are reducing pollution, many states are missing opportunities to take credit for these reductions. They are not incorporating their energy efficiency programs into SIPs and are instead relying on costlier compliance options.

ACEEE conducted a survey of state air regulators to understand why more states are not taking credit for what they are already doing. Responses suggest that a variety of real and perceived barriers hinder states' use of energy efficiency as a NAAQS compliance strategy. One such barrier involves the complex nature of the electric grid and the movement of pollutants through the atmosphere. The air quality benefits of reducing pollution extend throughout the country, but the exact location of air quality improvements depends on many complex factors. State regulators cannot assume that energy efficiency executed in a state or city will result in improved air quality in that same state or city, let alone a specific nonattainment area.

Modeling can be used to overcome this uncertainty. Our analysis uses a publicly available screening model to identify where state-level energy efficiency measures will result in some of the greatest in-state pollution reductions and determine which states can make the best use of energy efficiency to demonstrate compliance with NAAQS.

Using AVERT (AVoided Emissions and geneRation Tool), an emissions quantification tool developed by EPA, we evaluated the avoided power plant pollution that energy efficiency can achieve. We preliminarily identified 32 states where energy efficiency has the potential to reduce certain criteria pollutants required under NAAQS (modeled NAAQS obligations). We determined the potential for each state using results from AVERT that showed pollutant reductions from energy efficiency in geographic areas that coincide with modeled NAAQS obligations. Table ES1 gives an overview. Figure ES1 shows reductions from energy efficiency in every region of the country.

**Table ES1. Total in-state pollution reductions from energy efficiency in locations required for modeled NAAQS obligations**

| Potential pollution reductions | States |
|---|---|
| More than 2,500 tons | Texas, Pennsylvania, Ohio, Missouri, Illinois, Michigan, North Carolina, Wyoming, Iowa, Indiana, New York |
| 1,001–2,500 tons | South Carolina, Wisconsin, Maryland, Kentucky, Oklahoma, Minnesota, Arizona |
| 1–1,000 tons | Louisiana, West Virginia, Virginia, Tennessee, Nevada, Colorado, New Hampshire, Connecticut, Delaware, Oregon, California, Utah, New Jersey, Florida |

Total annual tons reduction of $SO_2$, $PM_{2.5}$, and ozone-season NOx. *Sources:* EPA 2017e; EPA 2016.

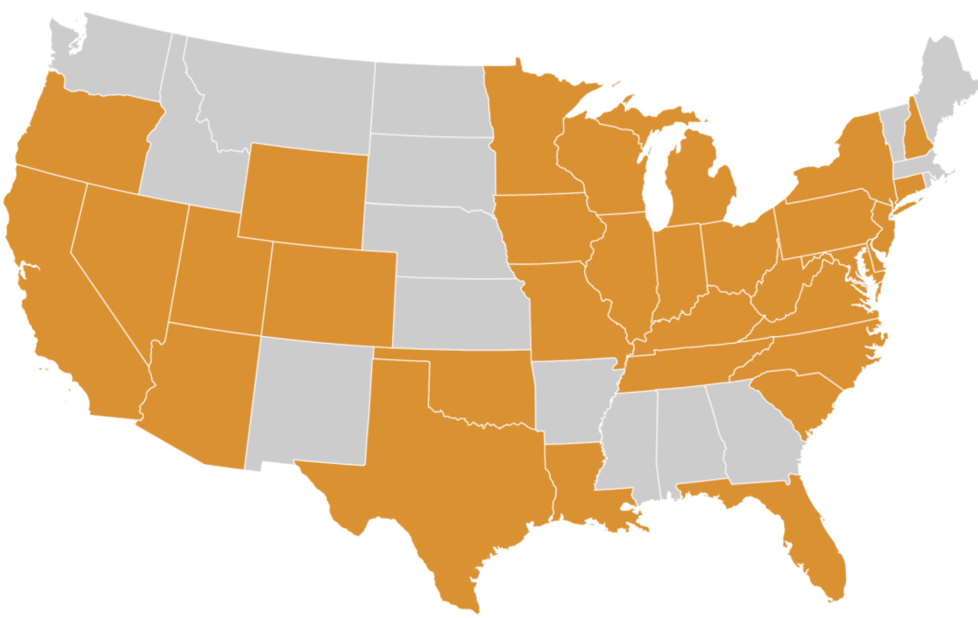

Figure ES1. In-state pollution reductions from energy efficiency in locations required for modeled NAAQS obligations. *Sources:* EPA 2017b; EPA 2017d.

Next, we selected five states with high potential (more than 2,500 tons) and developed a range of estimates for the amounts and locations of the pollutants that could be reduced by energy efficiency. The results indicate that savings from energy efficiency can be a significant contribution to a SIP depending on the state's obligations. The pollutant reductions from our scenario on a ton-per-day basis are comparable to those from nonenergy efficiency measures states currently rely on to demonstrate compliance.

## *RESULTS*

### Illinois

Our energy efficiency scenario resulted in multipollutant reductions in six geographic areas throughout the state. Illinois could incorporate energy efficiency as a compliance strategy to help meet NAAQS for sulfur dioxide ($SO_2$), particulate matter ($PM_{2.5}$), and ozone, including the 2015 Ozone NAAQS.

### Missouri

Our energy efficiency scenario resulted in multipollutant reductions in five geographic areas throughout the state, including two overlapping areas with Illinois. Missouri could incorporate energy efficiency as a compliance strategy to help meet NAAQS for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### Ohio

Our energy efficiency scenario resulted in multipollutant reductions in three key geographic areas throughout the state. Ohio could incorporate energy efficiency as a compliance strategy to help meet NAAQS for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### Pennsylvania

Our energy efficiency scenario resulted in multipollutant reductions in 11 geographic areas throughout the state. Pennsylvania could incorporate energy efficiency as a compliance strategy to help meet NAAQS for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### Texas

Our energy efficiency scenario resulted in multipollutant reductions in 14 major geographic areas throughout the state. Texas could incorporate energy efficiency as a compliance strategy to help meet NAAQS for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS. Energy efficiency can also help with obligations under the Ozone and PM Advance Program.

## *RECOMMENDATIONS*

Based on our survey of states and assessment of opportunities identified in our analysis, we recommend the following steps to help states incorporate energy efficiency in SIPs:

- Develop tools states can use to evaluate the impact energy efficiency measures will have on SIP compliance obligations.
- Develop a streamlined, EPA-acceptable approach for measuring and documenting outcomes of energy efficiency programs to be included in a SIP.
- Provide ongoing in-depth technical support to states looking to assess the potential role for energy efficiency in attaining air quality goals.

## Introduction

Energy efficiency can help states manage air quality, protect public health, and keep electricity affordable—all while growing the local economy. Efficiency reduces multiple pollutants simultaneously by decreasing the amount of fuel burnt at the power plant.[1] This approach benefits air quality regulators, who can incorporate energy efficiency into their planning efforts when complying with federal and state air regulations.

Many pollution control technologies target and reduce specific pollutants through direct capture (for stationary sources) or by modifying engine functions (for mobile sources) and regulating fuel quality. While these technologies have been successful in reducing specific pollutants, they also may have significant upfront costs and operation and maintenance requirements (EPA 2012a).[2] By contrast, energy efficiency lowers systemwide costs and pays for itself by eliminating the expense of generating additional electricity. In addition, energy efficiency reduces multiple pollutants simultaneously rather than targeting a single pollutant.

The low-cost, multipollutant reductions from energy efficiency also result in public health gains. A recent report by the American Council for an Energy-Efficient Economy (ACEEE) analyzed the health impacts attributable to ambient air quality improvements from avoided power plant pollution. The analysis found that a national 15% reduction in energy consumption would result in more than six lives saved each day, up to $20 billion annually in avoided health care costs, and nearly 30,000 fewer asthmatic episodes per year. These benefits were spread throughout states across the country (Hayes and Kubes 2018).

The US Environmental Protection Agency's (EPA's) National Ambient Air Quality Standards (NAAQS) provide an opportunity for states to leverage the multiple benefits of energy efficiency. To take advantage of this opportunity, states must sort through the available EPA guidance, understand the process of crediting energy savings, compare the cost of compliance through energy efficiency versus alternative control strategies, and determine efficiency's pollution reduction potential. States may miss out on the lowest-cost road to compliance because of perceived barriers. We conducted a survey of state air regulators to understand why more states are not accounting for the energy efficiency policies and programs that are on the books. The responses suggest that a variety of real and perceived barriers hinder states' use of energy efficiency as a NAAQS compliance strategy. Concerns about where energy efficiency savings are occurring, enforceability of pollutant reductions, and how to credit emission reductions can deter state air regulators from investing resources into counting the emission benefits of energy efficiency.[3]

This report responds to some of these concerns and offers possible solutions for state air and energy officials and other decision makers by assessing the value of energy efficiency as a

[1] Energy efficiency also reduces onsite fuel consumption from boilers and furnaces; however this report focuses only on the electricity system and emissions reductions from power plants.

[2] EPA developed a Menu of Control Measures for NAAQS Implementation list that describes common technologies for stationary and mobile sources and typical costs.

[3] NESCAUM (2014) had similar findings.

resource to comply with NAAQS. Our analysis estimates the avoided power plant pollution that energy efficiency can achieve in five states for compliance with existing and future NAAQS designations.

## National Ambient Air Quality Standards (NAAQS)

The federal Clean Air Act requires EPA to establish NAAQS for a set of pollutants that are harmful to public health and welfare. NAAQS regulate "criteria" pollutants by distinguishing between primary standards that require pollutants be limited to levels that protect public health and secondary standards that protect against damage to the environment, animals, buildings, and visibility (EPA 2016). The standards are applied to six criteria pollutants: carbon monoxide (CO), nitrogen dioxide ($NO_2$), lead (Pb), ozone, particulate pollution (both $PM_{2.5}$ and $PM_{10}$), and sulfur dioxide ($SO_2$).[4] EPA designates areas within states as either in "attainment" (meeting the standards) or in "nonattainment" (failing to meet the standards) for each NAAQS. States are required to develop state implementation plans (SIPs) to maintain or achieve these standards. States with a geographic area designated as nonattainment must submit a SIP demonstrating how they will reduce ambient concentrations of a certain pollutant. States that meet the standards are in attainment and must develop a "maintenance SIP" to ensure air quality will be maintained going forward (EPA 2017f).

A SIP comprises a set of emission reduction strategies and regulations that the state will implement by a certain date either to attain or to maintain the NAAQS.[5] States may rely on complex air quality modeling to demonstrate that the plan will achieve or maintain attainment with the standards. The stringency of control measures that states need to enact depends on the severity of the nonattainment designation. Areas with severe pollution must adopt more stringent control measures but are given more time to attain the NAAQS (EPA 2017f).

EPA is required to periodically review the NAAQS based on new evidence of related health or environmental harm of each criteria pollutant.[6] Once a standard is set, states submit monitoring data and recommended designations that EPA accepts or rejects based on the ambient air monitoring data for each criteria pollutant and other factors.[7] The timeline for SIP development depends on the designation and type of SIP required (EPA 2017e; Colburn Hausauer, and James 2012, 12).

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[4] Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$) depending on the criteria pollutant that is being addressed.

[5] If a state is in nonattainment for more than one NAAQS, EPA requires that it submit a separate SIP detailing how it will achieve attainment for each NAAQS.

[6] Typically completed in five-year intervals for each criteria pollutant standard.

[7] Some areas can be designated nonattainment based on factors believed to contribute to nonattainment in monitored areas, and some areas can be designated nonattainment based on modeled predictions.

Many states have areas in nonattainment for several existing NAAQS. Figure 1 shows that 37 states and 1 territory had areas in nonattainment for one or more NAAQS as of September 30, 2017.

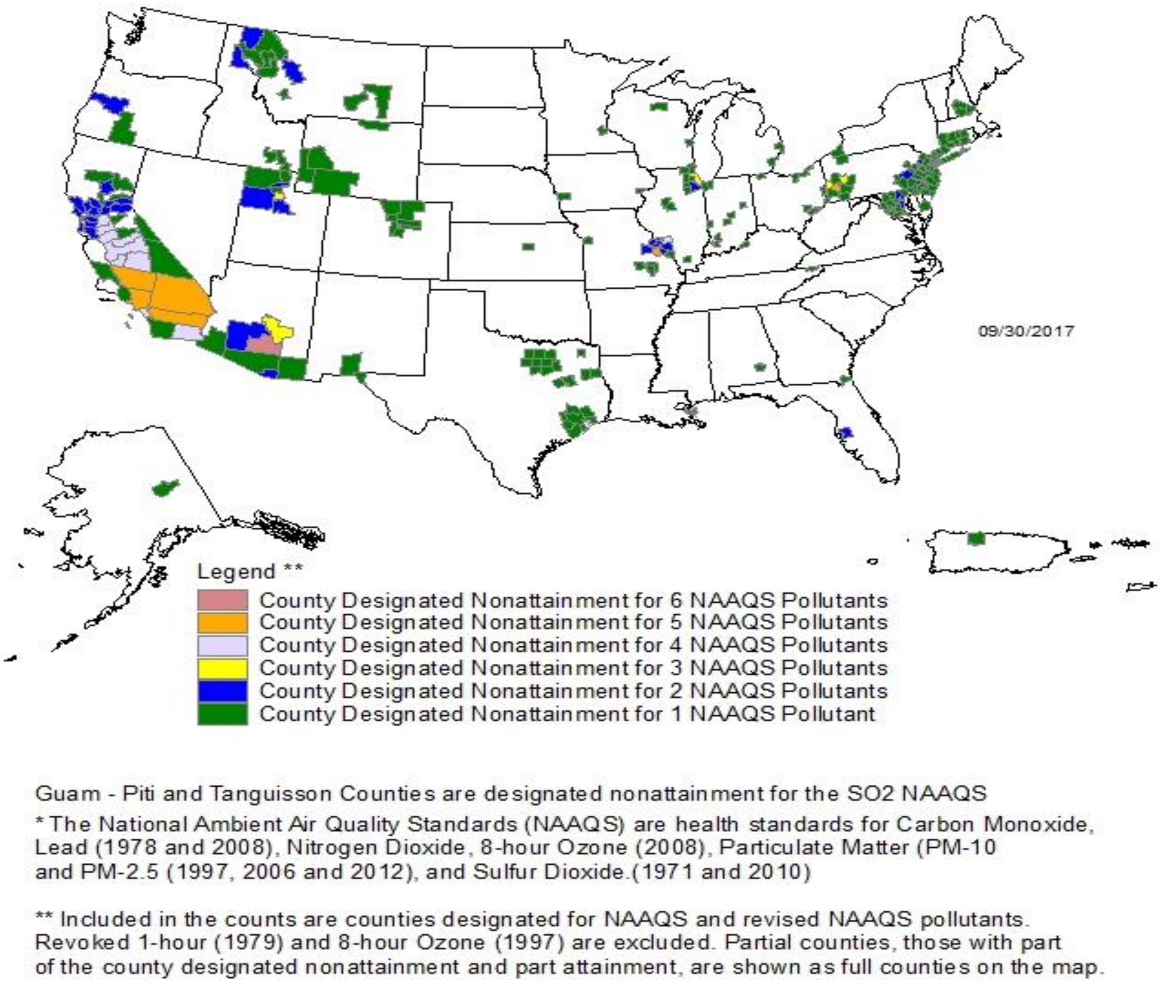


Figure 1. Counties designated "nonattainment" for NAAQS. *Source:* EPA 2017d.

Based on a review of new scientific evidence, EPA recently revised the primary and secondary ozone standard levels (EPA 2017h). The final rule was released in October 2015, with initial EPA designations intended to be set by May 2018.[8] States can take advantage of this time as an opportunity to look to energy efficiency as a least-cost strategy to achieve necessary reductions in nitrogen oxides (NOx), a precursor to ozone, to reach attainment.[9]

[8] EPA's Ozone Designations Mapping Tool provides air quality monitoring data for each county and details which counties exceed the 2015 Ozone NAAQS (EPA 2017g).

[9] SIP plans for meeting ozone standards rely on reductions of precursor pollutants that form ground-level ozone, including nitrogen oxides (NOx) and volatile organic compounds (VOCs). For the remainder of this report we refer to NOx reductions as the pollutant used to attain ozone standards throughout the year and during ozone season (May–September).

In addition to the NAAQS SIP schedules, states already meeting the NAAQS may develop and submit plans that help avoid a future nonattainment designation. EPA's Advance Program provides an opportunity for states to reduce emissions ahead of designations. Participants must meet a set of eligibility criteria to join the program. They must then regularly submit voluntary plans to EPA detailing how the state will reduce NOx and/or PM. Figure 2 shows the counties in states that are participating in the Advance Program as of December 2017.

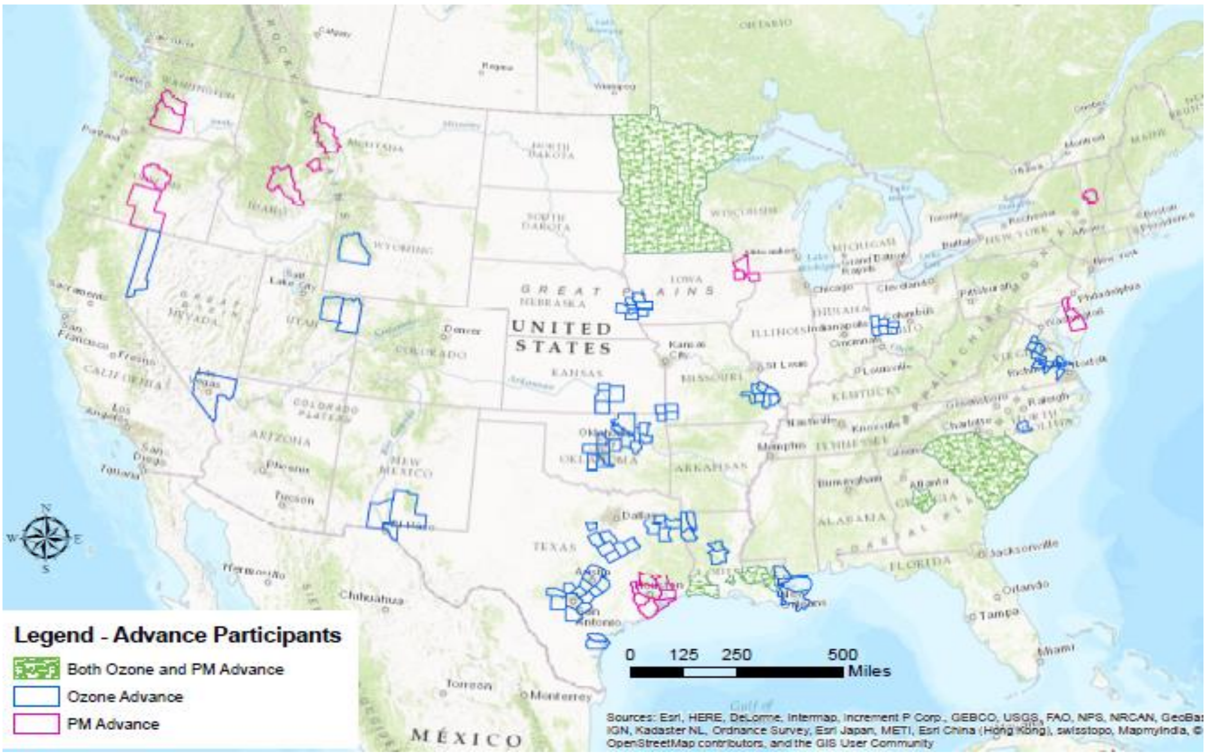


Figure 2. EPA Advance Program participants. *Source:* EPA 2017a.

## Incorporating Energy Efficiency in State Implementation Plans for NAAQS

States can use energy efficiency as a low-cost strategy to help reach or maintain attainment with NAAQS or to avoid initial nonattainment designations (EPA 2012b). States across the country have developed energy efficiency policies and programs, with investments ramping up each year. More than half of states have long-term energy savings goals in place, and every state has some kind of energy efficiency programs operated by electric utilities or a third party ( Berg, Gilleo, and Molina 2017).[10] In 2016, states committed more than $6.27 billion of ratepayer funding for electric energy efficiency programs (ACEEE 2017a).

Under the Clean Air Act, EPA is required to follow a set of guidelines for enforcing and updating NAAQS for each criteria pollutant. The SIP process for each NAAQS does not

[10] In addition, there are a variety of nonutility programs and policies that save energy in states, including building energy codes, appliance and equipment standards, and energy efficiency financing, among others.

follow a coordinated timeline, and states develop emission reduction strategies for each criteria pollutant separately. This can be resource intensive and costly. States can use energy efficiency to develop a more coordinated approach to pollution reduction because it reduces multiple pollutants simultaneously.[11]

Using energy efficiency to comply with federal air regulations is not a new concept. In the 1990s, EPA issued early guidance for how to include pollution reductions from energy efficiency in a SIP. Since that time, several additional guidance documents have been issued, some within the past few years (see Appendix B for details on EPA guidance). Nevertheless, state experiences have been limited, and few states have successfully incorporated energy efficiency into SIPs. Table 1 lists states identified by EPA as having included energy efficiency in a SIP.

Table 1. State experience with incorporating energy efficiency in SIPs

| State | Experience |
|---|---|
| Connecticut | Connecticut included energy savings and avoided NOx emissions from the Connecticut Energy Efficiency Fund Projects from 2003–2008 in its 8-hour ozone SIP. EPA Region 1 approved this SIP in 2013. |
| Louisiana | The state's SIP proposal included efficiency upgrades for 22 municipal buildings in Shreveport. The estimated energy savings resulted in reductions of 0.041 tons of NOx per ozone season-day. EPA Region 6 published approval of this SIP revision in August 2005. |
| Maryland, Virginia, and Washington DC | The Metropolitan Washington Council of Governments' regional air quality plan for 8-hour ozone standards was adopted by Maryland, Virginia, and Washington, DC. The plan included installation of LED traffic lights and building energy efficiency programs. The estimated daily savings generated for the two programs was over 40 million kWh. The 2009 estimated NOx emission reductions credits to the LED program was 0.02 tons per day. |
| Virginia | The Virginia Department of Environmental Quality incorporates ratepayer-funded energy efficiency programs and the Virginia Energy Management Program as voluntary emission reduction efforts in its plans for Ozone Advance. |
| Texas | The Texas Commission on Environmental Quality claimed credit for emissions reductions accruing from building energy codes of 0.72 tons per day of NOx in the 2005 Dallas-Fort Worth Increment of Progress SIP revision. |

*Sources:* Hayes and Young 2012; Virginia DEQ 2018.

The air quality benefits of reducing pollution from power plants with energy efficiency extend throughout the country. However the location of these reductions depends on factors such as the complexity of the electric grid, the location of power plants, and transport effects (i.e., wind patterns that carry pollution from one place to another). Emission reductions in SIPs need to be geographically targeted to reduce pollutant concentrations in designated areas. NAAQS nonattainment designations require that SIPs

[11] In addition to incorporating energy efficiency as a compliance strategy for NAAQS SIPs, energy efficiency can contribute to pollutant reductions required under other federal air regulations, such as the Cross-State Air Pollution Rule and Regional Haze. This is beyond the scope of this report.

demonstrate pollution reductions that will show up at air quality monitors in those locations. Energy efficiency measures implemented in one state might reduce pollution in another state. Even if a state generates 100% of its electricity within its boundaries, pollution from those power plants might drift into other states due to factors such as transport of emissions, wind patterns, and secondary formation of pollutants in the atmosphere. For example, a reduction of 100 tons of pollution might translate to only 50 tons of creditable reductions in a SIP, or none at all.

State air officials need to understand the location of reductions to rely on energy efficiency as a strategy for NAAQS compliance. Helping states understand and assess this challenge is the basis for the analysis contained in this report. Our analysis identifies which states can implement energy efficiency measures to achieve the greatest localized pollution reductions for inclusion in a SIP.

## Analysis

We performed an analysis to help state air officials and other decision makers understand which states can best employ energy efficiency to reduce pollution in the same geographic location as current or anticipated nonattainment areas and areas participating in EPA's Advance Program. Using an emission quantification tool called AVERT (AVoided Emissions and geneRation Tool), we evaluated the avoided power plant pollution that energy efficiency can achieve and identified all states where efficiency can have an impact on pollutant reductions that may be necessary to comply with NAAQS (EPA 2017b). AVERT is an EPA tool that estimates the emission benefits of energy efficiency and renewable energy policies and programs by representing the dynamics of electricity dispatch based on the historical patterns of actual generation in a selected year (for more information, see Appendix A). We performed this analysis in several steps:

1. Choose states for analysis
2. Estimate range of energy efficiency savings
3. Estimate pollutant reductions using AVERT
4. Determine overlap of AVERT results and modeled NAAQS obligations

### *CHOOSING STATES FOR ANALYSIS*

Using estimates for potential electricity savings in 2020, we conducted a preliminary screening for every state to determine where savings from energy efficiency would reduce power plant pollution. These estimates came from Electric Power Research Institute's (EPRI's) *State Level Electric Energy Efficiency Potential Estimates* report quantifying economic potential (EPRI 2017).[12] They represent the fraction of technical potential (an ideal scenario that sums all energy efficiency measures possible given limitations with technology) that is cost effective.[13] To determine where pollution reductions occur, we input potential GWh

[12] The EPRI report quantifies energy efficiency potential and may not reflect a state's current level of energy efficiency implementation. These estimates are also lower than other energy efficiency potential estimates (Neubauer 2014).

[13] The economic potential in this study represents potential savings across residential, commercial, and industrial sectors and varies for each state due to differences in electric loads and types of electric services.

savings for each state as annual savings distributed evenly across all hours of the year through the state's designated AVERT region (see Appendix A for more details and a breakdown of AVERT regions). We then used the avoided emissions results from AVERT to identify the geographic areas where pollution reductions would coincide with modeled NAAQS obligations. We used the following criteria to determine these modeled NAAQS obligations:

- Areas in nonattainment for EPA NAAQS as of September 30, 2017 (EPA 2017d)[14]
- Areas currently in attainment but participating in EPA's Advance Program for ozone and/or PM (EPA 2017a)
- Areas with monitored data that exceed the 2015 Ozone NAAQS requirements (EPA 2017h, 2017g).

We identified 32 states where a statewide energy efficiency scenario would reduce pollutants in one or more counties with modeled NAAQS obligations (table 2). Figure 3 shows reductions in every region of the country. We determined pollutant reduction totals for each state using results from AVERT that showed total $SO_2$, $PM_{2.5}$, or NOx reductions from energy efficiency in geographic areas that coincide with modeled NAAQS obligations.[15] The results indicate that savings from energy efficiency can be a significant contribution to a SIP depending on the state's obligations. The amount of pollutant reductions from our scenario on a ton-per-day basis is comparable to reductions from nonenergy efficiency measures that states currently rely on to demonstrate compliance.

**Table 2. Total in-state pollution reductions from energy efficiency in locations required for modeled NAAQS obligations**

| Potential pollution reductions | States |
|---|---|
| More than 2,500 tons | Texas, Pennsylvania, Ohio, Missouri, Illinois, Michigan, North Carolina, Wyoming, Iowa, Indiana, New York |
| 1,001–2,500 tons | South Carolina, Wisconsin, Maryland, Kentucky, Oklahoma, Minnesota, Arizona |
| 1–1,000 tons | Louisiana, West Virginia, Virginia, Tennessee, Nevada, Colorado, New Hampshire, Connecticut, Delaware, Oregon, California, Utah, New Jersey, Florida |

Total annual tons reduction of $SO_2$, $PM_{2.5}$, and ozone-season NOx. *Sources:* EPA 2017b; EPA 2017d.

[14] We considered nonattainment designations for ozone, $PM_{2.5}$, and $SO_2$ regulations.

[15] We determined total pollutant reductions for a given state by summing the total annual $SO_2$, annual $PM_{2.5}$, and ozone-season NOx tons that were reduced throughout the state through modeling energy efficiency savings in AVERT that coincided with modeled NAAQS obligations. We then placed the entire state in the range for that total.

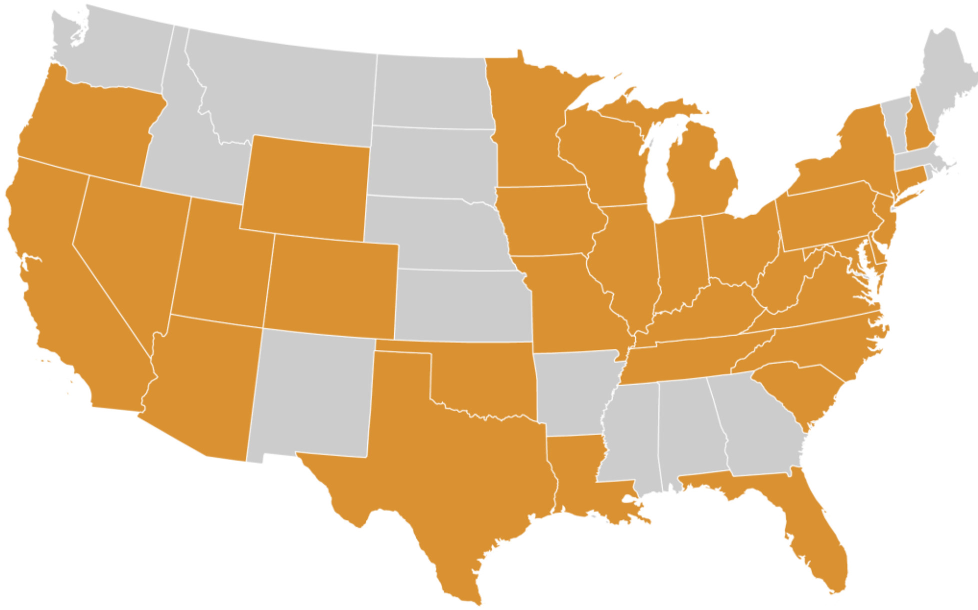

Figure 3. In-state pollution reductions from energy efficiency in locations required for modeled NAAQS obligations. *Sources:* EPA 2017b; EPA 2017d.

Though opportunities exist in all 32 states, evaluating the full list was beyond the scope of this effort. We limited the more in-depth analysis of Steps 2–4 to five states that we selected based on two criteria: (1) the magnitude of the pollution avoided in our screening assessment and (2) geographic diversity. Our screening resulted in the selection of the following states: Illinois, Missouri, Pennsylvania, Ohio, and Texas.

### *ESTIMATING THE RANGE OF ENERGY EFFICIENCY SAVINGS*

For our deeper analysis of Pennsylvania, Ohio, Illinois, Missouri, and Texas, we developed low- and high-energy savings scenarios. For the low estimate, we started with current reported utility savings from electric efficiency programs. For the states with an energy efficiency resource standard (EERS; Illinois, Ohio, Pennsylvania, and Texas), we estimated the savings from utility energy efficiency programs in 2020 using actual policy requirements ( Berg, Gilleo, and Molina 2017). For Missouri, we used reported utility savings from electric efficiency programs in 2015 and assumed those savings remained constant through 2020 (ACEEE 2017a). For each of the five states, we then took a snapshot of the annual savings in 2020 to determine our low savings estimate.[16] For the high savings estimate for each state, we once again relied on EPRI's *State Level Electric Energy Efficiency Potential Estimates* report (EPRI 2017).[17] The low savings represent an amount of energy efficiency that states are currently pursuing through utility programs. The high savings represent what EPRI

[16] Annual savings in 2020 from measures put in place 2016 onward.

[17] The EPRI analysis includes potential savings through 2035; for this analysis we confined ourselves to 2016–2020 data for the five states.

estimated is economically achievable across multiple sectors if each state were to ramp up current savings.[18]

### *Estimating Pollutant Reductions Using AVERT*

To estimate pollution reductions for each of the five states, we input the range of low and high savings estimates as separate modeling runs through AVERT. For states located within more than one AVERT region, we assigned a percentage of savings to each region based on the portion of the state's overall generation it meets (see Appendix A). We then completed separate runs for each region and each of the savings estimates and input potential GWh savings for each state as annual savings distributed evenly across all hours of the year through the state's designated AVERT region(s).

### *Determining Overlap of AVERT Results and Modeled NAAQS Obligations*

We identified the specific geographic areas in our five states where two conditions were met:

- A modeled NAAQS obligation exists.
- Our energy efficiency scenario from AVERT demonstrates that pollutant reductions would occur to help meet modeled NAAQS obligations in those specific geographic areas.

For each state, we selected the geographic areas that had reductions above zero for a given pollutant regulated under the state's modeled NAAQS obligations.

### *Limitations*

The analysis described in this paper is an initial step to help states see the location of pollution reductions from energy efficiency. More sophisticated modeling approaches may provide a clearer picture of how avoided power plant emissions from efficiency affect air quality. AVERT represents the changes in electricity dispatch based on historical patterns of generation and is generally accepted for use up to five years in the future. It does not account for long-term future changes to the electrical grid or fuel prices as would a dynamic capacity expansion model.[19] However AVERT's Future Scenario template, which allows users to adjust for power plant retirements and manually add new generation, can accommodate short-term forward-looking projections. AVERT's Sparse Matrix Operator Kernel Emissions (SMOKE) output files allow users to simulate atmospheric conditions and chemical changes within air quality models. This will further affect the associated pollutant reductions from energy efficiency.

In addition, the energy efficiency savings estimates used in this analysis are representative of policies and programs. They are not meant to represent the full extent of energy efficiency

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[18] States often, but do not always, achieve their stated goals. For more information, see ACEEE's State and Local Policy Database (ACEEE 2017b).

[19] Dynamic dispatch models are more sophisticated than AVERT and other backward-looking models in that they predict how the electric grid will react to a variety of scenarios and determine which generating units will be dispatched to meet a future load.

occurring in states. The low savings estimate includes only energy savings from utility customer–funded programs. States and localities are pursuing far more energy efficiency programs and policies that would produce pollutant reductions states could rely on for compliance with NAAQS. For example, as noted in table 1, states have also incorporated building energy codes and energy efficiency in government buildings.

Because AVERT does not model transmission constraints within a region, energy efficiency reductions are assumed to have region-wide impacts. A limitation of AVERT is that it is insensitive to the physical location of new energy efficiency programs within a region even though real-world dispatch decisions may be quite sensitive to the specific locations of new energy efficiency resources and power plants. AVERT assumes that energy efficiency programs are spread across the modeled region; it cannot currently identify the differential impacts of local versus regional efficiency programs (EPA 2017b).

## Results

The following results show the geographic areas where energy efficiency would have the greatest potential for helping a state meet modeled NAAQS obligations.[20]

### *ILLINOIS*

Figure 4 shows the location of pollutant reductions from energy efficiency in Illinois.

Figure 4. Location of multipollutant reductions from energy efficiency scenario in Illinois

[20] In some cases, the NAAQS compliance obligations of each state extend beyond the standards listed in each table. We list only those standards that are applicable to the three pollutants quantified by AVERT for NAAQS ($SO_2$, $PM_{2.5}$, and NOx). Refer to EPA's Green Book for more detailed information (EPA 2017d). In addition, we have incorporated results from EPA's Ozone Designation Mapping Tool when data were available (EPA 2017g). In some instances no valid data were present in the tool; therefore more counties than are listed here may have anticipated nonattainment designations under the 2015 Ozone NAAQS.

Table 3 specifies these pollutant reductions.[21]

**Table 3. Annual reductions from energy efficiency scenario and modeled NAAQS obligations in Illinois (low–high savings)**

| Illinois area name | County name | NAAQS | Displaced generation (GWh) | $SO_2$ (tons) | NOx (tons) | $PM_{2.5}$ (tons) | Ozone-season NOx (tons) |
|---|---|---|---|---|---|---|---|
| Pekin, IL | Peoria<br>Tazewell | Sulfur Dioxide (2010) | 145–220 | 275–410 | 95–140 | 10–15 | 35–55 |
| Chicago Naperville, IL-IN-WI (Moderate) | Cook<br>DuPage<br>Grundy<br>Kane<br>Kendall<br>Lake<br>Will | 8-Hour Ozone (2008) | 260–390 | 170–260 | 90–135 | 15–25 | 45–65 |
| Lemont, IL | Cook<br>Will | Sulfur Dioxide (2010) | 150–225 | 120–180 | 60–90 | 15–20 | 30–45 |
| Williamson County, IL | Williamson | Sulfur Dioxide (2010) | 30–45 | 85–125 | 10–20 | Less than 5 | 5–10 |
| St. Louis, MO-IL (Moderate) | Madison<br>Randolph | PM-2.5 (1997) | 220–325 | 25–40* | 65–95 | Less than 5 | 30–40 |
| Chicago Naperville-Elgin, IL-IN-WI | Cook<br>Lake | Ozone Rule (2015) | 60–85 | 50–80 | 30–45 | Less than 5 | 20–25 |

* Increase in emissions. *Sources:* EPA 2017d; EPA 2017g; EPRI 2017; ACEEE 2017a.

Our energy efficiency scenario in Illinois resulted in multipollutant reductions in six geographic areas throughout the state (figure 3). Illinois falls within two regions in AVERT: the Great Lakes/Mid-Atlantic and the Upper Midwest (see Appendix A). The low savings estimate was based on the state's EERS target, with annual savings in 2020 estimated at 11,663 GWh.[22] The high savings estimate included potential efficiency savings of 17,599 GWh (EPRI 2017).[23] Table 3 shows that reductions from these savings occurred in areas that are currently or anticipated to be in nonattainment (EPA 2017d, 2017g). Illinois could incorporate energy efficiency as a compliance strategy to help meet NAAQS in certain areas for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

[21] The results in tables 3 through 7 are rounded to the nearest 5.

[22] Illinois's EERS was enacted in 2007. Incremental savings targets vary by utility, averaging 1.77% of sales from 2018 to 2021, 2.08% from 2022 to 2025, and 2.05% from 2026 to 2030. Legislation set a rate cap of 4%, allowing targets to be adjusted downward should utilities reach spending limits (Berg, Gilleo, and Molina 2017). The annual savings in 2020 are estimated from measures put in place 2016 onward.

[23] The economic potential efficiency savings used for Illinois accounted for savings through 2025. The 2020 savings potential (10,806 GWh) for Illinois was not large enough to exceed the low savings estimate.

### *MISSOURI*

Figure 5 shows the location of pollutant reductions from energy efficiency in Missouri.

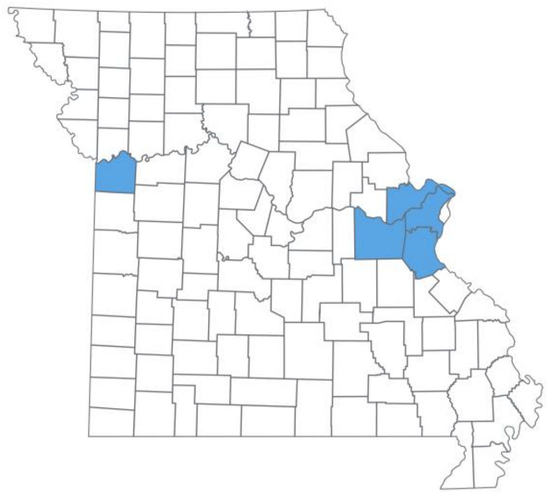

Figure 5. Location of multipollutant reductions from energy efficiency scenario in Missouri

Table 4 specifies these pollutant reductions.

Table 4. Annual reductions from energy efficiency scenario and modeled NAAQS obligations in Missouri

| Missouri area name | County name | NAAQS | Displaced generation (GWh) | $SO_2$ (tons) | NOx (tons) | $PM_{2.5}$ (tons) | Ozone-season NOx (tons) |
|---|---|---|---|---|---|---|---|
| Jackson County, MO | Jackson | Sulfur Dioxide (2010) | 30–60 | 40–90 | 25–55 | Less than 5 | 10–25 |
| St. Louis, MO-IL | Franklin<br>Jefferson<br>Saint Charles<br>Saint Louis | PM-2.5 (1997) | 105–225 | 240–505 | 60–130 | 5–15 | 25–50 |
| St. Louis-St. Charles-Farmington, MO-IL | Franklin<br>Jefferson<br>Saint Charles<br>Saint Louis | 8-Hour Ozone (2008) | 105–225 | 240–505 | 60–130 | 5–15 | 25–50 |
| Jefferson County, MO | Jefferson | Sulfur Dioxide (2010) | 25–55 | 65–140 | 10–25 | Less than 5 | 5–10 |
| St. Louis, MO-IL | Saint Charles<br>Saint Louis | Ozone Rule (2015) | 25–50 | 55–115 | 25–50 | Less than 5 | 11–23 |

*Sources:* EPA 2017d; EPA 2017g; EPRI 2017; ACEEE 2017a.

Our energy efficiency scenario in Missouri resulted in multipollutant reductions in five geographic areas throughout the state, including two overlapping areas with Illinois (see figure 4). Missouri falls within two regions in AVERT, the Lower Midwest and Upper

Midwest, with savings split accordingly in AVERT (see Appendix A).[24] The low savings estimate was based on the state's utility savings, with annual savings in 2020 estimated at 2,223 GWh.[25] The high savings estimate included potential efficiency savings of 4,671 GWh in 2020 (EPRI 2017). Table 4 shows that reductions from these savings occurred in areas that are currently or anticipated to be in nonattainment (EPA 2017d, 2017g). Missouri could incorporate energy efficiency as a compliance strategy to help meet NAAQS in certain areas for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### *OHIO*

Figure 6 shows the location of pollutant reductions from energy efficiency in Ohio.

Figure 6. Location of multipollutant reductions from energy efficiency scenario in Ohio

Table 5 specifies these pollutant reductions.

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[24] The low and high savings were evenly split between the regions.

[25] Missouri has a voluntary EERS with no binding requirement for utilities. Enacted in 2009, the Missouri Energy Efficiency Investment Act requires Missouri's investor-owned electric utilities to capture all cost-effective energy efficiency opportunities (ACEEE 2017b). The annual savings in 2020 are estimated from measures put in place from utility programs in 2016 onward.

Table 5. Annual reductions from energy efficiency scenario and modeled NAAQS obligations in Ohio

| Ohio area name | County name | NAAQS | Displaced generation (GWh) | $SO_2$ (tons) | NOx (tons) | $PM_{2.5}$ (tons) | Ozone-season NOx (tons) |
|---|---|---|---|---|---|---|---|
| Steubenville, OH-WV | Jefferson | Sulfur Dioxide (2010) | 290–430 | 275–410 | 145–210 | 95–135 | 55–80 |
| Cleveland, OH | Lorain | PM-2.5 (2012) | 50–75 | 430–630 | 100–145 | 10–15 | 45–65 |
| Cincinnati, OH-KY-IN | Butler Hamilton | Ozone Rule (2015) | 105–155 | 685–1,005 | 60–85 | 10–15 | 25–35 |

*Sources:* EPA 2017d; EPA 2017g; EPRI 2017; ACEEE 2017a.

Our energy efficiency scenario in Ohio resulted in multipollutant reductions in three key geographic areas throughout the state (figure 5). The entire state is located within the Great Lakes/Mid-Atlantic region in AVERT (see Appendix A). The low savings estimate was based on the state's current EERS target, with annual savings in 2020 estimated at 7,649 GWh.[26] The high savings estimate included potential efficiency savings of 11,266 GWh in 2020 (EPRI 2017). Table 5 shows that pollutant reductions from these savings occurred in areas that are currently or anticipated to be in nonattainment (EPA 2017d, 2017g). Ohio could incorporate energy efficiency as a compliance strategy to help meet NAAQS in certain areas for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### *PENNSYLVANIA*

Figure 7 shows the location of pollutant reductions from energy efficiency in Pennsylvania.

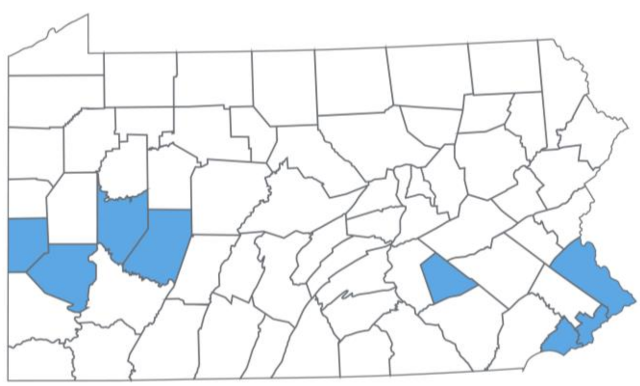

Figure 7. Location of multipollutant reductions from energy efficiency scenario in Pennsylvania

[26] Ohio's EERS was enacted in 2008 with incremental savings of 0.3% per year beginning in 2009, ramping up to 1% in 2014 and 2% in 2021. Savings targets resumed in 2017 following a freeze in 2015–2016 that allowed utilities that had achieved 4.2% cumulative savings to reduce or eliminate program offerings (Berg, Gilleo, and Molina 2017). The annual savings in 2020 are estimated from measures put in place 2016 onward.

Table 6 specifies these pollutant reductions.

**Table 6. Annual reductions from energy efficiency scenario and modeled NAAQS obligations in Pennsylvania**

| Pennsylvania area | County | NAAQS | Displaced generation (GWh) | $SO_2$ (tons) | NOx (tons) | $PM_{2.5}$ (tons) | Ozone-season NOx (tons) |
|---|---|---|---|---|---|---|---|
| Liberty-Clairton, PA | Allegheny | PM-2.5 (1997) | 45–95 | 45–85 | 60–125 | 5–10 | 25–50 |
| Liberty-Clairton, PA | Allegheny | PM-2.5 (2006) | 45–95 | 45–85 | 60–125 | 5–10 | 25–50 |
| Allegheny County, PA | Allegheny | PM-2.5 (2012) | 45–95 | 45–85 | 60–125 | 5–10 | 25–50 |
| Allegheny, PA | Allegheny | Sulfur Dioxide (2010) | 45–95 | 45–85 | 60–125 | 5–10 | 25–50 |
| Pittsburgh-Beaver Valley, PA | Allegheny Armstrong Beaver | 8-Hour Ozone (2008) | 290–580 | 550–1,095 | 260–510 | 20–40 | 50–105 |
| Armstrong Co, PA | Armstrong | Sulfur Dioxide (1971) | 155–305 | 385–770 | 130–255 | 5–10 | 25–50 |
| Indiana, PA | Armstrong Indiana | Sulfur Dioxide (2010) | 355–705 | 800–1,590 | 420–825 | 40–85 | 70–135 |
| Beaver, PA | Beaver | Sulfur Dioxide (2010) | 90–180 | 120–240 | 70–135 | 5–10 | 25–50 |
| Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE | Bucks Delaware Philadelphia | 8-Hour Ozone (2008) | 100–195 | Less than 5 | 10–20 | Less than 5 | 10–15 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | Bucks Delaware Philadelphia | Ozone Rule (2015) | 100–195 | Less than 5 | 10–20 | Less than 5 | 10–15 |
| Delaware County, PA | Delaware | PM-2.5 (2012) | 60–120 | Less than 5 | 5–10 | Less than 5 | 5–5 |
| Lebanon, PA | Lebanon | Ozone Rule (2015) | 15–25 | Less than 5 | Less than 5 | Less than 5 | Less than 5 |

*Sources:* EPA 2017d; EPA 2017g; EPRI 2017; ACEEE 2017a.

Our energy efficiency scenario in Pennsylvania resulted in multipollutant reductions in 11 geographic areas throughout the state (figure 6). The entire state is located within the Great Lakes/Mid-Atlantic region in AVERT (see Appendix A). The low savings estimate was based on the state's current EERS target, with annual savings in 2020 estimated at 5,060 GWh.[27] The high savings estimate included potential energy efficiency savings of 10,076

[27] Pennsylvania's EERS establishes varying targets for investor-owned utilities amounting to yearly statewide incremental savings of 0.8% for 2016–2020 and includes peak demand targets. Energy efficiency measures may

GWh in 2020 (EPRI 2017). Table 6 shows that reductions from these savings occurred in areas that are currently or anticipated to be in nonattainment (EPA 2017d, 2017g). Pennsylvania could incorporate energy efficiency as a compliance strategy to help meet NAAQS in certain areas for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS.

### *TEXAS*

Figure 8 shows the location of pollutant reductions from energy efficiency in Texas.

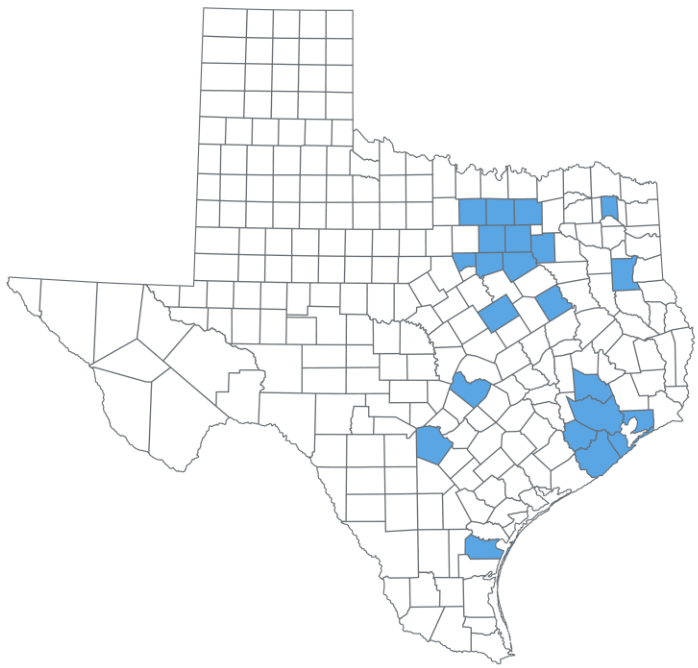

Figure 8. Location of multipollutant reductions from energy efficiency scenario in Texas

Table 7 specifies these pollutant reductions.

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not exceed an established cost cap (Berg, Gilleo, and Molina 2017). The annual savings in 2020 are estimated from measures put in place 2016 onward.

Table 7. Annual reductions from energy efficiency scenario and modeled NAAQS obligations in Texas

| Texas area name | County name | NAAQS | Displaced generation (GWh) | $SO_2$ (tons) | NOx (tons) | $PM_{2.5}$ (tons) | Ozone-season NOx (tons) |
|---|---|---|---|---|---|---|---|
| Houston-Galveston-Brazoria, TX | Montgomery<br>Brazoria<br>Chambers<br>Fort Bend<br>Galveston<br>Harris | 8-Hour Ozone (2008) | 195–4,115 | 170–3,620 | 50–1,005 | 10–190 | 30–600 |
| Houston-The Woodlands-Sugar Land, TX | Montgomery<br>Brazoria<br>Galveston<br>Harris | Ozone Rule (2015) | 60–1,310 | Less than 5 | 10–230 | 0–20 | 5–140 |
| Titus County, TX | Titus | Sulfur Dioxide (2010) | 45–925 | 155–3,225 | 35–690 | 5–70 | 15–300 |
| San Antonio, TX | Bexar | Ozone Advance | 75–1,560 | 60–1,260 | 40–755 | 0–40 | 20–425 |
| San Antonio-New Braunfels, TX | Bexar | Ozone Rule (2015) | 75–1,560 | 60–1,260 | 40–755 | 0–40 | 20–425 |
| Dallas-Fort Worth, TX | Collin<br>Dallas<br>Denton<br>Ellis<br>Johnson<br>Kaufman<br>Tarrant<br>Wise | 8-Hour Ozone (2008) | 95–1,985 | Less than 5 | 15–310 | 0–50 | 10–165 |
| Dallas-Fort Worth-Arlington, TX | Collin<br>Dallas<br>Denton<br>Johnson<br>Tarrant | Ozone Rule (2015) | 25–455 | Less than 5 | 5–125 | 0–20 | 5–105 |
| Freestone and Anderson Counties, TX | Freestone | Sulfur Dioxide (2010) | 45–985 | 155–3,285 | 25–510 | 5–95 | 10–185 |
| Houston, TX | Harris | PM Advance | 55–1,265 | Less than 5 | 10–210 | 0–20 | 5–130 |
| Granbury, TX | Hood | Ozone Advance | 10–240 | Less than 5 | 0–25 | Less than 5 | 0–15 |
| Waco, TX | McLennan | Ozone Advance | 25–480 | 10–235 | 5–125 | 0–15 | 0–50 |
| Corpus Christi, TX | Nueces | Ozone Advance | 30–590 | Less than 5 | 5–65 | 0–20 | 0–30 |
| Rusk and Panola Counties, TX | Rusk | Sulfur Dioxide (2010) | 80–1610 | 130–2,715 | 45–950 | 5–95 | 20–415 |
| Austin, TX | Travis | Ozone Advance | 20–375 | Less than 5 | 10–175 | Less than 5 | 10–140 |

*Sources:* EPA 2017a; EPA 2017d; EPA 2017g; EPRI 2017; ACEEE 2017a.

Our energy efficiency scenario in Texas resulted in multipollutant reductions in 14 geographic areas throughout the state (figure 7). Texas is split among four regions in AVERT: the Southwest, Texas, Lower Midwest, and Southeast (see Appendix A). The low savings estimate was based on the state's EERS target, with annual savings in 2020 estimated at 1,275 GWh.[28] The high savings estimate included potential efficiency savings of 26,935 GWh. Table 7 shows that reductions from these savings occurred in areas that are currently or anticipated to be in nonattainment (EPA 2017d, 2017g). Texas could incorporate energy efficiency as a compliance strategy to help meet NAAQS for $SO_2$, $PM_{2.5}$, and ozone, including the 2015 Ozone NAAQS. Energy efficiency can also help with obligations under the Ozone and PM Advance Program.

### *FURTHER DISCUSSION*

In many cases, emission reductions that could be claimed for SIP compliance will be a portion of the total decrease in pollution that could be achieved through a state's energy efficiency programs and policies. The air quality benefits of reducing pollution through efficiency extend throughout a state. However the particular location of these reductions depends on factors like the complexity and changing resource mix of the electric grid, the location of power plants, and the transport effects of wind patterns.

For example, Pennsylvania's energy savings in our scenario translate to roughly 3,500–6,900 total tons of $NO_x$ avoided per year throughout the state.[29] However the greatest NOx reduction located in any single area with modeled NAAQS obligations in our analysis is 260–510 tons (in the Pittsburgh-Beaver Valley nonattainment area). This is 7% of the total reductions occurring from our energy efficiency scenario throughout the state. Table 8 illustrates this relationship and includes an example of another area in the state with modeled NAAQS obligations where NOx reductions from energy efficiency savings occur. This level of NOx reductions can be a significant contribution to a SIP depending on the state's obligations. Looking to the *Texas Emissions Reduction Plan (2015–2016)* as an example, the Texas Commission on Environmental Quality relied on a series of programs that reduced NOx emissions by less than 1 ton per day (tpd) to meet NAAQS (TCEQ 2016). This level of reductions is comparable to those modeled in AVERT from energy efficiency savings. In fact, all five states in our analysis have levels of pollutant reductions from energy efficiency that well exceed 1 tpd.

[28] Texas adopted the nation's first EERS target in 1999, although it has the lowest targets as a percentage of sales of any state (Berg, Gilleo, and Molina 2017).

[29] This range of NOx reductions (3,500–6,900 NOx tons annually) represents the sum of reductions occurring in every county in Pennsylvania regardless of modeled NAAQS obligations when our low (5,060 GWh) and high (10,076 GWh) energy savings estimates are applied to the state.

Table 8. NOx emission reductions from energy efficiency in two areas in Pennsylvania

| Nonattainment area name | Total NOx reductions achieved by energy efficiency in Pennsylvania (annual tons) | NOx annual tons reduced (low-high tons in a single year) | NOx tons reduced during ozone season (low-high tons in a single year) | NAAQS designation |
|---|---|---|---|---|
| Pittsburgh-Beaver Valley | 3,500–6,900 | 258–512 | 52–104 | 8-Hour Ozone (2008) |
| Philadelphia-Wilmington-Atlantic City, PA-NJ-MD-DE | 3,500–6,900 | 10–19 | 8–16 | 8-Hour Ozone (2008) |

*Source:* EPA 2017b

While the total NOx reduced in the Pittsburgh-Beaver Valley nonattainment area is 260–510 tons annually (50–105 tons during ozone season), additional pollutant reductions from energy efficiency occurring throughout the state and beyond can affect Pennsylvania's NAAQS compliance. In particular, more complex air quality modeling that simulates atmospheric conditions and chemical changes may show additional pollutant reductions from energy efficiency occurring in a given area.[30]

Energy efficiency translates into thousands of tons of avoided pollution throughout the states in our scenario. In addition to the requirements of modeled NAAQS obligations in this report, states can incorporate these emission reductions in maintenance SIPs and as a strategy to avoid initial nonattainment designations.

Energy efficiency is occurring in all states, but rather than taking credit for these activities, many states are ignoring their benefits. They must therefore invest in other, potentially unnecessary control measures for reducing pollution. So the question remains: Why are states not taking SIP credit for what they are already doing?

## Survey on State Perceptions of Using Energy Efficiency in SIPs

The complexity of the electric grid, dispersion of pollutants, and scale of emission reductions are factors that can create uncertainty around the use of energy efficiency as a NAAQS compliance strategy. This uncertainty can cause an air regulator to decide that limited resources are better spent focusing on other opportunities to reduce pollution.

To better understand why more states are not seeking credit for energy efficiency in their SIPs, we conducted a survey of state air regulators. We received responses from eight regulators spread across the country.[31] Most of the respondents have areas currently in

[30] Results from AVERT can be used as inputs to more complex air quality models.

[31] ACEEE sent the survey to ten states, and importantly, this was a nonrandom sample. The survey was sent to respondents with the understanding that all responses would remain anonymous.

nonattainment for NAAQS. We asked them to provide details on their state's experience and perceived barriers with incorporating energy efficiency in SIPs.

The level of familiarity with energy efficiency policies and programs in each state varied. Five respondents identified themselves as somewhat familiar with the data sources and practices for quantifying efficiency savings, two were knowledgeable, and one was not at all familiar. The majority of respondents had no prior experience with incorporating energy efficiency in SIPs. Six respondents were familiar with one or more existing EPA resources on incorporating efficiency in SIPs (see Appendix B for details on EPA guidance). Respondents identified a variety of barriers as reasons why they were not incorporating efficiency in SIPs. One cited the need for additional resources. Another found existing resources sufficient but stated that the SIP credit energy efficiency could achieve in a nonattainment area could not justify the resources spent to develop it. One respondent noted a need for staff training, additional guidance, and appropriate utility energy efficiency programs. Another respondent indicated issues with a modeling tool and getting the reductions in the location needed.

The results of our survey suggest that a variety of real and perceived barriers hinder states' use of energy efficiency as a compliance strategy for NAAQS. This hesitance is a missed opportunity for states to reduce the cost of complying with federal regulations and streamline regulatory efforts to tackle pollution, all while strengthening grid reliability and maintaining affordable energy for all.

## Recommendations

Based on our survey of states and the opportunities for pollution reduction identified in our analysis, we recommend the following steps.

*Develop tools that states can use to evaluate the impact energy efficiency measures will have on SIP compliance obligations.* States have access to a number of valuable tools and guidance documents, but determining the impact of any single program or policy on overall attainment requires detailed and expensive power sector and atmospheric air quality modeling. This rigor of modeling is an integral part of the SIP process but is resource intensive for states. This means that to evaluate the impact a measure will have on the concentrations of a pollutant, a state must invest substantial resources. A tool or decision-making framework for making this assessment before investing the resources for atmospheric modeling could be useful.

*Develop a streamlined, EPA-acceptable approach for measuring and documenting outcomes of efficiency programs to be included in a SIP.* In 2012, EPA produced a *Roadmap* detailing pathways a state could take to include energy efficiency programs and policies in a SIP (EPA 2012b; Appendix B). This document provides valuable guidance on many aspects of incorporating energy efficiency into a SIP and has 11 supporting appendices outlining additional details. ACEEE and the National Association of State Energy Officials (NASEO) have also produced templates for guiding states through this process (ACEEE 2014; NASEO 2017). What seems to remain elusive is a simple, straightforward way to account for, document, and model the results of an energy efficiency program or policy for inclusion as part of a SIP plan. This may be partially because many efficiency programs are designed for the non–air quality benefits they provide. For example, utility-run energy efficiency programs are generally regulated by public service commissions, where cost and reliability are top goals. These programs are typically subject to rigorous evaluation, measurement, and verification-reporting requirements, but those results may not be presented in the format that air quality regulators might need. Ideally, programs would report one set of results that could be used by utility commissions and air regulators alike. One way to simplify this process is to treat pollution reductions from energy efficiency similarly to how area and mobile sources are treated in SIPs. Like energy efficiency measures, compliance strategies for area and mobile sources include many small and dispersed measures that states do not individually track but can reasonably model to demonstrate compliance (Colburn, James, and Shenot 2015; Seidman 2017). Building on these existing resources, states could benefit from additional guidance and a streamlined process for measuring and documenting energy efficiency outcomes in a SIP.

*Provide states with ongoing, in-depth technical support.* Many groups, including ACEEE, provide technical support to states looking to assess the potential role for energy efficiency in attaining air quality goals. However that assistance will be limited by budgets, time constraints, and other realities. Ideally, states would have a long-term support partner with the capacity to offer the rigor and in-depth analytics to answer their most complex questions. A permanently staffed institute or support organization dedicated to meeting these needs could be one way to supplement states' staffing and budget constraints. For example, Northeast States for Coordinated Air Use Management (NESCAUM) performs modeling for the Northeast states. Multijurisdictional organizations that already perform state and regional air quality modeling (e.g., Mid-Atlantic Regional Air Management Association [MARAMA] and Lake Michigan Air Directors Consortium [LADCO]) could incorporate both energy efficiency and other emission reduction strategies to help relieve individual states of this analysis burden.

## Conclusion

Energy efficiency is a valuable resource that can achieve low-cost, multipollutant reductions in states across the country. Air regulators can rely on energy efficiency to meet specific pollutant reductions required under NAAQS, but states are missing out on this opportunity. One reason for this is the complexity of determining the exact location where pollutant reductions from energy efficiency will show up.

Our analysis demonstrates that savings from energy efficiency can result in avoided pollution from power plants in the locations needed for modeled NAAQS obligations in 32 states. Looking further at Illinois, Missouri, Ohio, Pennsylvania, and Texas, potential reductions from energy efficiency savings occurred in areas that are currently or anticipated to be in nonattainment for $SO_2$, ozone, and $PM_{2.5}$. States can use energy efficiency as a low-cost strategy to help reach or maintain attainment with NAAQS or to avoid initial nonattainment designations.

While all states have energy efficiency programs and policies, experience with incorporating energy efficiency in SIPs has been limited. Ignoring the multipollutant reduction benefits from energy efficiency means states must invest in potentially unnecessary control measures for reducing pollution. Our survey of state air regulators indicates that a variety of real and perceived barriers hinder states' use of energy efficiency as a NAAQS compliance strategy.

Based on our survey of states and assessment of opportunities identified in our analysis, we recommend several actions to further the role of energy efficiency as an air quality strategy for states. To help states evaluate the impact energy efficiency measures can have on SIP compliance, we suggest developing a tool or decision-making framework for making this assessment prior to investing the resources required for atmospheric modeling. In addition, states could benefit from a streamlined, EPA-acceptable approach for measuring and documenting outcomes of efficiency programs for inclusion in a SIP. We also suggest providing ongoing and in-depth technical support. Although the value of energy efficiency as an air quality planning strategy is clear, further work is needed to incorporate energy efficiency into SIPs for NAAQS.

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## Appendix A. AVERT Model

AVERT is an EPA tool that estimates the emissions benefits of energy efficiency (EE) and renewable energy (RE) policies and programs. AVERT estimates displaced emissions by representing the dynamics of electricity dispatch based on the historical patterns of actual generation in one selected year.[32]

EPA describes how AVERT works as follows:

> 1. AVERT's Statistical Module uses hourly "prepackaged" data from EPA's Air Markets Program Data (AMPD) to perform statistical analysis on actual behavior of past generation, heat input, $SO_2$, NOx, $PM_{2.5}$, and carbon dioxide ($CO_2$) emissions data given various regional demand levels. (AVERT's Statistical Module can also analyze user-modified data created in AVERT's Excel-based Future-Year Scenario Template). AVERT's Statistical Module produces regional data files that are input files used in AVERT's Excel-based Main Module.
>
> 2. AVERT's Main Module prompts users to select one of 10 AVERT Regional Data Files and enter EE/RE impacts (MWhs or MW) from a selection of options.
>
> 3. The AVERT Main Module performs the emissions displacement calculations based on the hourly electric-generating unit information in the regional data files and the EE/RE impacts entered into the tool.
>
> 4. AVERT's Future Scenario Template allows users to alter emission rates and retire and add units to reflect a near-term future picture of generation.[33]

AVERT estimates displaced emission from energy efficiency by comparing the generation and emissions of all fossil resources before and after inputting the energy efficiency resource. Users can enter energy efficiency impacts into AVERT in the following ways:

- Based on the percentage reduction of regional fossil load
  - Apply reduction to top X% of hours
  - Reduction % in top X% of hours
- Distribute evenly throughout the year
  - Reduce generation by annual GWh
  - Reduce each hour by constant MW

For this report, we input energy efficiency savings for each scenario as reduced generation of annual GWh distributed evenly throughout the year. This is representative of a portfolio of energy efficiency programs that produce constant savings throughout the year. When modeling the impacts of seasonal energy efficiency programs or demand-response

[32] AVERT currently has data for 2007–2016.

[33] See EPA 2017b for additional detail about AVERT and a downloadable version of the tool.

programs, users can reference the other energy efficiency input options to estimate the time differentiation and associated change in emissions at various points throughout the year.

The savings are then applied across a given AVERT region (figure A1) and assumed to have region-wide impacts on reduced generation and emissions. While AVERT applies energy efficiency savings across an entire region, it displays emission reductions at the state and county levels. Users can see emission reductions broken out by hourly, daily, monthly, or annual reductions.

Figure A1 displays the regional breakdown in AVERT. For the states that are within more than one region, EPA assigned a percentage of savings to each region based on the portion of the state's overall generation that is met by each region (see table A1). Users can choose from emissions profiles representing 2012 through 2016 generation patterns. For this report, we relied on 2016 emissions data and did not make changes to any of the emissions profiles.

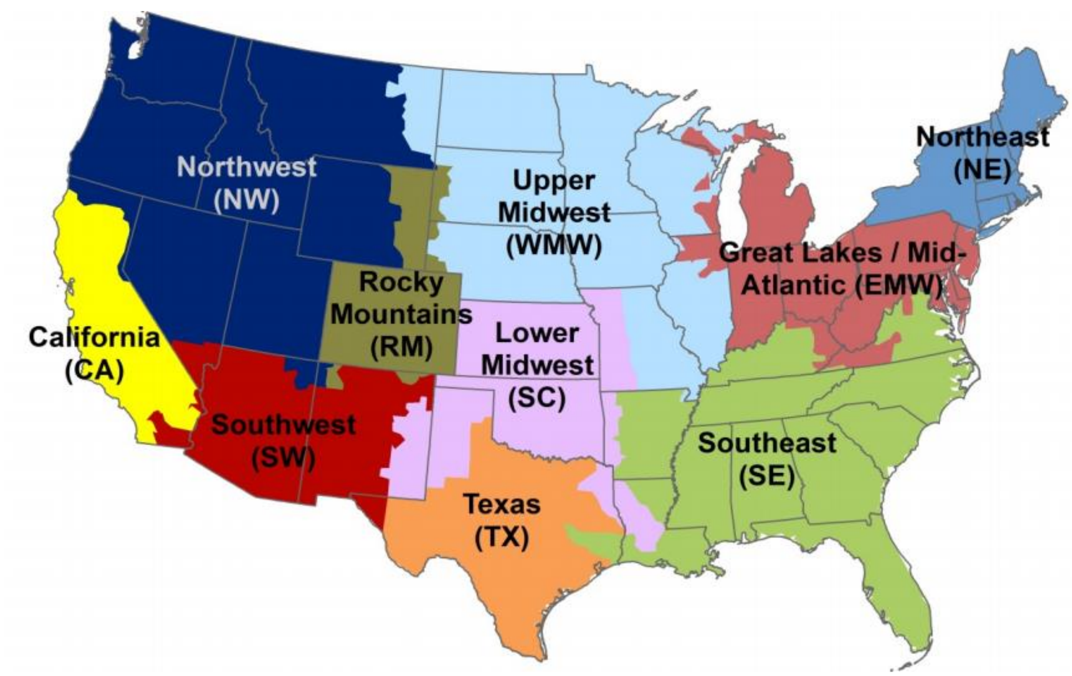


Figure A1. AVERT regions. *Source:* EPA 2017b.

Table A1. State apportionment in AVERT regions, based on fossil generation 2010–2013. *Source:* EPA 2017b.

| State (# regions) | Northeast | Great Lakes / Mid-Atlantic | Southeast | Lower Midwest | Upper Midwest | Rocky Mountains | Texas | Southwest | Northwest | California |
|---|---|---|---|---|---|---|---|---|---|---|
| Alabama | | | 100.0% | | | | | | | |
| Arkansas (2) | | | 88.7% | 11.3% | | | | | | |
| Arizona | | | | | | | | 100.0% | | |
| California | | | | | | | | 0.3% | | 99.7% |
| Colorado | | | | | | 100.0% | | | | |
| Connecticut | 100.0% | | | | | | | | | |
| District of Columbia | | 100.0% | | | | | | | | |
| Delaware | | 100.0% | | | | | | | | |
| Florida | | | 100.0% | | | | | | | |
| Georgia | | | 100.0% | | | | | | | |
| Iowa | | | | | 100.0% | | | | | |
| Idaho | | | | | | | | | 100.0% | |
| Illinois (2) | | 38.8% | | | 61.2% | | | | | |
| Indiana | | 100.0% | | | | | | | | |
| Kansas | | | | 100.0% | | | | | | |
| Kentucky (2) | | 9.4% | 90.6% | | | | | | | |
| Louisiana (2) | | | 76.1% | 23.9% | | | | | | |
| Massachusetts | 100.0% | | | | | | | | | |
| Maryland | | 100.0% | | | | | | | | |
| Maine | 100.0% | | | | | | | | | |
| Michigan | | 99.6% | | | 0.4% | | | | | |
| Minnesota | | | | | 100.0% | | | | | |
| Missouri (3) | | | 21.0% | 33.8% | 45.2% | | | | | |
| Mississippi (1) | | | 98.9% | | 1.1% | | | | | |
| Montana (1) | | | | | 2.3% | | | | 97.7% | |
| North Carolina | | | 100.0% | | | | | | | |
| North Dakota | | | | | 100.0% | | | | | |
| Nebraska | | | | | 100.0% | | | | | |
| New Hampshire | 100.0% | | | | | | | | | |
| New Jersey (2) | 23.4% | 76.6% | | | | | | | | |
| New Mexico (1) | | | | 2.9% | | | | 97.1% | | |
| Nevada (2) | | | | | | | | 72.0% | 28.0% | |
| New York | 100.0% | | | | | | | | | |
| Ohio | | 99.7% | | | 0.3% | | | | | |
| Oklahoma (1) | | | 4.1% | 92.8% | | | 3.1% | | | |
| Oregon | | | | | | | | | 100.0% | |
| Pennsylvania | | 100.0% | | | | | | | | |
| Rhode Island | 100.0% | | | | | | | | | |
| South Carolina | | | 100.0% | | | | | | | |
| South Dakota | | | | | 99.7% | 0.3% | | | | |
| Tennessee | | | 100.0% | | | | | | | |
| Texas (3) | | | 6.0% | 11.7% | | | 81.6% | 0.7% | | |
| Utah (2) | | | | | | | | | 65.1% | 34.9% |
| Virginia (2) | | 5.1% | 94.9% | | | | | | | |
| Vermont | 100.0% | | | | | | | | | |
| Washington | | | | | | | | | 100.0% | |
| Wisconsin (2) | | 45.2% | | | 54.8% | | | | | |
| West Virginia (2) | | 87.7% | 12.3% | | | | | | | |
| Wyoming (2) | | | | | | 38.3% | | | 61.7% | |

## Appendix B. EPA Guidance for Energy Efficiency in SIPs

EPA recognizes the multiple benefits of energy efficiency and supports its use as a pollution reduction strategy for NAAQS attainment. In 2004, EPA issued guidance detailing how states could incorporate energy efficiency and renewable energy in SIPs, including an explanation on quantifying and including emission reductions (EPA 2004a). EPA also released guidance that encourages the development of voluntary and emerging measures to be included in SIPs (EPA 2004b). Recognizing the need to aggregate savings from voluntary and emerging energy efficiency measures, EPA released additional guidance in 2005 (EPA 2005). Only a handful of states relied on this guidance to incorporate energy efficiency in their SIPs from 2005 to 2007 (Hayes and Young 2012).

In July 2012, EPA published the *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans* (the *Roadmap*) in an effort to clarify previous guidance and reduce barriers for states to incorporate energy efficiency and renewable energy into SIPs. The *Roadmap* has since been updated. It includes various factors to consider for energy efficiency, along with 11 appendices on topics such as the requirements of each implementation pathway, energy efficiency and air regulation terms, and methodologies for estimating emissions reductions (EPA 2012b). Table B1 details each of the four allowable pathways for energy efficiency in SIPs, the suggested approaches for quantifying emissions reductions, and the relevant guidance EPA associated with each. In addition, EPA released the *Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations* in July 2017. It details general principles and key criteria that inform development and review of electricity-generating unit (EGU) emission projections, including example tools states can use (EPA 2017c).[34]

[34] See Section 5.3.1

Table B1. Four allowable pathways for energy efficiency in SIPs. *Source:* EPA 2012b.

| Percentage of SIP "Credit" Allowed | Suggested Quantification Methods | Relevant EPA Guidance |
|---|---|---|
| ***Baseline Emissions Projection Pathway*** | | |
| • No SIP credit limit<br>• Allows for jurisdictions to account for established EE/RE policies in the SIP | • Energy model approach<br>• Historical hourly emission rate approach<br>• Alternative emissions projection tools or analysis | • More information on IPM is available at http://www.epa.gov/airmarkt/epa-ipm/<br>• "EIIP, Emissions Projections Volume X", EPA, http://www.epa.gov/ttnchie1/eiip/techreport/volume10/x01.pdf, 1999 |
| ***Control Strategy Pathway*** | | |
| • No SIP credit limit<br>• Need to present case for credit | • Energy model approach<br>• Historical hourly emission rate approach<br>• Capacity factor approach | • "Guidance on SIP Credits from Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures," EPA, http://www.epa.gov/ttncaaa1/t1/memoranda/ereseerem_gd.pdf, August 2004 |
| ***Emerging/Voluntary Measures Pathway*** | | |
| • Presumptive limit is 6 percent of the total amount of emission reductions required for SIP purposes<br>• Limit applies to the total number of emission reductions that can be claimed from any combination of emerging and/or voluntary measures<br>• Can be greater than six percent where a clear and convincing justification is made | • Capacity factor approach | • "Incorporating Emerging and Voluntary Measures in a State Implementation Plan (SIP)," EPA, http://www.epa.gov/ttncaaa1/t1/memoranda/evm_ievm_g.pdf, September 2004<br>• "Guidance on Incorporating Bundled Measures in a State Implementation Plan," EPA, http://www.epa.gov/ttn/caaa/t1/memoranda/10885guideibminsip.pdf, August 2005 |
| ***Weight of Evidence Pathway*** | | |
| • No SIP credit limit<br>• Only an option if the predicted air quality value in the attainment demonstration (using modeling) is within a prescribed margin of attaining the NAAQS | • Energy model approach<br>• Historical hourly emission rate approach<br>• Capacity factor approach<br>• eGRID sub region non-base load emission rates | • "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze," EPA, http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf, April 2007 |