States' Perspectives on EPA's Roadmap to Incorporate Energy Efficiency/Renewable Energy in NAAQS State Implementation Plans: Three Case Studies

Final Report to
the U.S. Environmental Protection Agency

Prepared by
NESCAUM

December 31, 2013

(Revised May 22, 2014)

Members of Northeast States for Coordinated Air Use Management

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FINAL REPORT
TO THE U.S. ENVIRONMENTAL PROTECTION AGENCY

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Appendix B: New York State Department of Environmental Conservation

Appendix C: Maryland Department of the Environment

Appendix D: NESCAUM

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Executive Summary

Air quality planners are interested in promoting the multi-pollutant air quality benefits of energy efficiency (EE) and renewable energy (RE) programs. EE and RE prevent emissions from occurring by reducing demand for energy from emitting sources. EE also prevents emissions associated with conversion losses, plant use, and transmission and distribution losses.[1] EE and RE programs have the potential to reduce the operation of the dirtiest energy generation sources that tend to run during unhealthy air quality episodes.

EE and RE have long-standing roles in helping to meet energy demand in the Northeast, Mid-Atlantic, and across the United States. Air quality planners are interested in assessing the air quality impacts and benefits of existing and new EE and RE programs and appropriately accounting for and incorporating their benefits into State Implementation Plans (SIPs), which detail how states plan to attain and maintain National Ambient Air Quality Standards (NAAQS).

With this interest in mind, the Northeast States for Coordinated Air Use Management (NESCAUM) worked with the U.S. Environmental Protection Agency (EPA), the Massachusetts Department of Environmental Protection (MassDEP), the New York State Department of Environmental Conservation (NYSDEC), and the Maryland Department of the Environment (MDE) to pilot case studies of EPA's *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans (the Roadmap)*.[2] The Roadmap clarifies and provides details on three new pathways for including EE and RE in SIPs: (1) baseline emissions forecast (baseline pathway); (2) control strategy quantification (control strategy pathway); and (3) weight-of-evidence (WOE pathway). A fourth pathway, innovative and emerging measures, was the basis for EPA's previous EE in SIPs guidance, issued in 2004.[3]

The project's goals were to highlight opportunities to include EE and RE in SIPs and to provide real-world examples and lessons learned in incorporating EE and RE in SIPs. Each state applied one of the three new Roadmap pathways and described its process, results, and policy questions in the case studies that are included in this report's appendices.

MassDEP's case study reviews how it might represent its statutory requirement of "all cost-effective EE" using EPA's **baseline pathway**.[4] MassDEP's case study reviews Massachusetts' recent experience developing load projections to support analysis of

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[1] According to the U.S. Energy Information Administration's Annual Energy Review 2011, every one unit of energy demand results in three units of energy consumed due to conversion losses, plant energy use, and transmission and distribution losses. Conversion losses occur as fuel is turned into mechanical energy to turn electric generators, in particular at steam-electric power plants. Transmission and distribution losses (also called line losses) occur as electricity is transported from power plants to end-use consumers. See: http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

[2] See: http://www.epa.gov/airquality/eere/pdfs/EEREmanual.pdf.

[3] See: http://www.epa.gov/ttn/caaa/t1/memoranda/ereseerem_gd.pdf.

[4] For the Massachusetts Green Communities Act of 2008 and Massachusetts's requirement to implement "all cost effective EE", see: https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.

potential changes to the Regional Greenhouse Gas Initiative (RGGI) program and shows what can be achieved through sustained collaboration among regulators from multiple state agencies and electric grid operators. MassDEP found that its utility commission and its independent system operator have valuable information on energy programs and their impacts on electricity demand. However, MassDEP noted a lack of consistent methods to quantify and forecast EE program savings, particularly with regard to timing and location of emissions reductions, which would be important for non-carbon dioxide pollutants. MassDEP also documented the lack of consistent methodology for determining and documenting the degree to which EE is captured in load forecasts.

NYSDEC's case study provides a hypothetical SIP submission using the **control strategy pathway**. NYSDEC's case study illustrates the magnitude of energy programs needed to achieve meaningful emissions reductions on a scale that noticeably affects ozone levels, and it underscores the potential for bundling EE and RE measures for inclusion in a SIP. NYSDEC had questioned whether EE/RE emissions reductions obtained through the control strategy pathway would be able to meet all four of the SIP credit criteria (permanent, enforceable, quantifiable, and surplus); NYSDEC chose to account for uncertainties associated with the quantifiable criterion by applying a discount factor to its calculated emissions reductions for one of the three measures that were quantified. NYSDEC's case study also brought forward a question as to whether EPA would accept particular quantification tools for SIP crediting purposes. NYSDEC is using the NE-MARKAL energy model and would use such an analysis for a future SIP. Based on discussions to date with EPA, it is understood that any analytical tools used in a SIP would need to be rigorously and appropriately applied and their use would be judged in the context of the SIP. NYSDEC's case study also underscores the importance of bundling EE and RE measures for inclusion in a SIP, as a small individual program would not achieve the magnitude of emissions reductions needed to significantly lower ozone levels.

MDE's case study is a status report of completed and planned work for its 2015 ozone SIP using an approach based on the **WOE pathway**. As written, EPA's WOE pathway allows states to assess likely attainment based on analysis using a variety of models of varying rigor, and does not allow for SIP crediting. Maryland's 2015 SIP will include EE and RE as part of a broader, rigorous multi-pollutant planning analysis. The case study describes a multi-pollutant planning process that combines traditional air quality assessment tools with less traditional assessment tools. Due to the rigor of its analysis, MDE created what it calls an "**expanded WOE approach**," and will request that EPA allow the measures quantified in that analysis to be included in its SIP. EPA and MDE plan to continue discussion on this expanded approach as the analysis proceeds.

This pilot project provided an opportunity for the three states to gain a deeper, working understanding of the Roadmap. It allowed them to engage with various EPA offices regarding key policy considerations, including:

- Promoting state and regional consistency in the development and review/approval of SIPs that incorporate EE and RE

- Addressing the challenge of determining location of emissions reductions from EE and RE programs, including using an approach similar to how mobile and area source programs are assessed credit for SIP purposes

- Clarifying expectations for how states demonstrate that EE and RE programs benefit the nonattainment area, as discussed in the August 2013 Frequently Asked Questions (FAQ) document [5]

- Promoting consistency in quantification methods, including the assessment of EE evaluation, monitoring and verification (EM&V) protocols

- Briefing the states on the U.S. Department of Energy (DOE) State and Local Energy Efficiency (SEE) Action Network and the DOE Uniform Methods project,[6] including timelines, expected outcomes, and applicability of these efforts to quantifying EE and RE in SIPs

The three states would like to continue discussion on some of these policy considerations. They are interested in maintaining ongoing discussion and dialogue with EPA as these case studies are introduced to other states, and as they and other states prepare SIPs that quantify EE and RE programs.

[5] See: http://www.epa.gov/airquality/eere/pdfs/eerefaqAug2013.pdf
[6] See: http://www1.eere.energy.gov/seeaction/ and http://www1.eere.energy.gov/office_eere/de_ump_about.html.

1. INTRODUCTION

1.1. Opportunity for Including Energy Efficiency and Renewable Energy in State Implementation Plans

Energy efficiency (EE) and renewable energy (RE) offer new and unique opportunities to improve air quality. As states are faced with fewer traditional air pollution control options that are cost-effective and can achieve significant criteria pollutant reductions, many EE and RE programs have the benefit of being "on the books" or "on the way," yielding multi-pollutant benefits such as reductions in nitrogen oxides, sulfur dioxide, and carbon dioxide, and avoiding emissions of the dirtiest electric generating units (EGUs) during unhealthy air quality episodes. Moreover, EE programs achieve additional benefits by avoiding energy losses from plant use, conversion, and transmission and distribution.[7]

EE has long helped in meeting energy demand in the Northeast and Mid-Atlantic, and other states and regions. The American Council for an Energy Efficient Economy estimates that, since 1970, about three-quarters of the new demand for electricity has been met by EE rather than energy generation.[8] Over the past several years, air regulators in the Northeast and Mid-Atlantic states have started examining ways to assess the air quality benefits of EE and RE and incorporate them into State Implementation Plans (SIPs), which detail how states plan to attain and maintain the National Ambient Air Quality Standards (NAAQS). Air regulators have become more active participants in regional and national dialogues with energy regulators, electricity generators, and system operators, and have engaged in multi-pollutant analysis exercises that integrate energy and air quality programs.[9],[10]

The Environmental Protection Agency's (EPA's) *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans (the Roadmap)* provides states with guidance for including EE and RE programs and technologies in SIPs.[11] The Roadmap provides three new pathways for including EE/RE in SIPs: (1) baseline emissions forecast ("baseline pathway"); (2) control strategy quantification ("control strategy pathway"); and (3) weight-of-evidence ("WOE pathway"). The Roadmap also expands upon a fourth pathway, voluntary and

[7] According to the U.S. Energy Information Administration's Annual Energy Review 2011, every one unit of energy demand results in three units of energy consumed due to conversion losses, plant energy use, and transmission and distribution losses. Conversion losses occur as fuel is turned into mechanical energy to turn electric generators, in particular at steam-electric power plants. Transmission and distribution losses (also called line losses) occur as electricity is transported from power plants to end-use consumers. See: http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

[8] See: http://aceee.org/research-report/e121.

[9] Regional and national dialogues on EE include the Northeast Energy Efficiency Partnership's (NEEP's) Evaluation, Measurement, and Verification (EM&V) Forum (http://neep.org/emv-forum/), Department of Energy's (DOE's) Uniform Methods Project for Determining Energy Efficiency Program Savings (http://www1.eere.energy.gov/office_eere/de_ump.html), and the State and Local Energy Efficiency (SEE) Action Network (http://www1.eere.energy.gov/seeaction/).

[10] For information on multi-pollutant planning, see: http://www.nescaum.org/topics/multi-pollutant-programs.

[11] See: http://www.epa.gov/airquality/eere/pdfs/EEREmanual.pdf.

emerging measures, which was the basis for EPA's 2004 EE in SIPs guidance. [12] In August 2013, EPA released a Frequently-Asked-Questions (FAQ) document, providing further clarification about the inclusion of EE and RE in SIPs.[13]

1.2. Challenges to Including Energy Efficiency and Renewable Energy in State Implementation Plans

Pilot states have noted that one hurdle to including EE and RE in SIPs is the enforceability of these programs. Unlike traditional air control programs, typically enforced through air permits or self-certification compliance, EE and RE programs are typically under the purview of public utility commissions (PUCs) or state energy offices. Enforceability is further complicated because EE and RE programs are not implemented at the source (i.e., the EGU), and thus the resulting emissions benefits may be realized at any EGU on the electricity grid, including out-of-state locations. A PUC or state energy office can only assure that the energy savings from the EE or RE program occurred.

Quantifying and characterizing energy savings from EE and RE programs for SIP crediting purposes is more complex than tracking emissions reductions from traditional controls on EGUs. First, meaningful reductions from EE and RE programs require implementation of many small measures (a bundled approach). Second, quantifying the energy savings from these measures requires realistic and transparent assumptions about the average energy savings, usage, and lifespan of each measure. Third, the data and information about energy savings are often housed within state PUCs or the utilities (where the utility acts as program administrator). Evaluation, measurement, and verification (EMV) of energy savings resulting from EE and RE programs is typically performed by the program administrator or PUC, and such processes differ by state.[14]

Air quality planners will likely find that energy savings data are available at an appropriate level of disaggregation for use in SIP planning. However, translating energy savings into emissions reductions introduces further complexity for air quality planners.[15] In the Roadmap, EPA outlines potential methodologies for estimating the emissions reductions from a unit of energy saved, which range from using a multiplier of regional annual, average non-baseload emissions rates (the average emission rate for the EGU's that could be displaced by an EE or RE program) to assessing hourly emissions reductions through dispatch modeling. The average non-baseload emissions factor approach may be too simplistic for SIP purposes, and the dispatch modeling approach may be too burdensome as air agencies do not have access to these models, they are costly to run, and may be at an inappropriate level of granularity for SIP purposes.

In addition, there are currently efforts underway to provide appropriate methodologies and tools for translating energy savings into emissions reductions for SIP purposes. For example, EPA's Avoided Emissions and Generation Tool (AVERT) quantifies hourly emissions reductions aggregated at the regional, state, and county levels, using statistical analysis of historical dispatch.[16] Also, the Northeast and Mid-

[12] See: http://www.epa.gov/ttn/caaa/t1/memoranda/ereseerem_gd.pdf.
[13] See: http://www.epa.gov/airquality/eere/pdfs/eerefaqAug2013.pdf
[14] See: www.raponline.org/document/download/id/6680.
[15] Ibid.
[16] For more information on AVERT visit: www.epa.gov/avert

Atlantic states are engaging with their regional system operators with the goal of developing a methodology to determine average annual marginal emissions rates for peak and off-peak hours for summer and non-summer seasons.

1.3. Report Overview

This report describes a pilot project by three volunteer states to apply three of the four Roadmap pathways to state EE and RE programs, and summarizes key policy considerations identified by the states. The remainder of Section 1 describes project background, goals, partners and their roles, and timeline. Section 2 provides a summary of the states' case study processes, findings, and recommendations. Section 3 highlights the state perspective on the outstanding issues the states have identified for EPA. Section 4 concludes with a review of key issues and a list of resource links and contacts. The case studies, as developed by the states, are contained in the appendices.

1.4. Project Overview

In October 2012, the Northeast States for Coordinated Air Use Management (NESCAUM) began working with EPA three volunteer states—Maryland, Massachusetts, and New York—to pilot the Roadmap. Each state applied one of the pathways to state energy programs and recorded its process, results, and policy questions in a case study. The project goals were to highlight opportunities to include EE and RE in SIPs, identify obstacles to incorporating EE and RE in SIPs, and provide real-world examples, lessons learned, and questions about the Roadmap.

EPA participants included:

- The Climate Protection Partnerships Division (CPPD) in the Office of Atmospheric Programs (OAP)the Office of Air Quality Planning and Standards (OAQPS), which is responsible for SIP-related rules and guidance and authored the Roadmap;
- OAP's Clean Air Markets Division (CAMD), which runs and maintains EGU-based forecasting tools such as the Integrated Planning Model (IPM) and the Emissions & Generation Resource Integrated Database (eGRID);
- The Office of Research and Development (ORD), which develops and uses energy models; and
- EPA Regions 1, 2, and 3, which review SIPs and will determine the approvability of EE/RE-related SIP submissions.

The Regulatory Assistance Project (RAP) provided technical and policy assistance on an as-needed basis. NESCAUM consulted with its Energy Efficiency-Air Quality Workgroup, which is comprised of Northeast and Mid-Atlantic state air regulatory staff and is working towards common methodologies for quantifying EE and RE emissions benefits.

Each state assessed a different Roadmap pathway. The Massachusetts Department of Environmental Protection (MassDEP) applied the baseline pathway to its statutory requirement to implement all cost-effective EE. The New York State Department of

Environmental Conservation (NYSDEC) applied the control strategy pathway to a hypothetical combined heat and power (CHP) program and to planned initiatives to incentivize solar and increase EE in public buildings. The Maryland Department of the Environment (MDE) is applying the WOE pathway to the energy programs included in its Greenhouse Gas Reduction Act Plan and has developed a comprehensive analytical approach that it calls an "expanded WOE approach." Two of these case studies are hypothetical, as neither Massachusetts nor New York currently have an ozone attainment SIP obligation. Maryland's ozone SIP is due in 2015, and its analytical efforts are ongoing.

Throughout the project, NESCAUM coordinated and facilitated routine discussions among the three states and the various participating EPA offices. These discussions promoted ongoing information exchange, including training opportunities in relevant topics. For example:

- NESCAUM provided EPA with training on the NE-MARKAL energy model and its ability to quantify emissions reductions from EE and RE programs;
- EPA created materials and provided training to educate states on the magnitude of EE and RE programs needed to achieve significant emissions reductions.[17]
- EPA provided briefings for MDE and MassDEP on EPA's analysis of EE and RE programs included in the U.S. Department of Energy (DOE) Energy Information Administration's (EIA's) Annual Energy Outlook (AEO) demand forecast for power sector modeling;[18] and
- EPA provided an overview and tutorial of the AVERT tool and responded to state concerns about the EGU-level of AVERT's results.

As the states began working with the Roadmap, they identified key policy considerations and questions, predominately stemming from the complexity of capturing and documenting the energy savings and emissions benefits of EE and RE. NESCAUM, EPA, and the States worked together to address each of these questions through a series of meetings and discussions. This document is intended to document that experience and help other states learn from progress in the pilot states to date.

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[18] For information about EPA's analysis of the EE/RE included in the AEO, see: http://www.epa.gov/statelocalclimate/state/statepolicies.html.

2. SUMMARY OF STATE ROADMAP CASE STUDIES

2.1. Massachusetts: The Baseline Pathway

The baseline pathway addresses emissions reductions from EE and RE by incorporating them directly into baseline emissions projections. To use this pathway, states must understand what is included in a chosen EGU baseline, account for the impact of EE and RE programs that are not already included in the EGU baseline, and then incorporate this electricity sales baseline into the SIP emissions baseline.

MassDEP examined how it would apply the baseline pathway to include Massachusetts Department of Public Utilities' (DPU's) statutory requirement to implement "all cost-effective EE" in a SIP.[19] The full case study is provided in Appendix A.

First, MassDEP reviewed program data from the DPU; MassDEP found that program data were readily available and that acceptable methodologies are in place in Massachusetts to estimate the energy savings from EE and RE programs and project these savings into the future.[20] Then it reviewed existing energy baselines embedded in state, regional, and national modeling efforts. This included examining data from EIA's AEO, the Eastern Regional Technical Advisory Committee's (ERTAC's) Electric Generating Utility Growth Model, and ISO-New England's load forecast.[21] MassDEP also examined the process of quantifying the emissions benefits of the DPU's EE requirement and how a load forecast might be adjusted if necessary to incorporate these benefits. MassDEP cited as a model recent experience working with ISO-New England to develop load forecasts deemed acceptable for use during the recent review of the RGGI program.[22]

MassDEP found that there is no standard methodology across the New England states for determining whether the benefits of EE and RE programs are included in the load forecasts embedded in electric sector models. The lack of standardized methodology could lead to significant double counting or under-reporting of the benefits of EE and RE programs. MassDEP recommends that EPA and DOE work together to reduce the complexity of implementing this pathway by including all "on-the-books" state EE and RE programs in the state energy forecasts that are developed at the national level, with requirements for the use of consistent and transparent EMV. MassDEP stresses the

[19] For the Massachusetts Green Communities Act of 2008 and Massachusetts's requirement to implement "all cost effective EE", see: https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.

[20] For an example of established methodology for quantifying and forecasting energy savings, see: http://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf.

[21] See: http://www.eia.gov/forecasts/aeo/, http://www.ertac.us/index_egu.html, and http://www.iso-ne.com/trans/celt/index.html.

[22] For a review of the RGGI process to understand the ISO-NE forecast, see: *Evolution of an Energy-Efficient Forecast: Building a model that works across states and programs*, by Gordon van Welie, Public Utilities Fortnightly, January 2013.

importance of ongoing work by EPA and DOE to develop a national methodology to estimate emissions reductions from EE and RE.[23]

MassDEP also recommends that EPA provide more specificity as to the level of detail on EE and RE programs that would be required of states for SIP purposes. This could address the location and timing of emissions reductions if necessary, and the characterization of load in energy forecasts. Clarification from EPA on these factors will be necessary for states to evaluate available baselines for use in this pathway.

2.2. New York: The Control Strategy Pathway

The control strategy pathway is intended for "on the way" EE and RE programs. The intent is to quantify these nontraditional programs in a manner similar to traditional air quality control programs and to demonstrate that the programs meet the four SIP criteria (permanent, enforceable, quantifiable, and surplus).

NYSDEC applied the control strategy pathway to three programs: a hypothetical CHP program, a planned initiative to incentivize solar energy (NY-Sun), and an initiative to increase EE in public buildings (Build Smart NY). NYSDEC used EPA's CHP Calculator tool for the CHP analysis, and worked with NESCAUM in using the NE-MARKAL energy model to analyze the associated energy and emissions changes resulting from implementing NY-Sun and Build Smart NY. The full case study is provided in Appendix B.

This case study highlights how both program design and the technique for quantifying energy savings and emissions benefits of EE and RE programs should be factored into determining appropriate SIP credit. It also provides EPA with a concrete example of how a state can use an energy model to quantify the emissions benefits of an EE or RE program. The NE-MARKAL model is the Northeast-specific version of MARKAL,24 which represents the energy infrastructure of the northeastern U.S., including energy demand and supply in the power generation, commercial, industrial, residential, and transportation sectors.25

For purposes of SIP crediting, NYSDEC chose to discount the CHP scenario by a factor of 20 percent to account for uncertainties as well as for potential discrepancies in calculated and real program performance and emissions benefits. When evaluating EPA guidance and deciding which quantification methodology to use for the NY-Sun and Build Smart NY initiatives, NYSDEC chose what it felt was the most sophisticated analytical approach to quantify emission reductions. Consequently, NYSDEC deemed that an emissions reduction discount was not necessary for those initiatives. NYSDEC requests that EPA provide states and EPA regional offices with guidance on determining appropriate discount factors for EE and RE programs during SIP development exercises.

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[23] For example, the U.S. DOE is currently developing a framework and protocols for determining energy efficiency program savings through the Uniform Methods Project.. See: https://www1.eere.energy.gov/office_eere/de_ump.html.

[24] For information on the MARKAL model, see: Loulou, R., G. Goldstein, and K. Noble, The MARKAL Family of Models, Energy Technology Systems Analysis Programme (ETSAP), October 2004. See http://www.iea-etsap.org/web/index.asp.

[25] See: http://www.nescaum.org/topics/ne-markal-model.

NYSDEC confirmed that the magnitude of EE and RE programs needed to achieve meaningful results could be significant. Because individual measures could result in relatively small emissions reductions, NYSDEC would likely bundle measures for inclusion in a future SIP. In its August 2013 FAQ document, EPA refers states to its "Guidance on Incorporating Bundled Measures in State Implementation Plans," was originally intended for emerging and voluntary measures.[26] NYSDEC would like to work with EPA during future SIP development to clarify how this guidance is appropriate for use with the control strategy pathway.

This case study also indicates that determining SIP credit for EE and RE—including choosing appropriate discount factors—will likely be done on a case-by-case basis until more standardized emission quantification protocols are available to states. It is therefore important that any case-specific decisions made on SIP crediting be reviewed and shared nationally. This would foster regional consistency in SIP reviews and provide states with access to approved approaches.

2.3. Maryland: The Weight-of-Evidence (WOE) Pathway

The WOE pathway allows states to use a variety of analytical methods to document how state programs will maintain or reduce emissions without the need for otherwise required air quality modeling. EPA does not allow for crediting of EE and RE programs using this pathway, but intends to consider the results of this pathway when reviewing SIP submittals. States have used WOE in the past when there is no clear quantification methodology or when resource constraints prevent states from conducting a more rigorous analysis.

Maryland Department of Environment (MDE) chose to apply the WOE pathway while also significantly modifying it to include a robust technical approach that combines traditional air quality modeling with less traditional assessment tools. This approach expands upon the "expanded weight-of-evidence" approach developed by the Ozone Transport Commission and outlined in a June 17, 2011 letter to EPA.27 Because MDE plans to conduct and submit a rigorous technical analysis for its ozone SIP, it asks EPA to provide guidance on allowing SIP credit for such an expanded WOE approach. The full case study is provided in Appendix C.

MDE describes its WOE assessment—which will be used to assess EE and RE programs for its ozone SIP that is due in 2015—in Chapter 5 of its Greenhouse Gas Emissions Reduction Act Plan.28 MDE will assess multi-pollutant benefits, including changes in emissions of nitrogen oxides, sulfur dioxide, fine particulates, air toxics, and greenhouse gases, for the EE and RE programs, and will analyze their impacts for attaining the ozone NAAQS. MDE anticipates that its analysis will be completed in late 2014.

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[26] See: http://www.epa.gov/ttn/oarpg/t1/memoranda/10885guideibminsip.pdf, August 2005.

[27] Letter to Chet Wayland and Scott Mathias, EPA/OAQPS, from the Ozone Transport Commission. June 17, 2011. See: http://www.otcair.org/upload/Interest/Modeling/OTC%20Expanded%20Weight-of-Evidence%20Letter%20and%20Recommendation.pdf.

[28] For MDE's Greenhouse Gas Emissions Reduction Act Plan, see: http://climatechange.maryland.gov/publications/greenhouse-gas-emissions-reduction-act-plan/.

MDE is using a series of linked models for its multi-pollutant assessment that include: NE-MARKAL, the Regional Economic Models, Inc. (REMI), EPA's Community Multi-scale Air Quality (CMAQ) model, and EPA's Environmental Benefits Mapping and Analysis Program (BenMAP). MDE requests that EPA clarify how results generated from this expanded approach could be credited.

3. STATES' PERSPECTIVES AND SUGGESTIONS ON KEY POLICY CONSIDERATIONS

These case studies achieved much in moving states towards incorporating EE and RE into SIPs. There are still some outstanding policy considerations, as well as corresponding suggestions, from MassDEP, NYSDEC, and MDE as a result of their experiences. These considerations can be categorized as follows: (1) location of energy programs and emissions reductions; (2) acceptable level of detail on energy programs and associated emissions reductions; and (3) acceptance of energy models, tools, and quantification methodologies.

3.1. Location of Energy Programs and Emissions Reductions

Pilot states noted that attributing energy savings and emissions reductions from EE and RE programs to specific EGUs is not achievable with any degree of certainty, especially when considering a portfolio of programs that are implemented across a county, state, or region. Both the Roadmap and the August 2013 FAQ document indicate that the location of emissions reductions with respect to a non-attainment area is important, and begin to provide states with options for estimating the location of EE/RE program impacts.

Over the course of the project, the states noted the inherent challenge of assigning emissions reductions to particular EGUs or other geographic locations because they have no way of guaranteeing that emissions reductions will occur at a particular EGU or within a particular non-attainment area. The states' interpretation of EPA's FAQ document is that assigning location to emissions reductions appears to provide some flexibility for states if there is no EGU in the nonattainment area or if the modeled emissions reductions occur outside the nonattainment area, provided that states demonstrate air quality benefits to the area. States' understanding is that if the EE/RE program were to perform as anticipated but the projected emissions reductions were not to occur in the specified area, then any further action would depend on the state's attainment status; the state may be required to implement contingency measures.

The states also interpret the FAQ document to allow flexibility only for certain types of SIPs. In the FAQ, EPA indicates that it is constrained with respect to location-specific emissions due to a court order. The states believe this could be ameliorated by allowing methodologies that generalize the location of emissions reductions, such as an approach that is similar to how area and mobile source programs are credited within SIPs. In quantifying SIP credit for area and mobile source programs, states are not required to specify the exact geographic location of impact of those sources. States use models such as MOVES, which rely on general emissions factors and, as appropriate, apply rule effectiveness and rule penetration discounting factors. States recommend that EPA consider this type of approach for EE and RE programs, with the acknowledgement that states are ultimately responsible for achieving the emissions reductions detailed in their SIPs.

3.2. Acceptable Level of Detail on Energy Programs and Associated Emissions Reductions

The Roadmap and the August 2013 FAQ document mention the magnitude of EE and RE needed to achieve meaningful emissions reductions. The pilot states noted that accounting for the energy savings and emissions reductions of many individual programs is complex. States noted that they would benefit from guidance on acceptable methods of estimating energy savings and emissions reductions of bundled programs, as well as easy access to available technical information on the energy savings associated with sample EE and RE measures. States also noted that DOE has expertise developing related EE measurement protocols, which could be useful for achieving SIP quantification objectives.[29]

The FAQ document describes how states can bundle the impacts of EE and RE programs so that the total effect of all the measures are considered, thus increasing the likelihood that the desired air quality results will be achieved. EPA's "Guidance on Incorporating Bundled Measures in State Implementation Plans"[30] addresses bundling of measures for voluntary and emerging measures for mobile and area sources and the application of a discount factor. For purposes of SIP development, the states expressed interest in clarifying guidance on the acceptability of this tool for other pathways and the determination of appropriate discount factors.

Another consideration for States is understanding the level of detail on the individual EE and RE programs that EPA regional offices will expect in their SIP submittals. The pilot states indicated that they intend to rely upon their energy offices, PUCs, and utilities for this evaluation, measurement, and verification (EM&V) information. States noted that this approach is consistent with EPA's FAQ document, which indicates that air quality regulators must ensure that rigorous, credible, and transparent EM&V is performed by utility commissions. The Massachusetts case study observes that states would benefit from guidance on how to evaluate existing EM&V practices and whether this information must be included in the SIP.

The three states expressed interest in continued and expanded coordinated efforts among EPA offices, particularly with the regions, to promote consistency in evaluating SIP submittals with regards to the level of program detail and rigor of analyses. This could take the form of trainings and a set of criteria developed before states submit their first SIPs incorporating EE and RE programs. The state perspective is that these criteria would greatly facilitate the inclusion of EE and RE in SIPs.

3.3. Acceptance of Energy Models, Tools, and Quantification Methodologies

EPA's FAQ document indicates that guidelines are being developed to help states select appropriate models and tools, in particular those that use capacity factors, historical hourly emissions rates, and energy modeling approaches. The FAQ document identifies

[29] For example, see DOE's Uniform Methods Project (https://www1.eere.energy.gov/office_eere/de_ump.html) and the SEE Action Network project (http://www1.eere.energy.gov/seeaction/).

[30] See: http://www.epa.gov/ttn/oarpg/t1/memoranda/10885guideibminsip.pdf.

NE-MARKAL as a model that states could use in quantify the emissions benefits of EE and RE programs. NYSDEC expressed interest in working with EPA to clarify expectations for crediting the results of this type of analysis during any future SIP development process to ensure acceptability. Moreover, the states requested that EPA continue discussions about this model and other models as they are introduced for SIP quantification purposes. The three states recommended that these discussions include additional training for the regional offices, and guidance for states on how these models may best be used to quantify EE and RE programs in SIPs.

State and EPA participants in the pilot also noted that the Northeast and Mid-Atlantic states and regional EPA offices are currently engaged in an effort with regional system operators to develop a methodology to determine average annual marginal emissions rates for peak and off-peak hours (rather than hourly emissions rates) for summer and non-summer seasons. If this effort is successful, states may be interested in using this new approach for their SIPs. At that time, states anticipate reviewing the methodology with EPA.

To address the considerations raised here, States expressed interest in continuing to work with EPA and in maintaining discussions begun through the Roadmap project and expand them to include other states. Their perspective is that this would be helpful as new, credible, documented quantification approaches are introduced for use in SIPs.

4. SUMMARY

The Roadmap provides states with opportunities to incorporate the multi-pollutant benefits of EE and RE programs into their SIPs. is The States are interested in exploring the pathways established in the Roadmap, recognizing that EE and RE programs can reduce emissions from the dirtiest energy generation sources that tend to run during unhealthy air quality episodes.

This project is the first application of the EPA Roadmap with state-based case studies. It has provided an opportunity for states and EPA, working in partnership, to uncover fundamental benefits and policy considerations around including EE and RE in SIPs. States noted that EPA participated in this effort with an unprecedented level of engagement, and this effort has thus built the foundation for continued discussions with the volunteer states and other states interested in including EE and RE in SIPs.

The states are interested in continuing to work with EPA to clarify acceptable approaches for estimating the location of emissions reductions, discuss the balance between flexibility and documented, credible SIP submittals, and establish the importance of evaluating future analytical tools. States also stressed the importance of working with state and national energy offices in the promotion of more standardized protocols for quantifying the energy savings of EE programs and for translating the energy savings from both EE and RE programs into emission reductions. In particular, the pilot project provided an opportunity for states to engage with various EPA offices regarding key policy considerations, including:

- Promoting state and regional consistency in the development and review/approval of SIPs that incorporate EE and RE
- Addressing the challenge of determining location of emissions reductions from EE and RE programs, including using an approach similar to how mobile and area source programs are assessed credit for SIP purposes
- Clarifying expectations for how states demonstrate that EE and RE programs benefit the nonattainment area, as discussed in the August 2013 Frequently Asked Questions (FAQ) document
- Promoting consistency in quantification methods, including the assessment of EE evaluation, monitoring and verification (EMV) protocols
- Briefing the states on the U.S. Department of Energy (DOE) State and Local Energy Efficiency (SEE) Action Network and the DOE Uniform Methods project,[31] including timelines, expected outcomes, and applicability of these efforts to quantifying EE and RE in SIPs

[31] See: http://www1.eere.energy.gov/seeaction/ and http://www1.eere.energy.gov/office_eere/de_ump_about.html.

The three states would like to continue discussion on some of these policy considerations. They are interested in maintaining ongoing discussion and dialogue with EPA as these case studies are introduced to other states, and as they and other states prepare SIPs that quantify EE and RE programs.

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For a copy of the Roadmap and supporting documents, see:

http://www.epa.gov/airquality/eere/manual.html

For a copy of the Roadmap Frequently-Asked-Questions document, see:

http://epa.gov/airquality/eere/pdfs/eerefaqAug2013.pdf

Appendix A: Massachusetts Case Study
The Baseline Pathway

Massachusetts Case Study- The Baseline Pathway

Introduction

Massachusetts is a leader among states implementing energy efficiency (EE) programs. The American Council for an Energy Efficient Economy ranked Massachusetts first in the nation for its energy efficiency programs in 2011 and 2012, and Massachusetts has directed more than 80% of its share of the revenue generated by the Regional Greenhouse Gas Initiative allowance auctions toward energy efficiency. Massachusetts is currently implementing numerous EE programs that reduce electricity, natural gas, and oil consumption, with associated reductions in emissions and ambient air pollution levels. This case study[1] reviews how EE programs might be incorporated into State Implementation Plans (SIPs) using the baseline approach described in the U.S. Environmental Protection Agency's (EPA's) *Roadmap for Incorporating Energy Efficiency/ Renewable Energy into SIPs/TIPs*.[2]

In the *Roadmap*, EPA describes the baseline pathway as best suited for "on the books" policies that states wish to address in SIPs. Consistent with this guidance, Massachusetts evaluated options for using the baseline pathway approach to incorporate its EE programs into SIPs. A suite of Massachusetts EE policies are "on the books," in that they are being implemented pursuant to orders of the Massachusetts Department of Public Utilities, and in that their continuation will be necessary to ensure ongoing compliance with the Massachusetts Green Communities Act of 2008 requirement that "electric and natural gas resource needs shall first be met through all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply."[3]

A significant challenge to including these policies into SIPs arises from the need to integrate projected EE effects with a broader modeling effort directed at establishing an emissions baseline. There is currently no standard method for determining whether reductions attributable to a specific EE policy are implicitly reflected in load forecasts embedded in electric sector models. A second set of challenges arises from the need to connect energy savings with reduced levels of ambient air pollution, especially if benefits must be correlated with pollution events that occur at specific times and locations. This case study describes these challenges, and how they may be addressed, in more detail. While some options for addressing these challenges may represent departures for regulating the electric sector (which has traditionally been regulated through requirements to install controls directly on emissions sources), they share some

[1] Massachusetts does not currently have a relevant SIP obligation; this case study is intended to inform the development of future SIPs, but the specific programs discussed in this case study are not intended for inclusion in any particular SIP at this time.

[2] http://www.epa.gov/airquality/eere/manual.html.

[3] M.G.L. c. 25, § 21(a).

characteristics with strategies that have been used to control emissions from mobile sources (such as transit programs that indirectly reduce vehicle use by reducing demand).

Massachusetts' statutory requirement for procuring all cost effective EE resources has significantly raised the importance of the evaluation, monitoring, and verification (EM&V) of the results of those programs. In addition to the general need to ensure that resources are being deployed efficiently, the application of the cost-effectiveness test requires detailed consideration of savings resulting from each measure implemented. For example, dozens of EM&V reports published since 2010 are available on the Massachusetts Energy Efficiency Advisory Council's web page.[4] These reports are used to evaluate program performance and inform future investment decisions. To ensure national consistency in calculated EE savings, simplify analysis for other states, and ensure that credited EE savings are realized, EPA must draw on these and similar efforts of other states and the US Department of Energy (DOE) to standardize the process of measuring, verifying, and projecting EE savings.[5] This will ensure that a ton of pollution saved through energy efficiency is consistently valued around the country, as EPA requires now for other control strategies.[6]

Massachusetts has experience estimating emissions impacts of EE measures. For example:

- Massachusetts' Regional Greenhouse Gas Initiative regulations include a provision that addresses voluntary purchases of renewable energy by retiring allowances corresponding to estimated emission reductions resulting from those purchases.[7] Similarly, as part of its NOx Allowance Trading Program, Massachusetts has allocated allowances to EE projects using a static formula that estimates potential emission reductions based on MWh savings.
- The Massachusetts Clean Energy and Climate Plan for 2020 includes estimates of the impacts of EE policies on greenhouse gas (GHG) emissions in Massachusetts.[8]
- Massachusetts and other states implementing the Regional Greenhouse Gas Initiative have worked to ensure load forecasts used for electric system modeling fully reflect efficiency spending in the region. Several other states have used data provided by Massachusetts to estimate impacts of their programs. This effort is discussed in detail below in the section titled *RGGI Experience*.

[4] See http://www.ma-eeac.org/.
[5] The Uniform Methods Project is an example of this type of effort. More information is available at http://www1.eere.energy.gov/office_eere/de_ump_about.html.
[6] For example, EPA publishes standard emission factors for use in a number of contexts, and establishes detailed monitoring requirements in regulation for key parameters such as emissions from power plants that are subject to cap-and-trade programs.
[7] 310 CMR 7.70(5)(c)1.b. requires the use of an emission factor to estimate avoided CO_2 emissions.
[8] See http://www.mass.gov/eea/docs/eea/energy/2020-clean-energy-plan.pdf, pp. 18 - 19.

- Studies of program benefits ("avoided cost studies") prepared for New England electric utilities, gas utilities, and other efficiency program administrators and state energy offices include estimates of avoided nitrogen oxide (NO_X), sulfur dioxide (SO_2), and carbon dioxide (CO_2) emissions that are occurring as a result of energy efficiency investments.[9]

One of the key questions that Massachusetts would need to address if including EE in a SIP is the level of detail with which EE policies should be specified. On the one hand, the broad requirement to capture all cost effective EE represents a specific, enforceable, "on the books" policy that should be sufficient to support inclusion in a SIP baseline. In fact, a baseline emissions projection that did not include this requirement would not be complete. On the other hand, it may be necessary in some cases to provide information about specific measures expected to deliver the anticipated reductions for at least three reasons:

- In order to determine whether anticipated reductions are likely to occur and persist over time, EPA will need sufficiently detailed technical descriptions of the measures that are driving the reductions.
- For SIPs that address National Ambient Air Quality Standards (NAAQS) that have relatively short averaging times (i.e., one or eight hour standards), analyses of individual measures may be necessary to establish the relationship between EE measures and pollutant levels at times and locations where exceedances are most likely to occur.
- Analysis of specific measures may be useful or necessary to avoid double counting of EE impacts that may be captured in load forecasts that do not explicitly detail whether EE measures are included.

This case study includes technical discussion of these issues, describes how Massachusetts recently approached a similar problem as part of a recent review of the Regional Greenhouse Gas Initiative program, and proposes that EPA adopt an approach to the inclusion of EE in SIP emissions baselines that draws on Massachusetts' experience implementing and evaluating comprehensive EE programs over time.

Technical Discussion of EE Quantification and EGU Modeling: Estimating Energy Savings

In order to establish an emissions baseline that fully reflects the impacts of EE policies and measures, Massachusetts needs to address two related technical challenges:

> (1) The impacts of the EE policies and measures must be specified with enough certainty and detail to support analysis of air quality impacts. For example, a measure directed at air conditioner efficiency would only be appropriate for inclusion after analysis of

[9] See http://www.ma-eeac.org/Avoided%20Costs.html.

uncertainty regarding any rebound effects,[10] and of the fact that air conditioners only operate in the summer months in Massachusetts.

(2) The impact of the efficiency measure must be evaluated in the context of a comprehensive forecast of electric load, for inclusion in a model of the electric sector. The primary challenge here is that, while models generally represent individual electric generating units (EGUs), or at least categories of EGUs, they generally do not represent individual loads in the same way. Instead, loads targeted by EE measures are often represented only in that their operation is included in aggregate load forecasts, often derived based on historical trends. In other words, EE measures change variables that are not explicitly represented in electric sector models, making them much more difficult to integrate than, for example, emissions control technologies installed at specific EGUs.[11] These challenges will require significant technical effort to adequately address.

Much work has been accomplished on the first of these challenges. For example, extensive EM&V work has allowed the use of "deemed savings" to specify impacts of measures for which extensive experience exists, such as light bulb replacement programs.[12] Similarly, studies that specify savings in kilowatt-hours saved per dollar invested (kWh/$) terms are increasingly viewed as reliable indicators of likely energy savings from future EE investments. While less well-developed, studies that separate EE impacts on electric system capacity needs (which reflect demand on hot summer days) from impacts on total energy demand may form a basis for beginning to address the need to specify the timing of EE impacts. And studies that consider impacts on locational electricity prices implicitly acknowledge that impacts of EE measures on emissions may depend to some degree on where the impacts occur. These issues are addressed in additional detail below.

Measuring the impact of an EE program or measure on electricity consumption represents a significant technical and conceptual challenge.[13] The key conceptual issue arises from the need to isolate program or measure impacts that cannot be directly measured. While the amount of energy used by a particular load can be measured directly, measuring the impact of replacing a given load with a more efficient version can only be determined indirectly, by making assumptions about the amount of electricity that would have been used if the load had not been

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[10] Rebound effects occur when users respond to lower operating costs of efficient appliances by using them more.

[11] This situation is somewhat similar to the challenge of modeling impacts of transit programs on motor vehicle emissions, in that the effect of the programs on the emission sources is indirect.

[12] As described by EPA at http://www.epa.gov/statelocalclimate/state/activities/measuring-savings.html: "To evaluate programs that target simpler efficiency measures with well–known and consistent performance characteristics, a deemed savings approach may be appropriate. This method involves multiplying the number of installed measures by an estimated (or deemed) savings per measure, which is derived from historical evaluations. Deemed savings approaches may be complemented by on–site inspections."

[13] Transportation programs may represent a useful model for understanding these challenges, as they also rely in some cases on strategies that reduce emission indirectly, without directly regulating the relevant emission source (e.g., transit programs).

replaced.[14] Myriad technical challenges arise from the need to understand what actually occurs when, for example, an efficient appliance is installed in a home or a business. Does the appliance perform as represented by the manufacturer? Does use of the appliance have indirect impacts on other loads? While challenges remain, much progress has been made in this area, primarily because of the need to ensure that funding is justified by realized savings.

For example, the following table provides an example of the number and range of EE measures that may be available for a given end-use sector, in this case low-income residences in Massachusetts.[15] As discussed below, in addition to successful implementation experience, Massachusetts has an extensive record of careful evaluation of the impacts of such programs.

EE Measures Used in Low-Income Residences in MA

Targeted End Use	Technology
Building Shell	Insulation (Attic, Wall, Pipe, & Duct)
Building Shell	Air Sealing / Duct Sealing
Heating	Heating System Repair & Replacement
Domestic Water Heating	DHW Measures (Low Flow Showerhead, Faucet Aerator, & Pipe Wrap)
Domestic Water Heating	50 and 80 gallon Heat Pump Water Heater (Electric)
Comprehensive, Whole House Approach	Weatherization Repairs (electrical repairs, roofs, etc.)
Comprehensive, Whole House Approach	Health and Safety
Lighting and Appliances	LEDs
Lighting and Appliances	CFLs
Lighting and Appliances	Lighting Fixtures
Lighting and Appliances	Torchieres
Lighting and Appliances	Refrigerator Replacement
Lighting and Appliances	2nd Refrigerator Removal
Lighting and Appliances	Freezer Replacement
Lighting and Appliances	"Smart" power strips
HVAC/Mechanical Systems	Window Air Conditioner Replacement

Numerous studies provide information that is used to estimate the impact of measures such as those listed in the above table. For example, the Massachusetts Energy Efficiency Advisory

[14] The challenge of determining the appropriate consumption baseline for comparison is even more challenging at the program level, where free-riders (i.e., consumers who would have implemented the efficiency measure anyway, absent the EE program) and spillover (i.e., cases in which consumers who do not participate directly in the EE program adopt a measure) complicate the analysis.

[15] The table is taken from *2013-2015 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan*, p.178, available at http://www.ma-eeac.org/Three%20Year%20Plans.html.

Council website lists 24 residential studies published in 2012 alone, ranging from *WiFi Programmable Controllable Thermostat Pilot Program Evaluation*, to *Consumer Survey Results* to *Home Energy Services Pre-Weatherization Initiative: Interim Evaluation Findings Memo*.[16] Massachusetts Program Administrators plan to spend nearly $70 million measuring program impacts over the next three years (2013 – 2015).[17] These measurement efforts have allowed the Massachusetts Public Utilities Commission and ISO New England (ISO-NE) to be confident that planned reductions in energy use will occur, and they should be sufficient, if referenced in a SIP, to allow EPA to reach the same conclusion without the need for additional evaluation. However, in the longer term, EPA should continue to work with DOE to publish consistent and replicable methods for quantifying EE program savings, and require the use of these methods in SIP submittals.[18]

Projections beyond the three-year periods covered by Massachusetts' efficiency plans and ISO-NE's forward capacity market are more challenging, but are essential. The challenge arises from the impracticality of specifying individual measures in detail more than three years into the future. Longer-term forecasts are essential because they are needed to plan capital investments to ensure adequate electricity supply and meet environmental goals. As states have gained experience in recent years planning and evaluating EE programs, the following method has been used by EPA and others to project EE savings a decade or more into the future:[19]

1. Drawing on EM&V and short-term planning experience, estimate average production costs of energy savings, expressed in dollars invested per kilowatt-hour saved.[20]
2. Project future production costs considering the estimate described above and any variables likely to affect future production costs (such as product efficiency standards that will take effect within the time period covered by the plan).
3. Develop an estimate of planned investment levels over a longer time period. For example, Massachusetts' ongoing statutory commitment to realize all cost effective EE savings provides a basis for such an estimate.
4. For each future year, multiply the projected production cost by the estimated spending level to determine the projected EE savings for that year.

[16] These studies are available at http://www.ma-eeac.org/EMV.html.
[17] See *2013-2015 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan*, p.30, available at http://www.ma-eeac.org/Three%20Year%20Plans.html.
[18] For example, EPA's existing processes for demonstrating equivalency in the context of emission inventories development could serve as a model.
[19] For example, see the Lawrence Berkeley National Laboratory report titled The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025 (2013), available at http://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf.
[20] In practice this will likely be expressed in terms of "first year" savings, and $/kWh estimates will be higher than retail electricity costs, even though per kWh costs will generally be low over the lifetime of the measure.

In response to requests by Massachusetts and other states, ISO-NE recently integrated this method into its load forecasting process. This change is discussed in more detail below in the section titled *RGGI Experience*.

For some purposes the timing of EE impacts may be nearly as important as the total magnitude. For example, while air conditioning needs in New England are less than in warmer locations, they contribute significantly to peak summer loads, which are highly correlated with summer ozone pollution events. States that wish to reflect such timing effects in SIP baselines would need to document them explicitly in SIPs, which may justify more sophisticated analysis than the four-step process described above.[21]

Technical Discussion of EE Quantification and EGU Modeling: Estimating Emissions Impacts

While much progress has been made in specifying the energy impacts of EE programs, integration of these impacts in models that forecast EGU emissions remains a challenge. As discussed above, the key difficulty arises from the fact that, even prior to the explicit specification of EE impacts, these models include load forecasts that implicitly reflect some level of EE deployment. EPA documents include a description of how states might proceed if the fraction of EE savings were known, but acknowledge reliance on an analysis that "lacking better information, assumes that the growth rates derived from the US Energy Information Administration's Annual Energy Outlook (AEO) forecast implicitly account for a continuation of 50 percent of historical levels of reported energy savings."[22] Unfortunately, however, there does not appear to be any widely applicable method for estimating the relevant percentage in particular cases, so this guidance may be of limited use to states. If possible, states and EPA should take steps to ensure that "on the books" EE policies are reflected in baseline forecasts, instead of introducing an adjustment at a later stage.

Several examples are provided below of modeling platforms that could be used in future SIP submittals. Note their similarity with regard to how load forecasts are used to develop emissions baselines:

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[21] Examples of efforts in this area include ISO-NE's estimates of EE impacts of generation capacity needs (see, for example, the "Summer EE Peak Impacts" on slide 18 of the presentation at http://www.iso-ne.com/committees/comm_wkgrps/othr/enrgy_effncy_frcst/2013frcst/index.html), and discussion of "coincidence factors" on page 17 of the 2013 – 2015 *Massachusetts Technical Reference Manual for Estimating Savings from Energy Efficiency Measures* (available at http://www.ma-eeac.org/TRMs.html.) Coincidence factors describe the degree to which EE savings are correlated in time with peak loads. The fact that coincidence factors are used by ISO-NE to forecast EE impacts on generation needs demonstrates their suitability for use in planning efforts such as SIPs.

[22] *Roadmap*, p. J-9.

- The Integrated Planning Model (IPM) is the modeling tool most often used by EPA to model EGU emissions in the SIP context. According to EPA: *Developed by ICF Consulting, Inc. and used to support public and private sector clients, IPM is a multi-regional, dynamic, deterministic linear programming model of the U.S. electric power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies for meeting energy demand and environmental, transmission, dispatch, and reliability constraints. IPM can be used to evaluate the cost and emissions impacts of proposed policies to limit emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), and mercury (Hg) from the electric power sector.*[23]
- States are currently collaborating as the Eastern Regional Technical Advisory Committee (ERTAC) to develop an alternative to IPM.[24] This model is explicitly intended for use in the SIP context, and is expected to have capabilities similar to those of IPM. The advantage of the ERTAC model will be greater transparency; states are dissatisfied with the fact that, because IPM is a proprietary model developed and operated by a private contractor, states and other stakeholders have limited ability to independently verify that IPM appropriately represents relevant aspects of the EGU sector.
- According to NESCAUM: *The NE-MARKAL initiative, which began in 2003 through collaboration between NESCAUM and the U.S. EPA Office of Research and Development, has resulted in the development of a MARKet ALlocation (MARKAL) least-cost optimized linear programming (LP) model tailored specifically to the energy infrastructure of the Northeast. NE-MARKAL is a data-rich analytical framework for examining energy policy options and their resultant impact on energy services in the region. The model serves as the centerpiece of the integrated policy analysis framework developed at NESCAUM that aids in developing a comprehensive understanding of technology, economic, environmental and public health consequences of air quality and climate initiatives.*[25]

For the purposes of this case study, the important similarity among these modeling platforms is that they all allow users to customize electricity load forecasts. Therefore, as long as states or EPA are able to develop load forecasts that reflect EE programs, these forecasts can be reflected in baseline modeling.

As an alternative to adjusting load forecasts explicitly, as discussed above, it may be possible to adjust emissions baselines in SIP submittals using default or case-specific emission factors. This could be appropriate if, for example, EPA were to provide states with a baseline emissions

[23] See http://www.epa.gov/airmarkt/progsregs/epa-ipm/.
[24] See http://www.ertac.us/#.
[25] NESCAUM is Northeast States for Coordinated Air Use Management. NESCAUM is described at http://www.nescaum.org/about-us/overview/, and NE-MARKAL is described at http://www.nescaum.org/topics/ne-markal-model .

forecast derived using IPM, and a state concluded that this baseline emissions forecast did not fully reflect planned state EE investments. Instead of re-running IPM, the state could develop an appropriate emission factor (i.e., in lbs/MWh) and use it to adjust EPA's emissions forecast. This process could be improved if EPA were to develop a procedure for producing such emission factors as part of the modeling process, for example through sensitivity analysis of multiple IPM runs using different load forecasts. Such adjustments, however, could introduce additional complexity and uncertainty to the modeling process, and may not be the preferred method for reflecting on-the-books EE programs in baseline models.

A second challenge arises from the need, for some pollutants, to specify when and where impacts occur. Even for measures for which the location and timing of impacts may be reasonably well characterized, EGU models may not include sufficient resolution to project impacts. To cite an obvious example, EE measures that target commercial air conditioners in the Boston area may not have much impact on ambient wintertime levels of particulate pollution in western Massachusetts, even if the particulate pollution includes a significant contribution from EGUs. Models vary in their ability to reflect these dynamics.

RGGI Experience

The Regional Greenhouse Gas Initiative (RGGI) is a cap and trade program for carbon dioxide emissions from power plants in nine northeastern states. As part of a recent program review, the RGGI states, including Massachusetts, modeled electric sector emissions through 2020 using IPM. To support this modeling effort, it was necessary for each state to provide (or approve) a projection of electric load.

One option available to states was to use load forecasts provided in the US Energy Information Administration's Annual Energy Outlook (AEO), as is common for electric sector modeling using IPM. This option was rejected for two reasons: (1) states did not believe that AEO forecasts were reflective of planned EE investments in the region, and (2) states believed that regional ISOs would be a more reliable source of information, as they require a detailed understanding of future loads to fulfill their function of ensuring reliable operation of the electric grid over the long term. In particular, all New England states, including representatives of the Massachusetts Department of Energy Resources, began reviewing ISO-NE's load forecasts to determine whether they would be suitable for use in the RGGI modeling effort.

While all New England states, including Massachusetts, eventually decided to use ISO-NE's load forecasts without adjustment, this occurred only after ISO-NE responded to state input and developed a load forecast reflecting state EE investments. The following aspects of this process are relevant:[26]

- ISO-NE produces numerous forecasts using varied assumptions regarding variables such as fuel prices and weather conditions, as would be expected, given their mandate to ensure that the electric grid will operate reliably under reasonably anticipated stresses. Among the assumptions that vary across these scenarios are assumptions about the impacts of EE investments on load.
- ISO-NE's wholesale electric market includes a forward capacity market, in which entities willing to commit to deliver energy to the electric grid three years in the future are paid for making such a commitment. By reducing demand from particular loads, EE projects increase the amount of energy available for delivery to other loads, therefore increasing the overall capacity of the system to serve all connected loads at times when demand is highest. Therefore, EE projects are allowed to participate in the forward capacity market in direct competition with generators. In order to participate in the forward capacity market, EE program administrators must provide projections of electricity savings that are sufficiently reliable and detailed to allow ISO-NE to be confident that the savings will be realized as projected. These projections are incorporated into load forecasts and, because of the financial incentive provided by the forward capacity market, are believed to reflect most energy efficiency investment in the region.
- Prior to 2012, ISO-NE's load forecasts did not include any energy efficiency investments beyond the three-year period covered by the forward capacity market. However, after extensive consultations with states, ISO-NE began publishing a 10-year load forecast reflecting ongoing EE investments, beyond the three-year period reflected in the forward capacity market. [27]

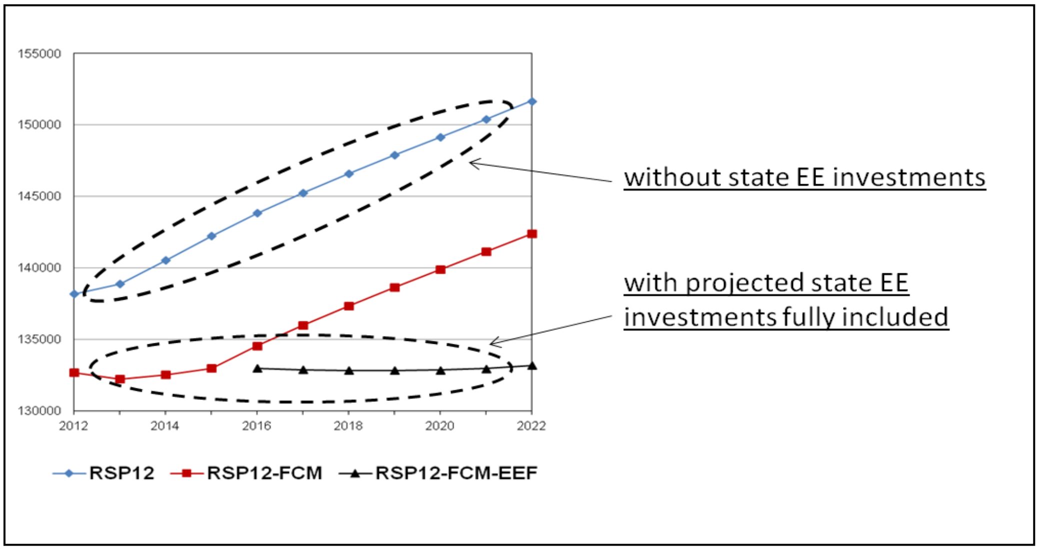
Initially, before ISO-NE revised its load forecast as described above, Massachusetts and other New England states were unwilling to rely on ISO-NE's load forecast beyond the three-year period covered by the forward capacity market. Instead, states completed the first round of RGGI program review modeling in 2011 by adjusting ISO-NE load forecasts downward. Each state determined the amount of the adjustment by dividing a state-specific estimate of future levels of annual EE investment (in dollars) by a state-specific production cost for EE savings (in dollars per kilowatt-hour). However, after review of ISO-NE's revised load forecasts and their similar treatment of EE investment, Massachusetts and other states decided to rely on ISO-NE's load

[26] For more information, see *Evolution of an Energy-Efficient Forecast: Building a model that works across states and programs*, by Gordon van Welie, Public Utilities Fortnightly, January 2013.

[27] In some cases, ISO-NE's calculations include a "Budget Uncertainty Rate" to account for the possibility that forecasted spending levels are not realized. For a Massachusetts-specific example, see ISO-NE's Final 2013 Energy Efficiency Forecast 2016 – 2022, available at http://www.iso-ne.com/committees/comm_wkgrps/othr/enrgy_effncy_frcst/2013frcst/iso_ne_final_ee_forecast_2016_2022.pdf (see slide 46).

forecasts for use in the final IPM modeling conducted for the RGGI program review.[28] The figure below illustrates the effect of reflecting EE investments in ISO-NE's load forecasts.[29]

ISO-NE Annual Load Forecast (GWh)



This experience provides a useful framework for developing load forecasts that reflect EE investments. If it is necessary, in a given situation, to use a load forecast that is believed not to fully reflect EE investment, then such a forecast may be adjusted downward using EE spending and production cost estimates. However, a preferable approach is to work directly with an entity with expertise and responsibility in the area of load forecasting, such an ISO or state energy office, to reach a forecast that is viewed by all participants as reflective of EE investments. One relevant aspect of the RGGI experience is that, while ISO-NE considered information about specific measures being implemented by the states, forecasts beyond the three-year time frame of the forward capacity market are based on general commitments to fund EE programs, not commitments to continue investing in the same specific measures.

Conclusions

Massachusetts strongly supports EPA's efforts to provide pathways that states can use to include electric EE programs in SIPs. This case study supports two key conclusions that should inform

[28] Illustrative load growth forecasts are available on slide 6 of the presentation available at http://www.rggi.org/docs/ProgramReview/RGGI%20DRAFT%20Reference%20Case%20Assumptions%20071212v6.pdf.

[29] See slide 6 of the presentation available at http://www.iso-ne.com/committees/comm_wkgrps/othr/enrgy_effncy_frcst/2013frcst/iso_ne_final_ee_forecast_2016_2022.pdf. The red line includes only EE reflected in the three-year-ahead forward capacity market.

the development of SIPs that include EE policies using the baseline approach described in the *Roadmap*, and other similar efforts:

1. Including EE policies via the baseline pathway should not require more specificity in SIPs than is necessary to provide an adequate level of assurance that EE savings reflected in the SIP will be realized. Traditionally, EGU policies included in SIPs have directly regulated EGUs through enforceable caps on emissions from specific facilities, or through cap-and-trade programs that control aggregate emissions from a set of facilities. In contrast, EE policies do not directly regulate EGUs. While this concept may represent a departure for the EGU sector, the transportation sector includes many examples of SIP-approved policies that reduce emissions from vehicles without directly regulating them, such as transit programs.[30] EPA should treat EE policies similarly; as long as a state can demonstrate the connection between enforceable investment commitments and reductions through a robust modeling program, these policies should be acceptable for inclusion in SIP emission baselines.

2. To ensure national consistency in calculated emission reductions, simplify analysis, and ensure that programs realize credited EE savings, EPA should collaborate with DOE and states to standardize the process of measuring, verifying, quantifying and projecting EE savings. Massachusetts' recent experience working with other states and ISO-NE to embed future EE investments in ISO-NE's load forecast, and subsequently using these forecasts to project electric sector emissions in the RGGI region, represents a useful model for how states and EPA can incorporate EE savings in future SIP emission baselines.

[30] See http://www.epa.gov/OMS/stateresources/policy/pag_transp.htm for examples of policies that may be included in SIPs even though realization of reductions requires behavior changes that cannot always be directly enforced.

Appendix B: New York Case Study
The Control Strategy Pathway

NYSDEC FINAL DRAFT REPORT
EPA PILOT PROJECT
ENERGY EFFICIENCY / RENEWABLE ENERGY IN STATE IMPLEMENTATION PLANS

December 19, 2013

In July 2012 the U.S. Environmental Protection Agency (EPA) released guidance entitled "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans." The goal of this "Roadmap" is to facilitate the use of Energy Efficiency / Renewable Energy (EE/RE) emissions reduction strategies in air quality plans, and to provide methodologies that could be used by states to account for emission reductions from EE/RE programs in State and Tribal Implementation Plans (SIPs/TIPs).

New York has a strong interest in incorporating EE/RE programs into future SIPs. Air quality modeling conducted by DEC indicates that the 2008 ozone National Ambient Air Quality Standard (NAAQS) will be difficult to attain, so it will be necessary to consider all potential sources of emission reductions, including energy efficiency and renewable energy programs. Since EE/RE programs are vigorously being implemented in New York State, it is in our best interest to receive SIP credit for the resulting criteria pollutant reductions.

The Roadmap describes four SIP pathways that are available to states as they consider which approach to adopt for incorporating policies and programs in SIPs. The four pathways are:

1. Baseline emissions projection pathway;
2. Control strategy pathway;
3. Emerging/voluntary measures pathway; and
4. Weight of evidence (WOE) determination pathway.

The New York State Department of Environmental Conservation (DEC) utilized the Roadmap's control strategy pathway as part of the pilot project and in formulating the enclosed hypothetical SIP submission, focusing on three EE programs currently being conducted in New York State: the installation of combined heat and power systems; the NY-Sun Initiative; and the Public Buildings Initiative (or "Build Smart NY").

- Combined heat and power is a form of distributed generation that creates electric power and thermal energy at or near the source, rather than from separate units at separate locations. It is being considered as an alternative compliance measure for EPA's recent update to the boiler maximum achievable control technology (MACT) regulation.

- The NY-Sun Initiative began on April 19, 2012 as a public/private partnership seeking to drive growth in the solar industry. The program's initial goal was to install 60 MW of photovoltaic (PV) capacity in 2012 and 120 MW in 2013, for a total statewide installed photovoltaic capacity of 239 MW by the end of 2013. Recently, the program was provided with additional funding through 2023 to further attract private investment in solar photovoltaic systems, enable the sustainable development of a robust solar power industry in New York, create well-paying skilled jobs, improve the reliability of the electric grid, and reduce air pollution over the next decade. On December 9, 2013, it was announced that the largest NY-Sun solar project, a 1.56 megawatt rooftop installation in New York City, was completed. $30 million is available through NY-Sun's competitive PV Program to stimulate other large-scale solar and biogas projects in New York City and the Hudson Valley.

- Build Smart NY was established through an Executive Order to improve EE in state-owned buildings. It dictates that, by April 1, 2020, the average energy usage of state buildings by reduced by at least 20 percent from a baseline of the 2010/2011 fiscal year. The upgrade projects include new lighting fixtures, heating and ventilating systems, electric motors, automated energy management systems, fuel cells, and solar power installations, while beneficiaries include schools, colleges, police and fire stations, municipal buildings, transit facilities, public housing, libraries, and wastewater treatment plants.

DEC utilized various tools to estimate the emission reductions resulting from these EE programs, but primarily relied upon the Northeast Market Allocation (NE-MARKAL) energy model run by the Northeast States for Coordinated Air Use Management (NESCAUM). Additional EE/RE program details were obtained from official EE/RE program reports posted on public websites. As needed, additional information would be available from the various administering groups (i.e., New York State Energy Research & Development Authority (NYSERDA), New York Power Authority (NYPA), and Long Island Power Authority (LIPA)). The New York Independent System Operator (NYISO) and the New York State Department of Public Service (NYSDPS) could also assist in providing supply-side data. The DEC regularly collaborates with NYSERDA, the NYISO, and NYSDPS on a myriad of workgroups and committees, and the advancement of incorporating energy efficiency in SIPs, to the extent practicable, will be an extension of the already established relationships.

Emission reductions can be quantified through future-year emission modeling, but models such as NE-MARKAL are not forecast tools and real-world reductions can therefore vary from those projected by the model. Some uncertainty is inherent in any modeling tool. To mitigate the possible over-estimation of future reductions, DEC would propose to discount the projected emission reductions from the CHP initiative in its hypothetical submission. Previous EPA guidance suggested starting with a 20% discount, but recognizes variability due to models used and respective inputs and assumptions. Discounting emissions from the NY-Sun or Build Smart NY initiatives would be discussed as a potential option at such time that a real SIP would be submitted.

Overall, DEC found that EPA's Roadmap is very well written and fully supports the use of the four pathways to obtain EE/RE SIP credit. A few potential challenges are noted as follows:

- Emissions reductions occurring outside boundaries of nonattainment areas
  - DEC feels this issue could be an issue for states wishing to use the control strategy pathway. According to EPA's August 27, 2013 EE/RE in SIPs FAQ document and their interpretation of the Clean Air Act (Act), EE/RE policies and programs can help states meet attainment and maintenance SIP requirements for areas that are designated nonattainment, or have attained with an approved maintenance SIP, even when the emissions reductions resulting from EE/RE are projected to occur outside the boundaries of nonattainment areas, as long as they benefit the nonattainment area's air quality. EPA believes the CAA requires emissions reductions that apply to Reasonable Further Progress (RFP) plans come from sources of emissions located within the boundaries of nonattainment areas. Therefore, in order to make such demonstrations for either SIP type, states would need to quantify their emission reductions through using the most sophisticated (and costly) quantification approach … energy models.

- Bundling of measures
  - The three programs analyzed in this hypothetical submission resulted in emissions reductions that were not insignificant, but also not at a level that would largely reduce ozone concentrations individually. Because of their relatively small magnitude, these measures would very likely be bundled together if they were to be included in a SIP through the control strategy pathway (or any of the four pathways). This topic is addressed in EPA's EE/RE in SIPs FAQ document and is recommended by EPA in certain cases. EPA states that "bundling together relatively small-scale or local SIP measures can be beneficial if individually these measures would be difficult or resource-intensive to quantify or verify in the SIP."

  - In addition to the Roadmap, DEC referred to the August 2005 EPA guidance entitled "Incorporating Bundled Measures In A State Implementation Plan (SIP)" for additional information to see if bundling would be an option when using the control strategy pathway. Page 6 of that guidance states that "Bundled measures should include only those measures that are considered to be voluntary or emerging measures, or traditional measures too small-scale to be typically included in a SIP." Traditional emissions reductions measures are defined as measures that individually have small amounts of emissions reductions and typically would not be included in a SIP. Traditional emissions reductions measures differ from voluntary and emerging measures in that they are enforceable against an individual source and can be reliably and replicably measured or determined. Some uncertainty remains as to the likelihood that EE/RE measures could be, or would be bundled when using the control strategy pathway when considering both sets of EPA guidance. Perhaps the guidance could be amended to address this uncertainty.

- Cap and Trade programs
    - In order to receive SIP credit, all emissions reductions, including those resulting from EE/RE measures using the Control Strategy pathway, must be *permanent*, *enforceable*, *quantifiable*, and *surplus*. As part of the "surplus" criteria, a state must demonstrate emission reductions are not used for other CAA requirements (e.g., under a cap and trade program). If an EE program causes several EGUs that are part of a cap and trade program to scale back the amount of electricity they generate and, therefore, reduce overall emissions, then, absent additional limitations, it may be difficult to show that these reductions meet the "surplus" criteria for crediting the measure. Per EPA guidance, one acceptable way of achieving additional emission reductions from EE and RE measures in the presence of a cap and trade program is through the retirement of allowances commensurate to the emissions expected to be reduced by the EE measures. Another way is to clearly demonstrate that emissions will decrease in the area despite the cap and trade program and the ability of plants to sell more electricity to other areas. This demonstration will likely entail a detailed analysis of electricity dispatch and allowance markets to determine the specific impact of the measures on the system. While not insurmountable, these issues could be problematic for states with limited budgets and staff.

Because of the emerging nature of incorporating EE/RE programs in SIPs, DEC expects that it will work closely with EPA Region 2 staff to deal with any questions concerning application of the Roadmap for official SIP submissions. For now, DEC feels this hypothetical SIP submission is a suitable representation of what a future submission would be comprised of under the Roadmap's Control Strategy pathway.

In conclusion, DEC found that EPA's Roadmap is very well written and should be followed when considering including energy programs in SIPs. Having the option of the four delineated pathways is helpful because states vary in the emphasis they put on EE programs and how far along they are in program development and implementation. Larger EE programs could take advantage of the Baseline or Control Strategy pathways, whereas smaller or less-developed programs can benefit from the Emergency/Voluntary Measures or WOE pathways. The ability to utilize the different pathways is also helpful depending on how close the state is to meeting the NAAQS. The pathway chosen may also depend on whether a number of programs could be bundled together that would significantly impact ozone levels and, at the same time, would prove to be quantifiable, surplus, enforceable, and permanent. Energy modeling support from NESCAUM was extremely helpful to DEC in quantifying future reductions, so a similar methodology would be recommended for other states, especially if the Control Strategy pathway is desired.

EE.0 Energy Efficiency/Renewable Energy Measures

EE.1 Introduction

Energy efficiency (EE) and renewable energy (RE) policies and programs represent a real opportunity for improving air quality as part of a multi-pollutant emissions reduction strategy. EE/RE programs also have the potential to reduce regional haze, thereby increasing visibility, as well as reduce air toxics and greenhouse gas (GHG) emissions. This submittal represents New York's first incorporation of EE and RE programs in any State Implementation Plans (SIPs).

The following energy programs included in the "hypothetical SIP" are current energy efficiency and/or renewable energy programs in the State of New York:

- NY-Sun initiative
- Build Smart NY
- Combined Heat and Power (CHP)

The DEC used EPA's "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans" for the development of this section of the "hypothetical SIP."

EE.2 EPA's "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans"

In July 2012, EPA issued guidance entitled "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans". The roadmap includes charts and tables for decision makers to consider in weighing which of the four pathways to pursue for incorporating EE/RE policies into SIPs. Each pathway is appropriate for a specific set of circumstances and has its own documentation and analytical provisions. For this hypothetical SIP submission, the DEC is using the "Control Strategy" pathway which is appropriate for the situation where a state is contemplating the adoption of new EE/RE policies before it submits its SIP.

This hypothetical SIP attempts to adhere to the control strategy pathway tasks of the Roadmap by:

- Demonstrating that the EE/RE policies and programs are permanent

- Estimating the magnitude of the emissions reductions
- Demonstrating that the EE/RE policies and programs are surplus and not accounted for as part of another pathway or mechanism
- Ensuring that the EE/RE policies and programs are traditionally federally enforceable

EE.3 "Hypothetical SIP" EE/RE Measures

- **NY-Sun Initiative**[1]

The NY-Sun Initiative was launched on April 19, 2012 and is a dynamic public-private partnership intended to drive growth in the solar industry and make solar technology more affordable for all New Yorkers. It is expected to attract significant private investment in solar photovoltaic systems, enable the sustainable development of a robust solar power industry in New York, create well-paying skilled jobs, improve the reliability of the electric grid, and reduce air pollution over the next decade.

As part of a balanced statewide renewable energy policy, NY-Sun will install twice the customer-sited solar photovoltaic (PV) capacity added during 2011 in 2012, and quadruple that in 2013. This policy promotes clean energy innovation and protects the environment while cutting dependence on foreign oil.

The NY-Sun Initiative brings together and expands existing programs administered by the New York State Energy Research and Development Authority (NYSERDA), Long Island Power Authority (LIPA), and the New York Power Authority (NYPA), to ensure a coordinated, well-funded solar energy expansion plan.

The NY-Sun Initiative increases financial incentives for large, commercial-sized photovoltaic (PV) projects and expands incentive programs for small-to-medium residential and commercial systems. It also provides additional funding for its competitively-bid solar program for larger-scale and aggregated systems that currently focuses on businesses, colleges and universities, and other large buildings located in New York City, Westchester, and the lower Hudson Valley.

The NY-Sun Initiative introduces a balance-of-system (BOS) program, where NYSERDA and NYPA will work with private and public partners across New York State to standardize and streamline procedures for permitting and interconnection, and development and training. It will build

[1] Source: http://ny-sun.ny.gov/ on December 10, 2012

on the BOS advancements made by the City University of New York (CUNY) and the efforts underway in the PV Manufacturing Consortium.

- **Build Smart NY (also referred to as the NY Public Buildings 20% Initiative)**[2]

  Build Smart NY is an ambitious program for aggressively pursuing energy efficiency in New York State government buildings while advancing economic growth, environmental protection, and energy security in New York State out to 2020. It was established through Executive Order No. 88, "Directing State Agencies and Authorities to Improve the Energy Efficiency of State Buildings."

  The Build Smart NY agenda calls for accelerating EE improvements to public buildings, highlighting the multiple benefits that include saving taxpayer dollars, improving the environment, and creating jobs. The upgrade projects include new lighting fixtures, heating and ventilating systems, electric motors, automated energy management systems, fuel cells, and solar power installations, while beneficiaries included schools, colleges, police and fire stations, municipal buildings, transit facilities, public housing, libraries, and wastewater treatment plants.

  In support of Build Smart NY, NYPA will finance $450 million in cost-effective EE projects over the next four years, with a goal to reduce energy consumption in state buildings by 20 percent. NYPA also intends to finance an additional $350 million over the next four years to provide EE financing and technical services to county and local governments and schools, helping to lower local government costs for taxpayers.

- **Combined Heat and Power (CHP) Conversion**

  In exploring opportunities for partnership to promote investment in CHP, New York State Government, the United States Department of Energy and the EPA has identified the EPA pilot project as one of two opportunities for immediate partnership. An overall goal is to provide a model for the country, where best practices and policies can be replicated to support increasing investment in CHP systems and industrial energy efficiency.

  The DEC has chosen a hypothetical facility in the Bronx as its primary case study for including EE and RE in SIPs. The facility has four boilers that burn heavy oil with a total firing capacity of 370 million British thermal units per hour (MMBtu/hr) that were theoretically replaced with eight CHP, natural gas-fired combustion turbines rated at 13,500 kilowatts (kW) each.

[2] Source: http://www.governor.ny.gov/press/070212-cuomo-energy-efficient on December 10, 2012

EE.4 Emissions Quantification

In order to quantify emissions reductions from the NY- Sun Initiative and the Build Smart NY program, DEC used the Northeast Market Allocation energy model (NE-MARKAL).

The core NE-MARKAL database used for this analysis had a 2002 base year. The reference case that was used was developed, calibrated, and approved by DEC and NYSERDA for a previous analytical effort conducted in 2009 through 2010. The Northeast States for Coordinated Air Use Management (NESCAUM) reviewed the model constraints from that reference case and made some updates for the purposes of this analysis. Energy price projections were updated to be consistent with the 2012 Annual Energy Outlook, and characterized fine particulate matter ($PM_{2.5}$) and volatile organic compounds (VOC) emissions factors for all sectors in the model.[3]

- NY-Sun Initiative

The NY-Sun Initiative was represented in the NE-MARKAL model by setting the lower bound on customer-sited commercial and residential solar PV capacity to 50 megawatts (MW) in 2011, 119 MW by 2012, and 239 MW from 2013 through 2029.[4] Energy efficiency and other technology deployment in this model run were constrained to isolate the energy and emissions results associated with the program's target for solar PV deployment. As a result, solar technology deployment was solely responsible for all modeled energy and emissions changes.

- Build Smart NY

The Build Smart NY Initiative was represented in the NE-MARKAL model by establishing an upper-bound on the total amount of fuel consumed by public buildings. The upper bound was derived by applying a 20 percent decrease in energy demand from public buildings. Public building energy demand was isolated using the ratio of public building floor space to all commercial floor space in New York State.[5] This decrease in demand was applied starting in 2011 and then linearly interpolated, reaching full implementation by 2020, and remaining constant afterwards. This run is called "New York Public Buildings 20 Percent Initiative -a".

[3] The updated emissions factors were based on the 2011 release of the US 9 Region MARKAL model. NOx emissions had been characterized.
[4] NE-MARKAL produces results in three year increments. Results for model year 2029 are an average of the results for years 2028-2030.
[5] Public buildings in New York State account for five percent of the overall commercial floor space.

- CHP Conversion

  For this hypothetical scenario, DEC used EPA's CHP Calculator tool to gauge the level of emission reductions that would result from the installation of a CHP system. In order to take SIP credit for a real-world CHP installation, DEC would need to engage with the New York Independent System Operator (NYISO) and/or the New York State Department of Public Service (NYSDPS) to determine the impact of the subject facility's reduced reliance on an electric generating unit (EGU) (or multiple EGUs), and the related impact on pollutant emissions from the EGU(s). Since this was not practical at this time, DEC would propose to discount the emissions reductions projected by EPA's CHP calculator by 20 percent, or another negotiated amount.

EE.5 Energy Modeling Emission Reduction Results

- NY-Sun Initiative

  The emissions results of the NY-Sun Initiative are presented in the appendix. Included are buildings sector and power sector emissions summaries.

  Modeled building sector emissions relative to the reference case show a modest decline due to the displacement of a small amount of natural gas usage by thermal solar electric devices. During the 2002 to 2029 modeling timeframe, carbon dioxide (CO_2) and nitrogen oxides (NO_x) are projected to decline in the buildings sector, while other emissions are essentially unchanged.

  Emissions effects were seen particularly in the power sector, where emissions declined over the modeled timeframe, especially for SO_2 and NO_x. The emissions effects are attributable to the backing-off on conventional fossil fuel generation resources due to decreased load from the buildings sector.

  The table below represents the net cumulative change in emissions from the power and buildings sectors for the NY Sun Initiative.

Cumulative Change 2002-2029 (thousand tons):

	2002	2005	2008	2011	2014	2017	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	0.0	0.0	-0.1	-1.5	-2.2	-2.1	-2.0	-0.7	-0.3	0.0	-3.8	-8.9
NOx	0.0	-0.1	0.0	-1.5	-2.9	-2.3	-1.3	-0.4	0.7	0.8	-4.5	-7.1
PM2.5	0.0	0.0	0.0	-0.4	-0.1	-0.4	-0.5	-0.2	-0.2	-0.2	-0.5	-2.1
SO2	0.0	0.0	-0.1	-6.0	-2.4	-3.3	-1.5	-0.5	0.9	1.7	-8.5	-11.2
VOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	-0.17

*** CO2 in Million Tons**

- Build Smart NY

The emissions results of the Public Buildings Initiative are presented in the appendix.

The initial modeling indicates a modest decrease in emissions in the buildings sector, countered by a slight increase in emissions from the power sector. In the second analysis, where energy efficiency is deployed first, changes in the buildings sector emissions are negligible, while the overall decline in electricity demand-- as a result of EE in the buildings sector--leads to decreased power sector emissions across all pollutants.

In the initial analysis, the buildings sector appears to experience sector-wide emissions reductions as more efficient non-emitting electrical devices displace natural gas equipment. However, the greater use of electrical devices in the buildings sector leads to a modest increase in the demand for electricity and results in increased emissions from the power sector. Sulfur dioxide in the power sector declines due to the slight displacement of coal-fired generation by natural gas, as mentioned above.

After accounting for the trade-off in emissions between the buildings and power sectors, net emissions from the public buildings scenario decrease across all emissions indicators in both sets of runs. The magnitude of net emissions reductions is similar for both iterations of the analysis.

The table below represents the net cumulative change in emissions from the power and buildings sectors for the Public Buildings Initiative.

Cumulative Change (thousand tons):

	2002	2005	2008	2011	2014	2017	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	0.0	0.0	0.0	-0.1	-0.8	-0.8	-0.7	-0.6	-0.6	-0.1	-0.9	-3.7
NOx	0.0	-0.1	0.0	0.0	-0.7	-1.1	-0.2	0.1	0.1	1.0	-0.8	-0.9
PM2.5	0.0	0.0	0.0	0.0	0.0	-0.1	-0.2	-0.3	-0.3	-0.2	-0.1	-1.1
SO2	0.0	0.0	-0.1	-1.9	-1.7	-1.5	-0.3	0.5	0.2	1.8	-3.7	-2.9
VOC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1

*** CO2 in Million Tons**

EE.6 CHP Conversion Emissions Reductions

EPA's Combined Heat and Power (CHP) Emissions Calculator compares the anticipated carbon dioxide (CO_2), methane (CH^4), nitrous oxide (N_2O), carbon dioxide equivalent (CO_2e), sulfur dioxide (SO_2), and nitrogen oxide (NO_x) from a CHP system to those of a separate heat and power system.

The calculator uses fuel-specific CO_2, CH^4, and N_2O emissions factors used in the EPA Greenhouse Gas Reporting Program, region-specific transmission and distribution loss values, and data from Emissions & Generation Resource Integrated Database (eGRID) 2012. The calculator also presents estimated emissions reductions as metric tons of carbon equivalent and emissions from passenger vehicles, as shown below.

The DEC acknowledges that the resulting estimates of environmental benefits of CHP generated by the calculator are appropriate for educational and outreach purposes only. However, the calculator allows users to specify up to 26 additional CHP system characteristics for those who are interested in more accurate emissions estimates. Given the time and staff constraints of the EE in SIPs Pilot Project, the DEC modified the 26 additional CHP characteristics to the best of its ability. Therefore, the DEC believes the estimates would be adequate for SIP credit purposes when applying a discount, tentatively set at 20 percent.

The CHP Emissions Calculator estimates a 50.41 ton per year reduction in NOx from 2012 levels in 2018. A 20 percent discount reduces the estimate to 40.3 tons per year. A rough conversion to ozone season day converts to 0.11 tons (221 lbs) per day.

In order to take SIP credit for a real-world CHP installation, DEC would need to further engage with NYISO and/or NYSDPS to determine the impact of the subject facility's reduced reliance on an EGU, and the related impact on pollutant emissions from the EGU. These estimations would serve as appropriate supporting materials to submit to EPA.

Also bear in mind that these estimates are for a single hypothetical CHP conversion. In all likelihood, the DEC would bundle projected CHP projects when considering for inclusion in an actual SIP.

EE.7 Appendices

DEC has attached the NE-MARKAL modeling results performed by NESCAUM. This modeling work represents a thorough analysis of the NY-Sun and Build Smart NY program impacts on energy consumption and pollutant emissions through 2029. Also attached in the appendix is the results generated by the CHP Emissions Calculator.

DEC would also submit the April 19, 2012 press release announcing the NY-Sun program, and information from the program's official website. Other potential resources are NYSERDA's Solar Technologies webpage, NYPA's Solar Market Acceleration Program webpage (once further developed), and LIPA's webpage containing information on solar energy systems.

For the Build Smart NY program, DEC would also submit the December 28, 2012 press release and executive order announcing the program, and information from the program's official website—notably the August 2013 Build Smart NY 2013 Baseline Energy Performance Report and the September 2013 Build Smart NY Executive Order 88 Guidelines.

CHP Emissions Calculator Inputs

DE CHP EPA COMBINED HEAT AND POWER PARTNERSHIP

Introduction Documentation

1. CHP: Type of System Combustion Turbine [Submit]

2. CHP: Electricity Generating Capacity (per unit)

Normal size range for this technology is 1,000 to 40,000 kW

13,500 kW [Submit]

3. CHP: How Many Identical Units (i.e., engines) Does This System Have?

8 [Submit]

4. CHP: How Many Hours per Year Does the CHP System Operate?

5 days per week, 8 hours per day - 2,080 hours [Submit]

As a number of hours per year: 2,080

OR As a percentage: 0%

5. CHP: Does the System Provide Heating or Cooling or Both?

Heating Only

If Heating and Cooling: How many of the 2,080 hours are in cooling mode?

As a number of hours per year: -

as a percentage of the 2,080 hours? 0% [Submit]

If Heating and Cooling: Does the System Provide Simultaneous Heating and Cooling?

No

6. CHP: Fuel

Fuel Type: Natural Gas [Submit]

7. CHP: If Diesel, Distillate, Coal or Other: What is the Sulfur Content?
If WHP, what is the sulfur content of the stack?

0

[I will enter a value in one of the following blocks] or [High sulfur oil: 0.15% or 1,500 ppm] [Low sulfur oil: 0.05% or 500 ppm] [Ultra low sulfur diesel: 15 ppm] [Submit]

Enter Sulfur Content of Fuel as a percent: 0.000%

OR ppm: - ppm

8. CHP: What is the CO_2 Emission Rate for this Fuel? (default completed for fuel in Item 6) [Submit]

Enter alternative value: 116.9 lb CO2/MMBtu

9. CHP: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes) [Submit]

1,028 Btu/cubic foot (HHV)

OR - Btu/gallon (HHV)

OR - Btu/lb (HHV)

10. CHP: Boiler Steam To Process (Steam Turbine CHP Only)

Boiler Steam to Process as lb Steam/hr: 0

Boiler Steam to Process as MMBtu Steam/hr: 0

11. CHP: Steam Turbine System Boiler Efficiency (Steam Turbine CHP Only)

Enter Boiler Efficiency as %: 0%

12. CHP: Electric Efficiency

1

[I will enter an efficiency in one of the following blocks] [Use default for this technology] [Submit]

Enter Generating Efficiency as %: 29% (HHV)

OR Enter Generating Efficiency as Btu/kWh HHV: 11,725 Btu/kWh (HHV)

OR Enter Generating Efficiency as Btu/kWh LHV: 10,611 Btu/kWh (LHV)

DOE CHP &EPA COMBINED HEAT AND POWER PARTNERSHIP — Introduction | Documentation

13. CHP: Base Power to Heat Ratio

The Power to Heat Ratio should reflect ONLY the thermal production of the generating unit (i.e., combustion turbine). Thermal Output of the duct burners (if equipped) should not be included.

[I will enter a Power to Heat ratio] [Use default for this technology] [Submit]

Power to Heat Ratio	0.69
If WHP: Useful Thermal Output (MMBtu/hr)	0

14. CHP: NOx Emission Rate

1

[I will enter a NOx rate in **one** of the following blocks]

[Use default emissions for this technology.
Note: Default emissions are without aftertreatment. Some areas may require add-on controls and you will need to enter an emission rate based on your local requirements. SCR can reduce emissions by up to 90%]

	Enter a NOx Rate as ppm (15% O_2)	25.0	ppm
OR	Enter a NOx Rate as gm/hp-hr	-	gm/hp-hr
OR	Enter a NOx Rate as lb/MMBtu	0.092	lb NOx/MMBtu
OR	Enter a NOx Rate as lb/MWh	1.078	lb NOx/MWh

[Submit]

15. Duct Burners: Does the System Incorporate Duct Burners?

1 No [Submit]

16. Duct Burners: What is the Total Fuel Input Capacity of the Burners for Each CHP Unit?

For reference, the Combustion Turbine has a heat input of 158.3 MMBtu/hr

- MMBtu/hr [Submit]

17. Duct Burners: The CHP system operates 2,080 hours per year. How much do the duct burners operate?

As a number of hours per year	-
As a percentage of the 2,080 hours?	0%

[Submit] 0

18. Duct Burners: NOx Emission Rate for the Duct Burners

[I will enter a NOx rate in **one** of the following blocks] [Use default for this technology] [Submit]

0

0 - lb/MMBtu

OR - ppm NOx at 15% O2

19. Cooling: Does the CHP Provide Cooling? No [Submit]

2 You indicated No Cooling in Item 5

20. Cooling: Type of Absorption Chiller Used? [Submit] 0

Coefficient of Performance (COP) -

21. Cooling: What is the Cooling Capacity of the System? 0

Based on your other entries, the maximum cooling capacity is . tons or . MMBtu/hr of cooling [Submit]

(Enter a value in only ONE of the boxes)

- Cooling Tons

- OR MMBtu per Hour of Cooling

22. Displaced Cooling: What is the Efficiency of the Cooling System that is Being Displaced? [Submit]

0

(Enter a value in only ONE of the boxes)

	Electricity Demand (kW per ton)	-
OR	Coefficient of Performance (COP)	-

Introduction Documentation

23. Displaced Thermal: Type of System:

Existing Gas Boiler

Submit

24. Displaced Thermal: If not a Natural Gas System: What is the Sulfur Content?

I will enter a value or

Commercial coal: 1% sulfur

High sulfur oil: 0.15% or 1,500 ppm

Low sulfur oil: 0.05% or 500 ppm

Submit

0

Enter Sulfur Content as a percent 0.00%

OR ppm - ppm

25. Displaced Thermal: What is the CO2 Emission Rate for this Fuel? (default completed for fuel in Item 23)

Enter alternative value: 116.9 lb CO2/MMBtu

Submit

26. Displaced Thermal: What is the Heat Content of this Fuel? (Enter a value in only ONE of the boxes)

	1,028	Btu/cubic foot (HHV)
OR	-	Btu/gallon (HHV)
OR	-	Btu/lb (HHV)

Submit

27. Displaced Thermal: Efficiency (usually a boiler)

I will enter an efficiency

Use default for this thermal technology

Submit

Enter Generating Efficiency as % 80%

28. Displaced Thermal Production: NOx Emission Rate

I will enter the NOx rate

Use default for NOx rate

Submit

NOx Rate 0.100 lb NOx/MMBtu

DE | CHP &EPA COMBINED HEAT AND POWER PARTNERSHIP | Introduction | Documentation

29. Displaced Electricity: Generation Profile

eGRID 2012 Average Fossil (2009 data)

Modify one of the Three User Defined Generating Sources

Submit

Link to EPA's eGRID (Emissions & Generation Resource Integrated Database)

30. Displaced Electricity: Select U.S. Average or individual state or NERC region/subregion for EGRID Data

Submit

NY

NERC Region Definitions

31. Displaced Electricity: Select Electric Grid Region for Transmission and Distribution (T&D) Losses

Submit

Eastern Interconnect

5.82%

Link to EIA's Electric Grid Interconnection Map

CHP Emissions Calculator Results

CHP Results

The results generated by the CHP Emissions Calculator are intended for eductional and outreach purposes only; it is not designed for use in developing emission inventories or preparing air permit applications.

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

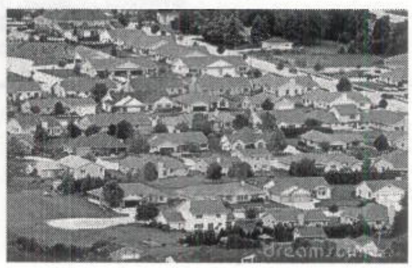
Annual Emissions Analysis	CHP System	Displaced Electricity Production	Displaced Thermal Production	Emissions/Fuel Reduction	Percent Reduction
NO_x (tons/year)	121.08	102.06	69.43	50.41	29%
SO_2 (tons/year)	0.77	195.21	0.41	194.84	100%
CO_2 (tons/year)	153,997	151,914	81,160	79,077	34%
CH_4 (tons/year)	2.90	6.350	1.53	4.977	63%
N_2O (tons/year)	0.29	1.622	0.15	1.484	84%
Total GHGs (CO_2e tons/year)	154,148	152,550	81,239	79,642	34%
Carbon (metric tons/year)	38,077	37,562	20,068	19,553	34%
Fuel Consumption (MMBtu/year)	2,634,676	2,150,696	1,388,536	904,556	26%
Number of Equivalent Cars Removed				13061	
Number of Equivalent Homes Removed				3,731	

This CHP project will reduce emissions of Greenhouse Gases (CO2e) by 79,642 tons per year

This is equal to 19,553 metric tons of carbon equivalent (MTCE) per year

This reduction is equal to removing the carbon emissions of 13,061 homes.

This reduction is equal to removing the carbon emissions of 3,731 homes.



CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

CHP Technology:	Combustion Turbine	
Fuel:	Natural Gas	
Unit Capacity:	13,500	kW
Number of Units:	8	
Total CHP Capacity:	108,000	kW
Operation:	2,080	hours per year
Heat Rate:	11,728	Btu/kWh HHV
CHP Fuel Consumption:	2,634,676	MMBtu/year
Duct Burner Fuel Consumption:	-	MMBtu/year
Total Fuel Consumption:	**2,634,676**	**MMBtu/year**
Total CHP Generation:	**224,640**	**MWh/year**
Useful CHP Thermal Output:	1,110,829	MMBtu/year for thermal applications (non-cooling)
	-	MMBtu/year for electric applications (cooling and electric heating)
	1,110,829	**MMBtu/year Total**
Displaced On-Site Production for Thermal (non-cooling) Applications:		Existing Gas Boiler
	0.10	lb/MMBtu NOx
	0.00%	sulfur content
Displaced Electric Service (cooling and electric heating):	There is no displaced cooling service	
Displaced Electricity Profile:	eGRID 2012 Average Fossil (2009 data)	
Egrid State:	NY	
Distribution Losses:	6%	
Displaced Electricity Production:	224,640	MWh/year CHP generation
	-	MWh/year Displaced Electric Demand (cooling)
	-	MWh/year Displaced Electric Demand (electric heating)
	13,882	MWh/year Transmission Losses
	238,522	**MWh/year Total**

CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.

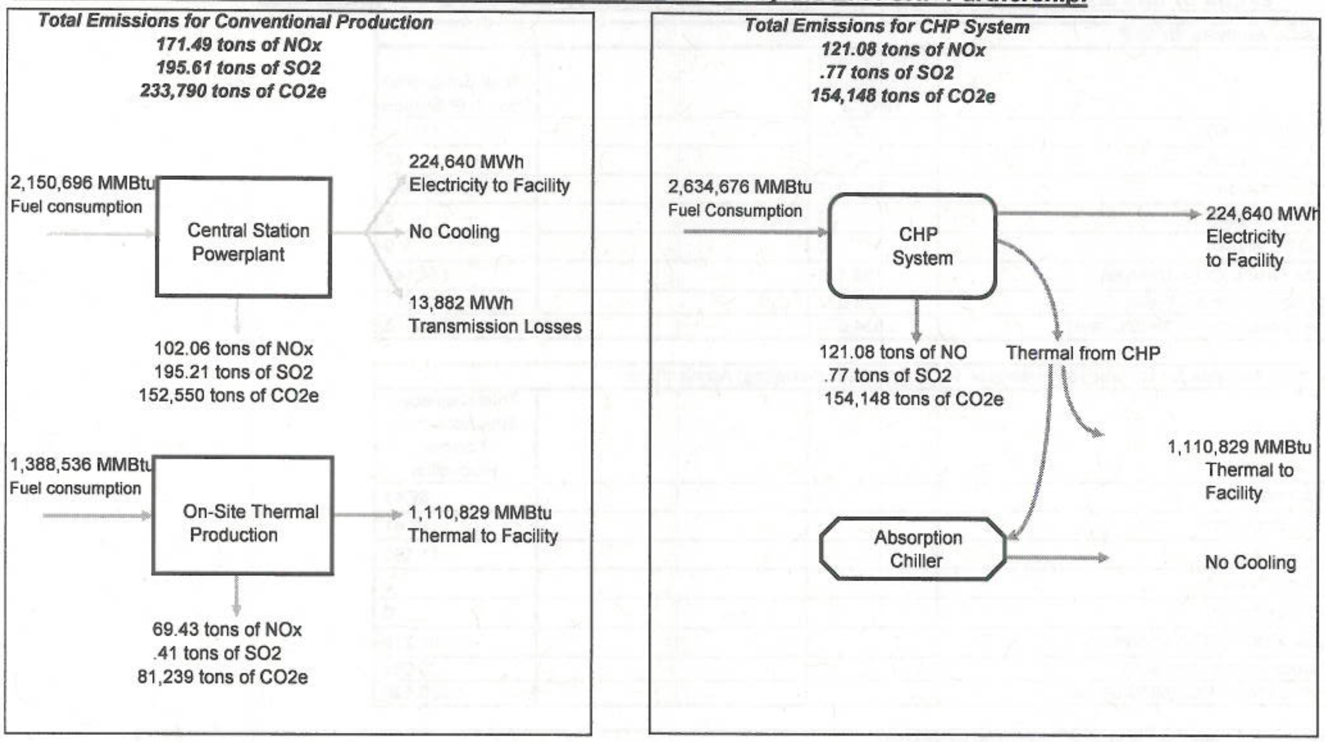
Annual Analysis for CHP	CHP System: Combustion Turbine			Total Emissions from CHP System
NO_x (tons/year)	121.08	-		121.08
SO_2 (tons/year)	0.77	-		0.77
CO_2 (tons/year)	153,997	-		153,997
CH_4 (tons/year)	3	-		3
N_2O (tons/year)	0	-		0
Total GHGs (CO_2e tons/year)	154,148	-		154,148
Carbon (metric tons/year)	38,077	-		38,077
Fuel Consumption (MMBtu/year)	2,634,676	-		2,634,676

Annual Analysis for Displaced Production for Thermal (non-cooling) Applications				Total Displaced Emissions from Thermal Production
NO_x (tons/year)				69.43
SO_2 (tons/year)				0.41
CO_2 (tons/year)				81,160
CH_4 (tons/year)				2
N_2O (tons/year)				0
Total GHGs (CO_2e tons/year)				81,239
Carbon (metric tons/year)				20,068
Fuel Consumption (MMBtu/year)				1,388,536

Annual Analysis for Displaced Electricity Production	Displaced CHP Electricity Generation	Displaced Electricity for Cooling	Displaced Electricity for Heating	Transmission Losses	Total Displaced Emissions from Electricity Generation
NO_x (tons/year)	96.12	-	-	5.94	102.06
SO_2 (tons/year)	183.85	-	-	11.36	195.21
CO_2 (tons/year)	143,073	-	-	8,841.42	151,914
CH_4 (tons/year)	5.981	-	-	0.370	6.350
N_2O (tons/year)	1.527	-	-	0.094	1.622
Total GHGs (CO_2e tons/year)	143,672	-	-	8,878	152,550
Carbon (metric tons/year)	35,376	-	-	2,186	37,562
Fuel Consumption (MMBtu/year)	2,025,526	-	-	125,171	2,150,696

CHP Results

The results of this analysis have not been reviewed or endorsed by the EPA CHP Partnership.



Emission Rates	CHP System including Duct Burners	Combustion Turbine Alone	Displaced Electricity
NOx (lb/MWh)	1.08	1.08	0.86
SO2 (lb/MWh)	0.01	0.01	1.64
CO2 (lb/MWh)	1,371	1,371	1,274

Emission Rates	Displaced Thermal Production
NOx (lb/MMBtu)	0.10
SO2 (lb/MMBtu)	0.00059
CO2 (lb/MMBtu)	116.90

NE-MARKAL
Results

Scenario Definitions:

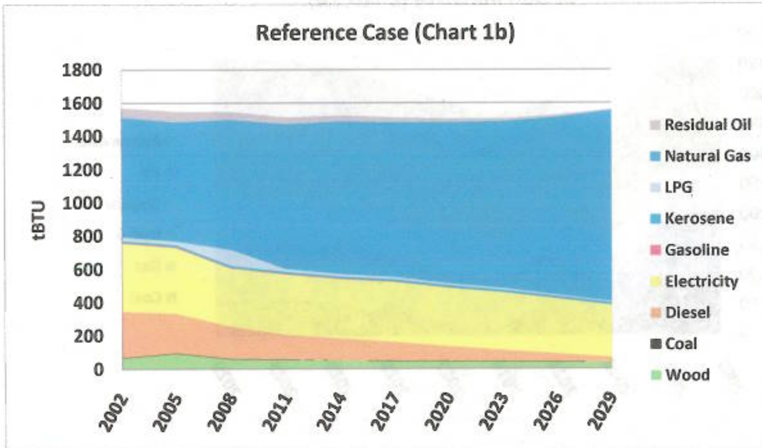
Scenario	Target
All NY Buildings Initiative	All Buildings increase overall efficiency 20% relative to reference case
NY Public Buildings Initiative	Public buildings increase overall efficiency 20% relative to reference case
NY Sun Initiative	Customer-sited commercial and residential solar PV capacity (MW): {2011 = 59, 2012 = 119, 2013-2029 = 239}
Combo Scenario	NY Sun and Public Buildings Initiatives modeled together

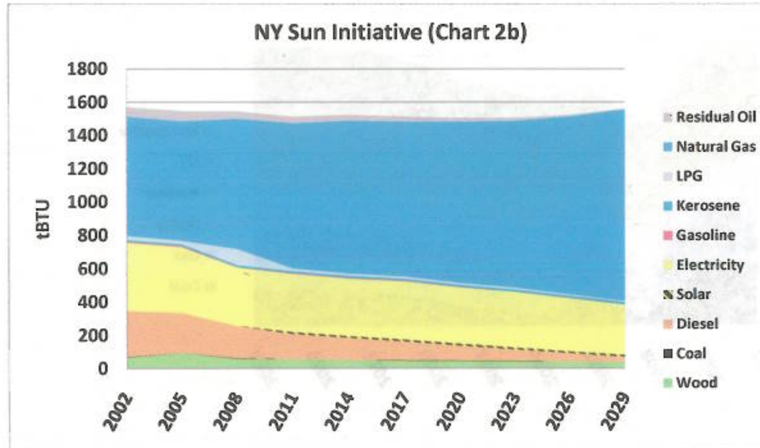
Scenario	Scenario (Reference / Start) Date	Full Implementation Date	Notes
All NY Buildings Initiative	2011	2020	Constant after 2020
NY Public Buildings Initiative	2011	2020	Constant after 2020, Public buildigs represent 5% of all commercial floorspace
NY Sun Initiative	2011	2020 / 2030	
Combo Scenario	2011	2020	

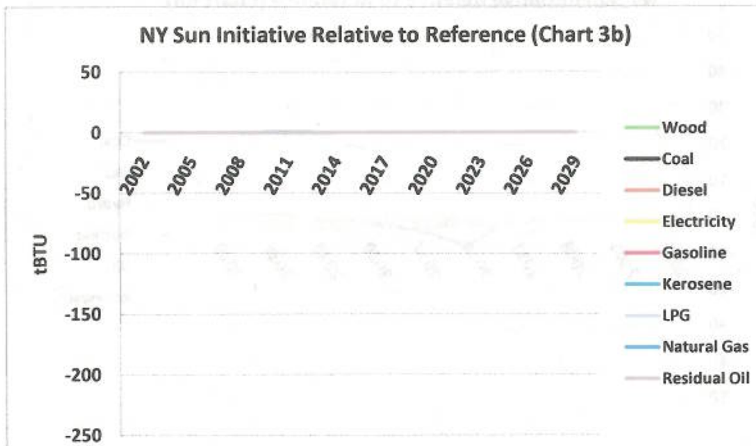
Key Updates to the NE-MARKAL database used in this modeling exercise include:

1) Updated fuel price projections to AEO2012

2) Added PM2.5 and VOC emission factors for all sectors represented in NE12



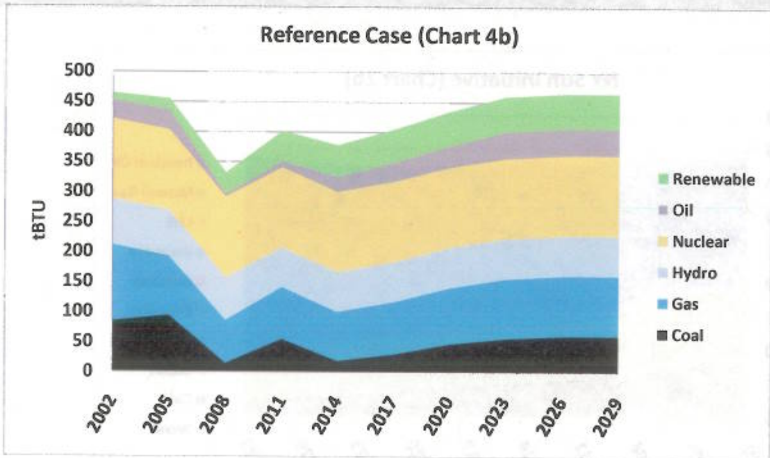


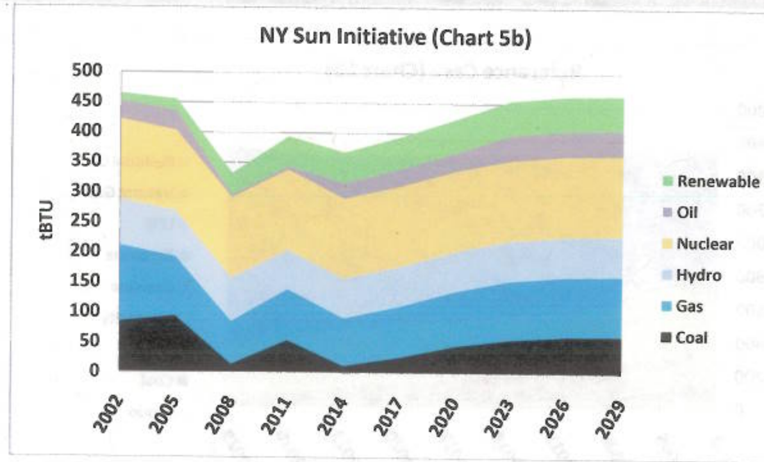


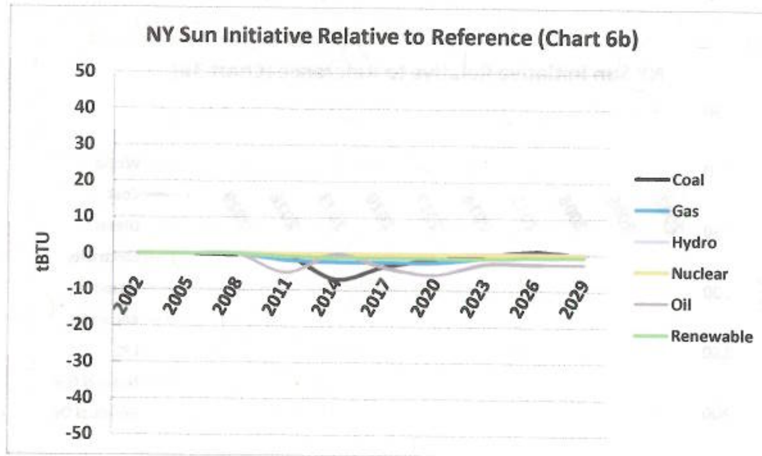
Cumulative Change (tBTU) - Table 1b:

	2002-2014	2002-2029
Wood	0	0
Coal	0	0
Diesel	0	0
Electricity	0	0
Gasoline	0	0
Kerosene	0	0
LPG	0	0
Natural Gas	0	0
Residual Oil	0	0

Electricity Generation by Fuel Type - b





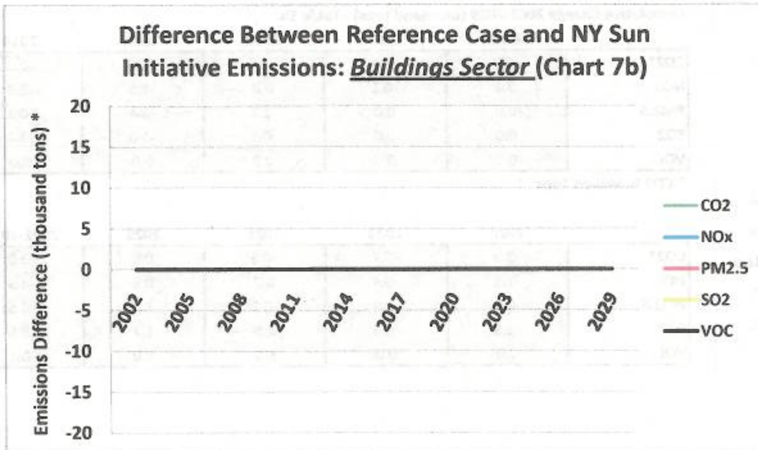


Cumulative Change 2002-2029 - Table 2b:

	MWh	tBTU
Coal	-3,481,565	-12
Gas	-3,021,366	-10
Hydro	267,321	1
Nuclear	0	0
Oil	-6,485,492	-22
Renewable	-1,842,409	-6

NY-Sun Initiative Emissions Indicators - b

Indexed Buildings Sector Emissions - b



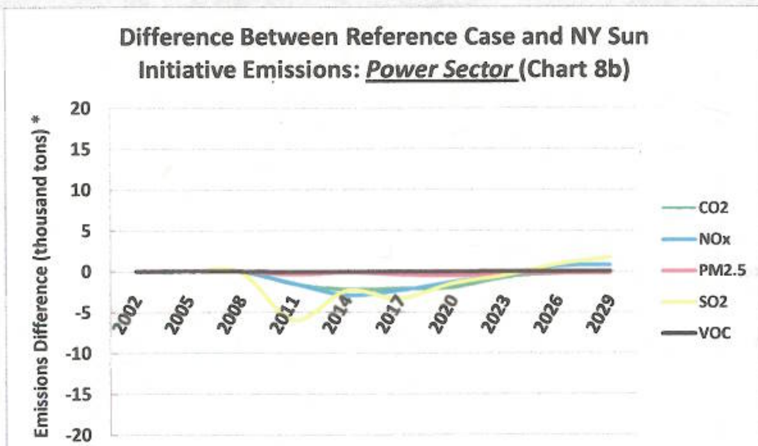
Cumulative Change (thousand tons) - Table 3b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	0.0
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

Indexed Power Sector Emissions - b



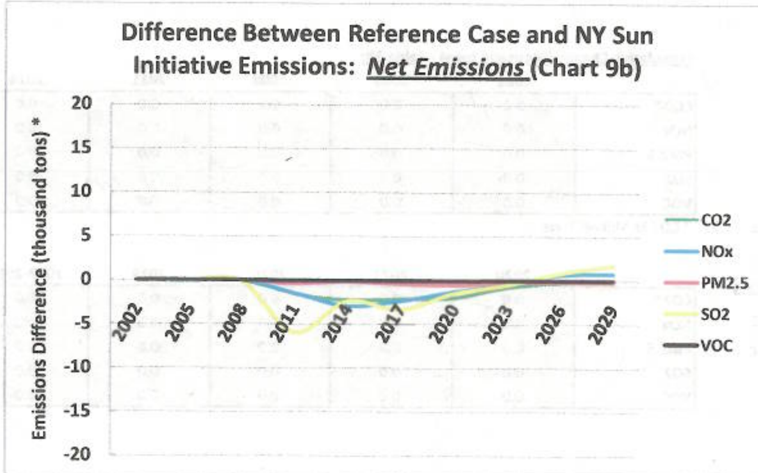
Cumulative Change (thousand tons) - Table 4b :

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	-0.1	-1.5	-2.2	-2.1
NOx	0.0	-0.1	0.0	-1.5	-2.9	-2.3
PM2.5	0.0	0.0	0.0	-0.4	-0.1	-0.4
SO2	0.0	0.0	-0.1	-6.0	-2.4	-3.3
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-2.0	-0.7	-0.3	0.0	-3.8	-8.9
NOx	-1.3	-0.4	0.7	0.8	-4.5	-7.1
PM2.5	-0.5	-0.2	-0.2	-0.2	-0.5	-2.1
SO2	-1.5	-0.5	0.9	1.7	-8.5	-11.2
VOC	0.0	0.0	0.0	0.0	-0.1	-0.17

Indexed Net Power and Buildings Emissions - b



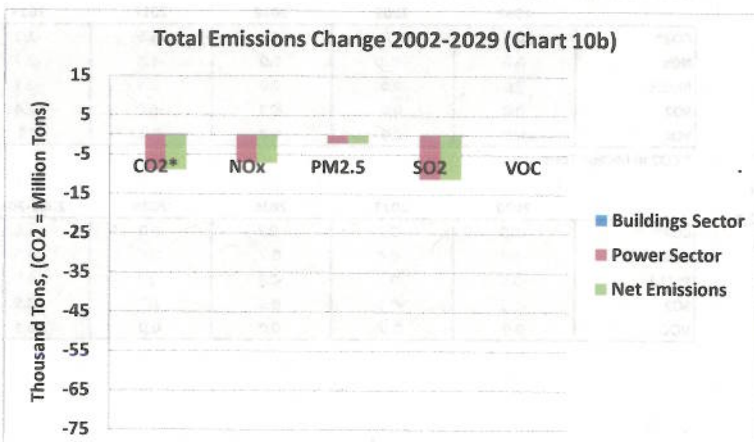
Cumulative Change 2002-2029 (thousand tons) - Table 5b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	-0.1	-1.5	-2.2	-2.1
NOx	0.0	-0.1	0.0	-1.5	-2.9	-2.3
PM2.5	0.0	0.0	0.0	-0.4	-0.1	-0.4
SO2	0.0	0.0	-0.1	-6.0	-2.4	-3.3
VOC	0.0	0.0	0.0	0.0	0.0	0.0

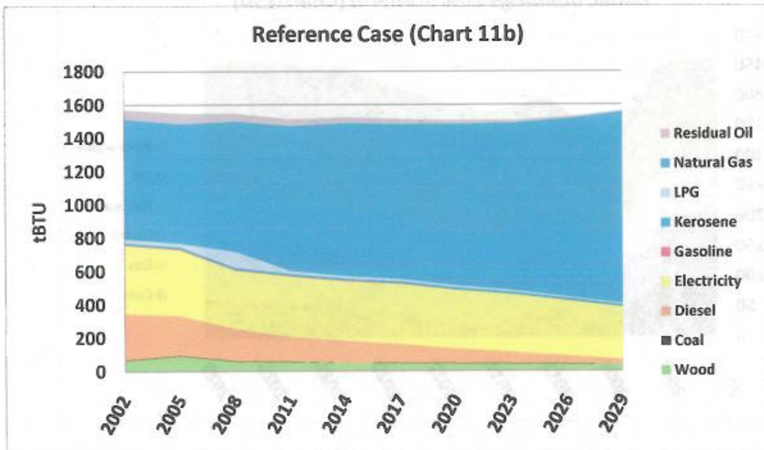
* CO2 in Million Tons

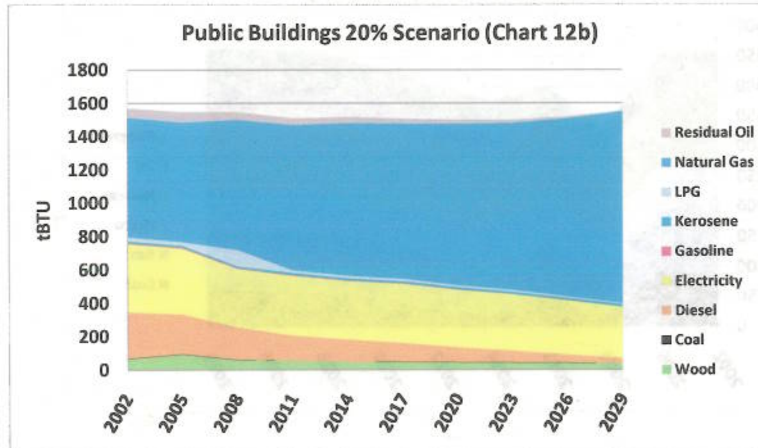
	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-2.0	-0.7	-0.3	0.0	-3.8	-8.9
NOx	-1.3	-0.4	0.7	0.8	-4.5	-7.1
PM2.5	-0.5	-0.2	-0.2	-0.2	-0.5	-2.1
SO2	-1.5	-0.5	0.9	1.7	-8.5	-11.2
VOC	0.0	0.0	0.0	0.0	-0.1	-0.17

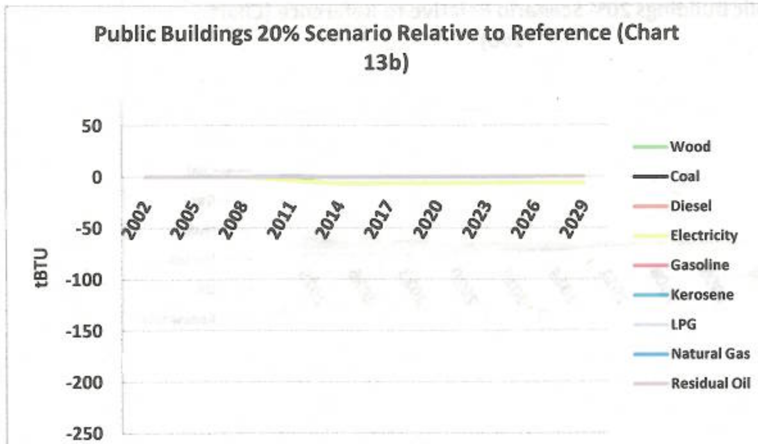
Net Emissions Summary - b



Buildings Sector Final Energy Consumption - b



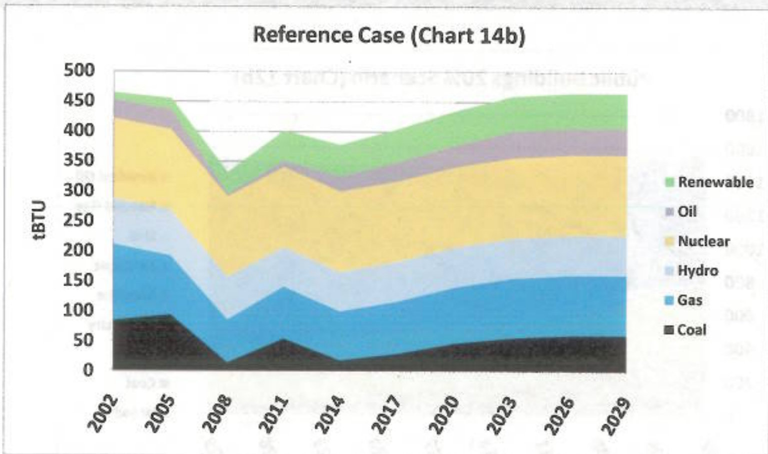


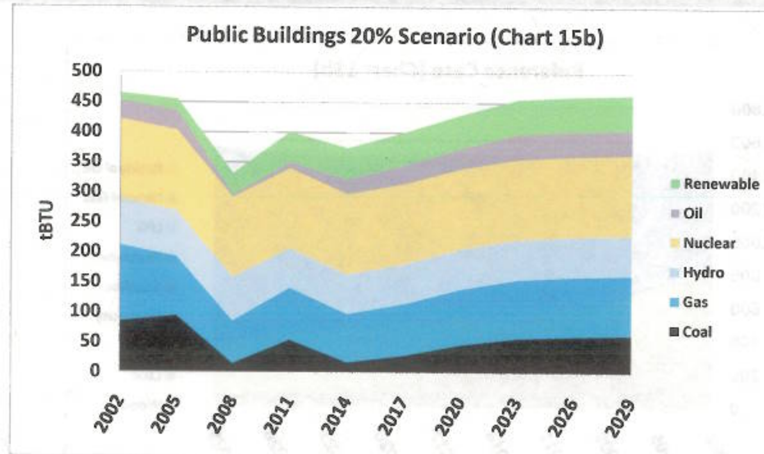


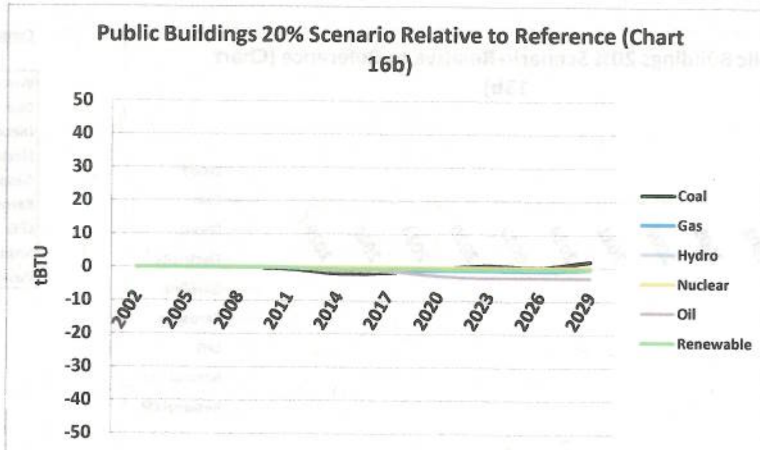
Cumulative Change (tBTU) Table 6b:

	2002-2014	2002-2029
Wood	0.0	0.0
Coal	0.0	0.0
Diesel	0.0	-0.1
Electricity	-9.8	-40.9
Gasoline	0.0	0.0
Kerosene	0.0	0.0
LPG	0.0	0.0
Natural Gas	0.4	-0.7
Residual Oil	0.0	0.0

Electricity Generation by Fuel Type - b





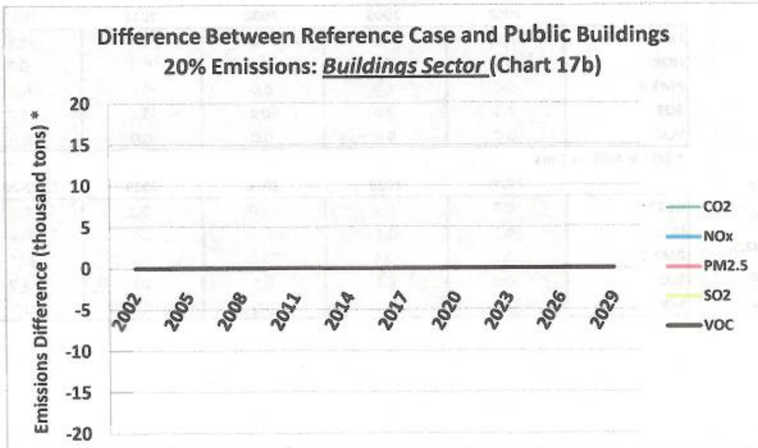


Cumulative Change 2002-2029 Table 7b:

	MWh	tBTU
Coal	-414,859	-1
Gas	-1,443,669	-5
Hydro	-55,158	0
Nuclear	0	0
Oil	-4,040,973	-14
Renewable	-741,208	-3

Public Building Scenario Emission Indicators - b

Indexed Buildings Sector Emissions - b



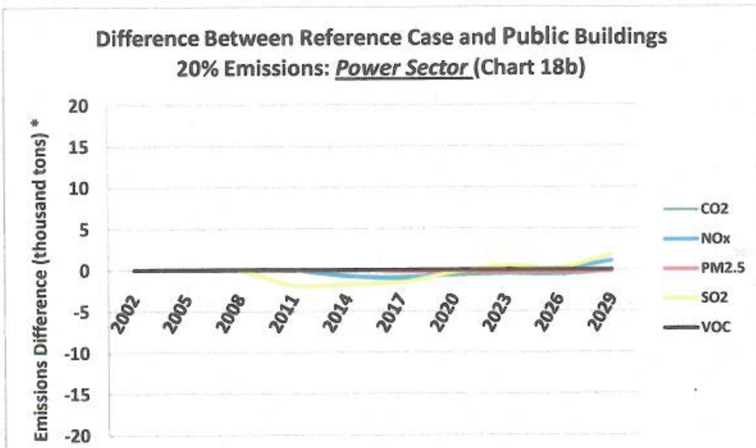
Cumulative Change (thousand tons) Table 8b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.1	0.0	0.0
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	0.0	0.0	0.0	0.0	0.0	0.0
NOx	0.0	0.0	0.0	0.0	0.0	-0.1
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

Indexed Power Sector Emissions - b



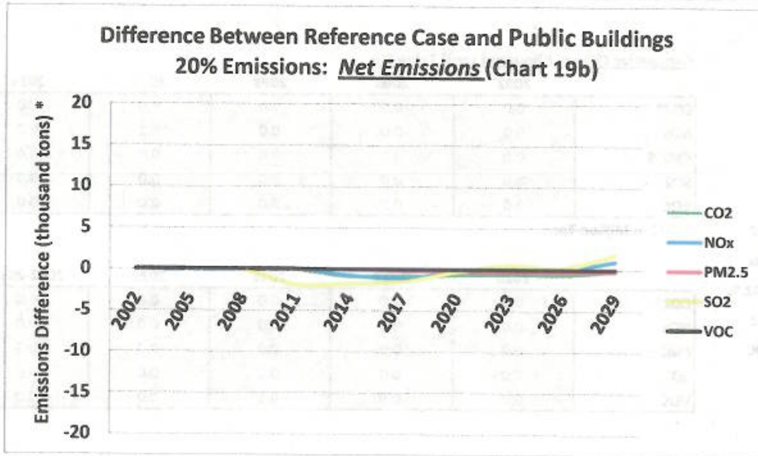
Cumulative Change (thousand tons) Table 9b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	0.0	-0.1	-0.8	-0.8
NOx	0.0	-0.1	0.0	0.0	-0.7	-1.0
PM2.5	0.0	0.0	0.0	0.0	0.0	-0.1
SO2	0.0	0.0	-0.1	-1.9	-1.7	-1.5
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-0.7	-0.5	-0.6	-0.1	-1.0	-3.7
NOx	-0.2	0.2	0.1	1.0	-0.8	-0.8
PM2.5	-0.2	-0.3	-0.3	-0.2	-0.1	-1.1
SO2	-0.3	0.5	0.2	1.8	-3.7	-2.8
VOC	0.0	0.0	0.0	0.0	0.0	-0.1

Indexed Net Power and Buildings Emissions - b



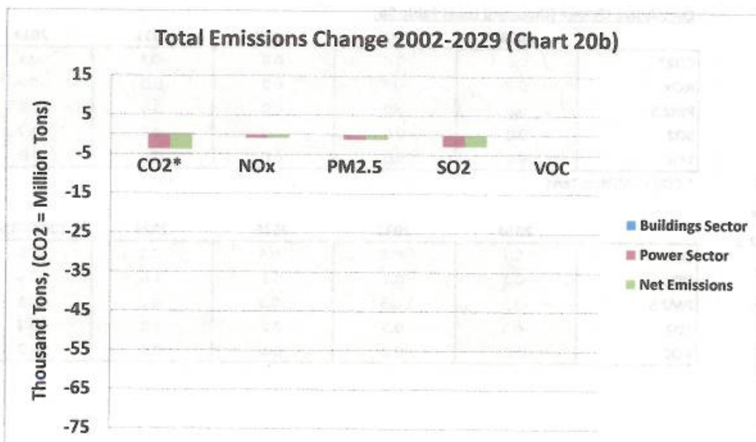
Cumulative Change (thousand tons) Table 10b:

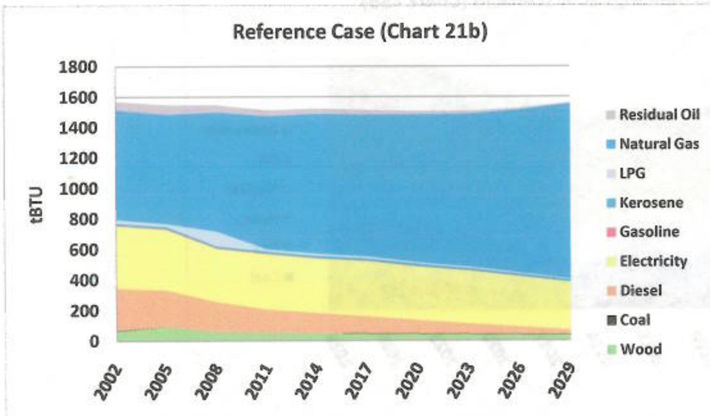
	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	0.0	-0.1	-0.8	-0.8
NOx	0.0	-0.1	0.0	0.0	-0.7	-1.1
PM2.5	0.0	0.0	0.0	0.0	0.0	-0.1
SO2	0.0	0.0	-0.1	-1.9	-1.7	-1.5
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

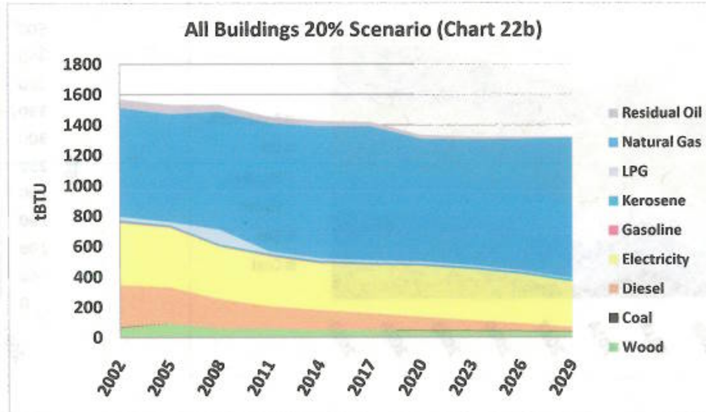
	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-0.7	-0.6	-0.6	-0.1	-0.9	-3.7
NOx	-0.2	0.1	0.1	1.0	-0.8	-0.9
PM2.5	-0.2	-0.3	-0.3	-0.2	-0.1	-1.1
SO2	-0.3	0.5	0.2	1.8	-3.7	-2.9
VOC	0.0	0.0	0.0	0.0	0.0	-0.1

Net Emissions Summary - b

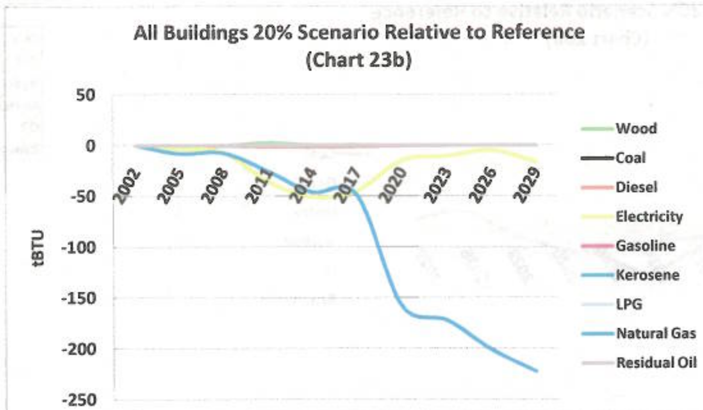




Reference Case (Chart 21b)



All Buildings 20% Scenario (Chart 22b)

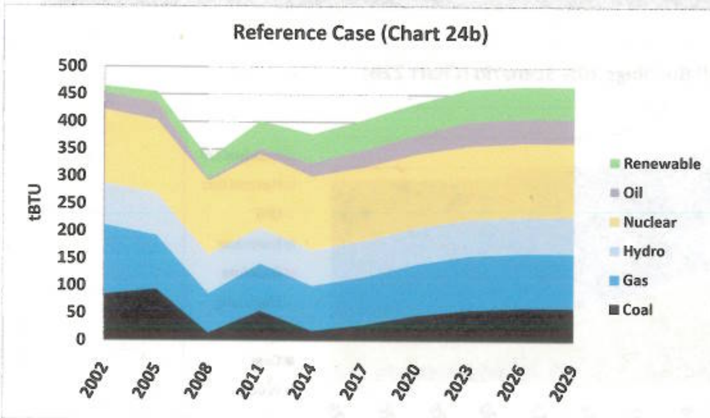


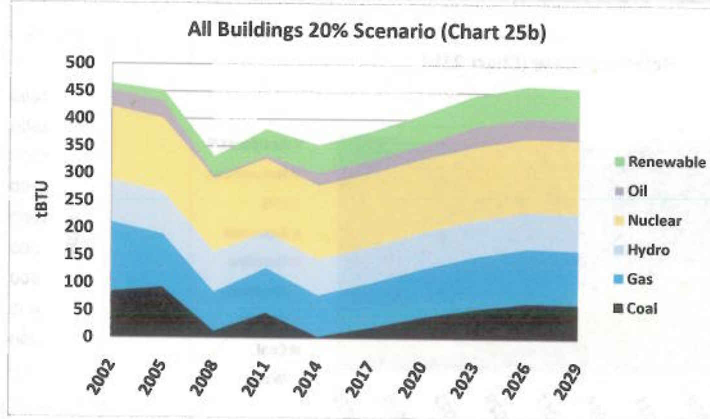
All Buildings 20% Scenario Relative to Reference (Chart 23b)

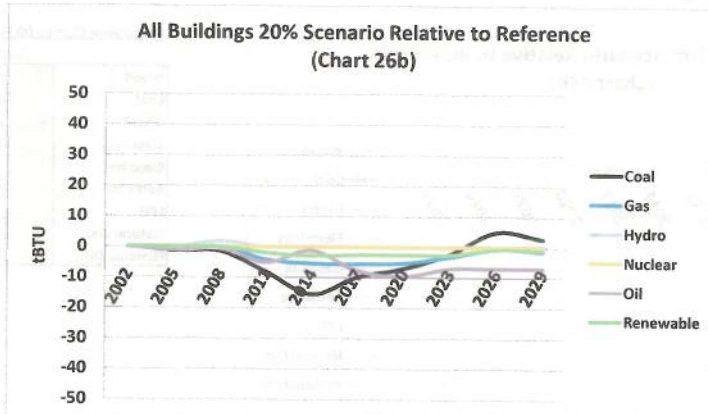
Cumulative Change (tBTU) Table 11b:

	2002-2014	2002-2029
Wood	3	3
Coal	0	0
Diesel	-5	-7
Electricity	-97	-189
Gasoline	0	0
Kerosene	0	0
LPG	0	0
Natural Gas	-87	-891
Residual Oil	0	0

Electricity Generation by Fuel Type - b





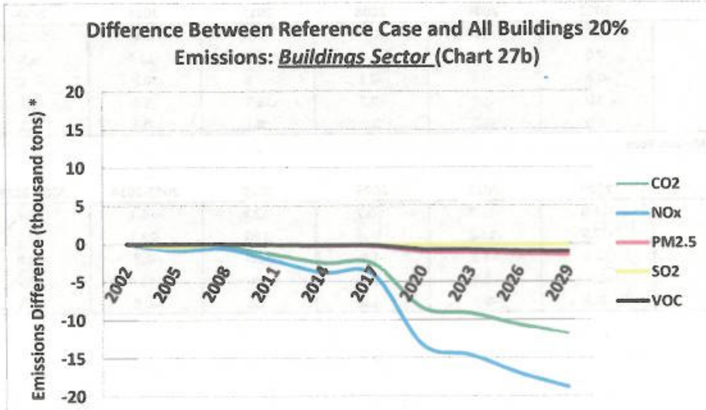


Cumulative Change 2002-2029 Table 12b:

	MWh	tBTU
Coal	-11,191,178	-38
Gas	-7,726,700	-26
Hydro	730,393	2
Nuclear	0	0
Oil	-13,524,678	-46
Renewable	-4,131,682	-14

All Building Scenario Emission Indicators - b

Indexed Buildings Sector Emissions - b



Difference Between Reference Case and All Buildings 20% Emissions: *Buildings Sector* (Chart 27b)

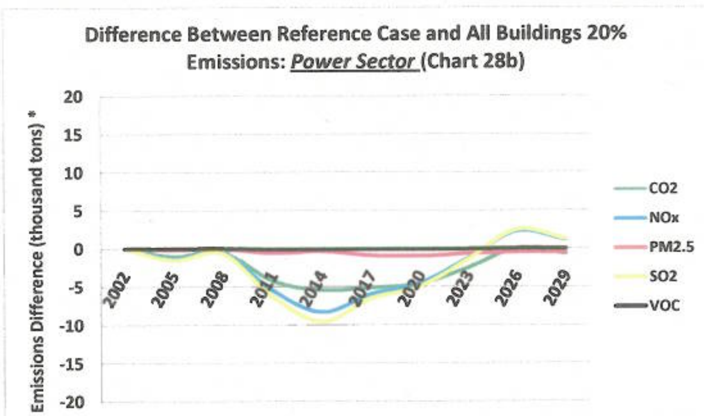
Cumulative Change (thousand tons) Table 13b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	-0.6	-0.4	-1.4	-2.5	-2.6
NOx	0.0	-0.8	-0.6	-2.2	-3.8	-4.0
PM2.5	0.0	-0.1	-0.1	-0.2	-0.3	-0.3
SO2	0.0	-0.4	0.0	-0.2	-0.2	-0.2
VOC	0.0	0.0	0.0	-0.1	-0.2	-0.2

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-8.4	-9.2	-10.7	-11.8	-5.0	-47.7
NOx	-13.2	-14.6	-17.0	-18.8	-7.5	-75.2
PM2.5	-1.0	-1.1	-1.3	-1.5	-0.6	-5.9
SO2	-0.2	-0.1	-0.1	-0.1	-1.0	-1.7
VOC	-0.8	-0.8	-1.0	-1.1	-0.4	-4.3

Indexed Power Sector Emissions - b



Difference Between Reference Case and All Buildings 20% Emissions: *Power Sector* (Chart 28b)

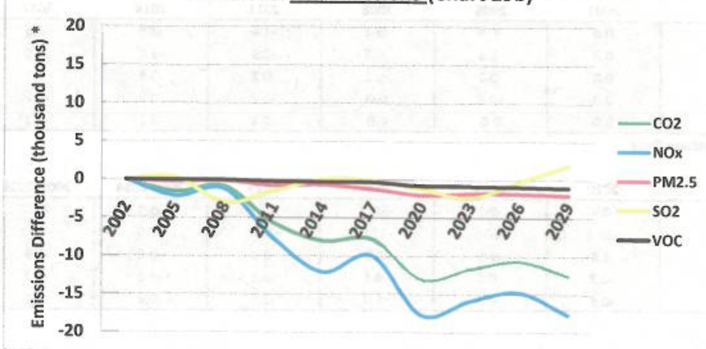
Cumulative Change (thousand tons) Table 14b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	-1.0	-0.5	-4.2	-5.4	-5.1
NOx	0.0	-1.3	-0.6	-5.5	-8.3	-5.9
PM2.5	0.0	-0.1	-0.1	-0.6	-0.4	-0.9
SO2	0.0	-1.5	-0.7	-6.3	-9.5	-6.5
VOC	0.0	0.0	0.0	-0.1	-0.1	-0.1

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-4.6	-2.5	0.0	-0.7	-11.1	-24.1
NOx	-4.5	-1.2	2.3	1.2	-15.6	-23.9
PM2.5	-1.0	-0.7	-0.5	-0.5	-1.1	-4.7
SO2	-4.9	-1.4	2.5	1.3	-18.0	-27.0
VOC	-0.1	0.0	0.0	0.0	-0.2	-0.4

Indexed Net Power and Buildings Emissions - b



Difference Between Reference Case and All Buildings 20% Emissions: *Net Emissions* (Chart 29b)

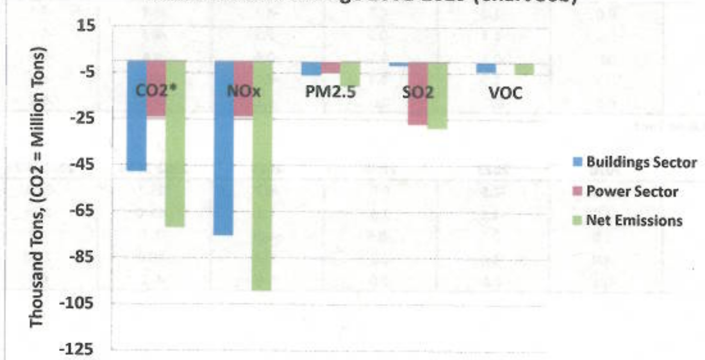
Cumulative Change (thousand tons) Table 15b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	-1.6	-0.9	-5.7	-8.0	-7.8
NOx	0.0	-2.1	-1.2	-7.7	-12.1	-9.9
PM2.5	0.0	-0.2	-0.1	-0.8	-0.7	-1.2
SO2	0.0	-1.9	-0.7	-6.5	-9.8	-6.7
VOC	0.0	-0.1	0.0	-0.2	-0.3	-0.3

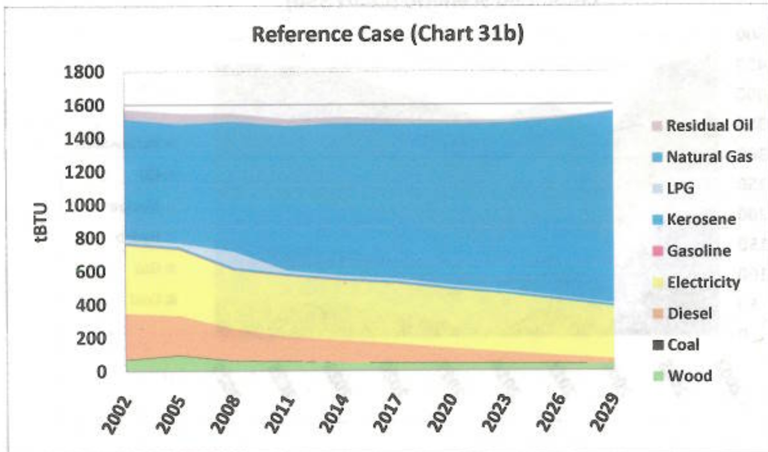
* CO2 in Million Tons

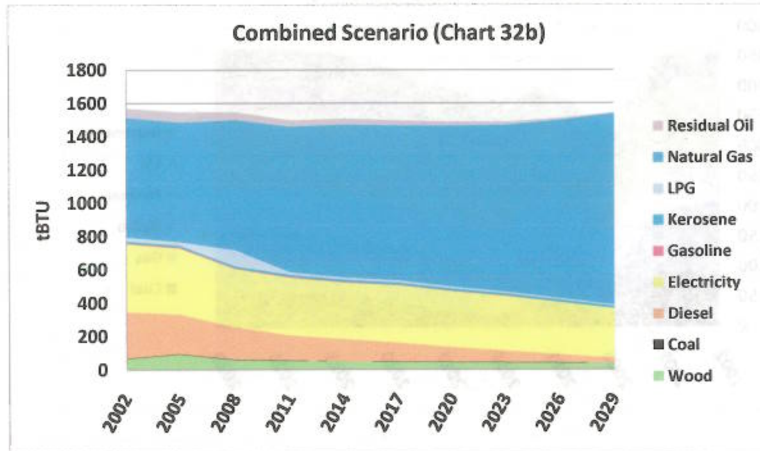
	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-13.0	-11.7	-10.7	-12.5	-16.1	-71.8
NOx	-17.7	-15.8	-14.8	-17.7	-23.1	-99.1
PM2.5	-2.0	-1.8	-1.8	-2.0	-1.7	-10.6
SO2	-5.1	-1.5	2.4	1.1	-18.9	-28.7
VOC	-0.8	-0.9	-1.0	-1.1	-0.6	-4.7

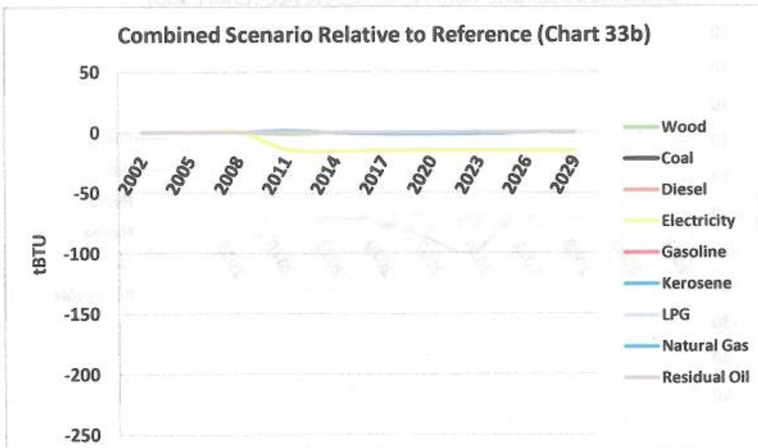
Net Emissions Summary - b



Total Emissions Change 2002-2029 (Chart 30b)



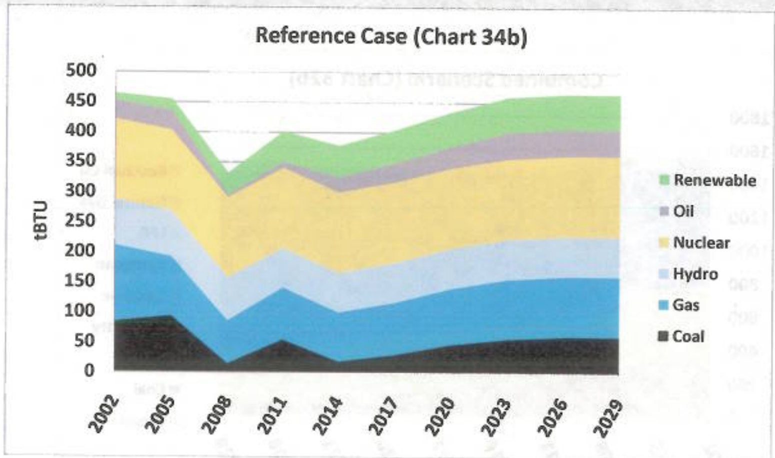


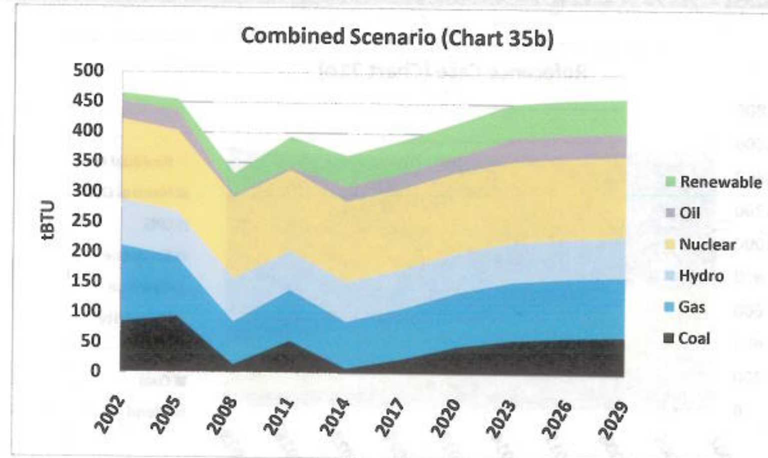


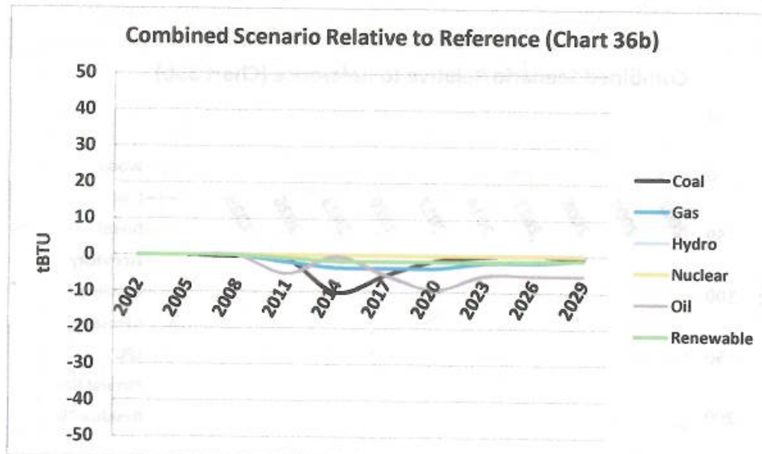
Cumulative Change (tBTU) Table 16b:

	2002-2014	2002-2029
Wood	-1	-1
Coal	0	0
Diesel	0	0
Electricity	-30	-105
Gasoline	0	0
Kerosene	0	0
LPG	0	0
Natural Gas	1	-3
Residual Oil	0	0

Electricity Generation by Fuel Type - b







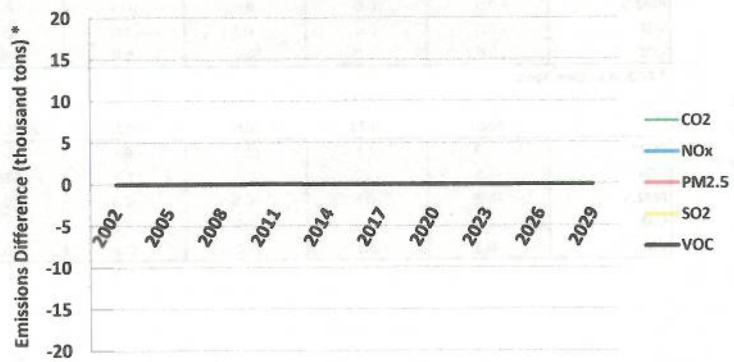
Cumulative Change 2002-2029 Table 17b:

	MWh	tBTU
Coal	-5,571,893	-19
Gas	-4,904,396	-17
Hydro	285,199	1
Nuclear	0	0
Oil	-10,713,277	-37
Renewable	-2,828,429	-10

Combined Scenario Emission Indicators - b

Indexed Buildings Sector Emissions - b

Difference Between Reference Case and Combined Scenario Emissions: *Buildings Sector* (Chart 37b)



Cumulative Change (thousand tons) Table 18b:

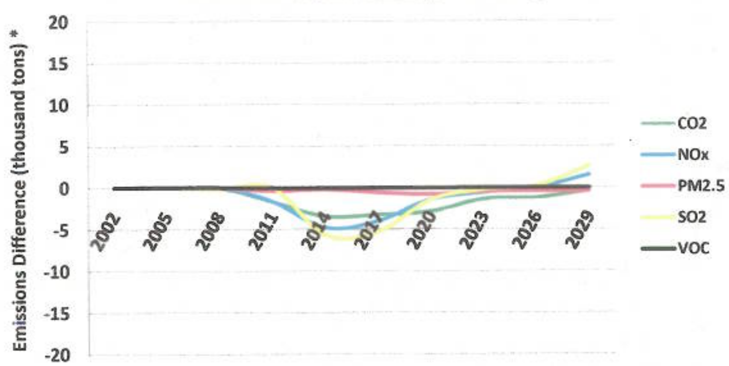
	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	0.0	0.1	0.0	-0.1
NOx	0.0	0.0	0.0	0.1	0.0	-0.1
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-0.1	-0.1	0.0	0.0	0.1	-0.2
NOx	-0.1	-0.1	0.0	0.0	0.1	-0.2
PM2.5	0.0	0.0	0.0	0.0	0.0	0.0
SO2	0.0	0.0	0.0	0.0	0.0	0.0
VOC	0.0	0.0	0.0	0.0	0.0	0.0

Indexed Power Sector Emissions - b

Difference Between Reference Case and Combined Scenario Emissions: *Power Sector* (Chart 38b)



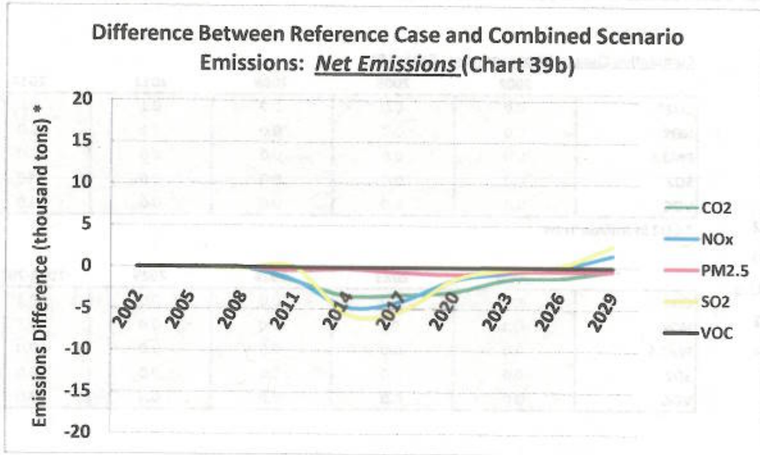
Cumulative Change (thousand tons) Table 19b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	-0.1	-1.7	-3.4	-3.2
NOx	0.0	0.0	0.0	-1.6	-4.8	-4.0
PM2.5	0.0	0.0	0.0	-0.4	-0.2	-0.6
SO2	0.0	0.0	-0.1	0.0	-5.7	-5.3
VOC	0.0	0.0	0.0	0.0	-0.1	-0.1

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-2.9	-1.4	-1.2	-0.4	-5.2	-14.3
NOx	-1.4	-0.6	0.0	1.5	-6.5	-11.0
PM2.5	-0.8	-0.5	-0.5	-0.4	-0.6	-3.4
SO2	-1.5	-0.3	0.2	2.6	-5.8	-10.1
VOC	-0.1	0.0	0.0	0.0	-0.1	-0.3

Indexed Net Power and Buildings Emissions - b



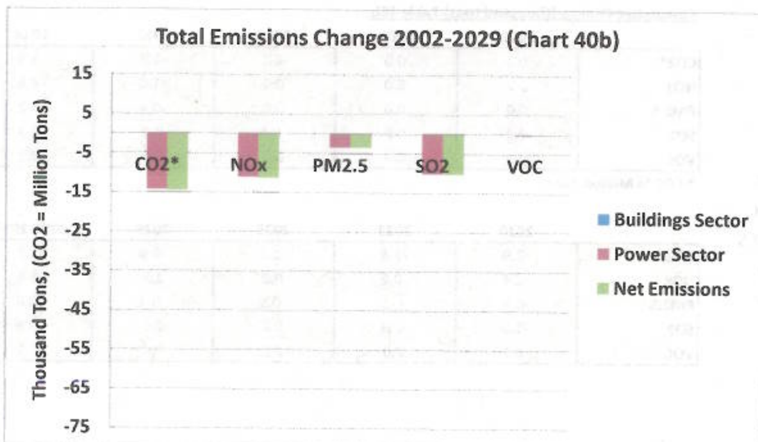
Cumulative Change (thousand tons) Table 20b:

	2002	2005	2008	2011	2014	2017
CO2*	0.0	0.0	-0.1	-1.6	-3.4	-3.3
NOx	0.0	0.0	0.0	-1.5	-4.8	-4.1
PM2.5	0.0	0.0	0.0	-0.4	-0.2	-0.6
SO2	0.0	0.0	-0.1	0.0	-5.7	-5.3
VOC	0.0	0.0	0.0	0.0	-0.1	-0.1

* CO2 in Million Tons

	2020	2023	2026	2029	2002-2014	2002-2029
CO2*	-2.9	-1.5	-1.2	-0.4	-5.1	-14.4
NOx	-1.5	-0.7	0.0	1.5	-6.4	-11.2
PM2.5	-0.9	-0.5	-0.5	-0.4	-0.6	-3.4
SO2	-1.5	-0.3	0.2	2.6	-5.9	-10.2
VOC	-0.1	0.0	0.0	0.0	-0.1	-0.3

Net Emissions Summary - b



Appendix C: Maryland Case Study
The Weight-of-Evidence Pathway

Appendix C – The Maryland Pilot Project

A pilot project to use "expanded weight-of-evidence" to include emission reductions and air quality benefits from local and regional energy efficiency and renewable energy (EE/RE) efforts as part of Maryland State Implementation Plans for the ozone and fine particulate standards

TABLE OF CONTENTS

Summary of the Maryland Pilot Project

The Maryland pilot project is actually more than a pilot project. It is the preliminary work Maryland is doing to build credit for energy efficiency and renewable energy (EE/RE) programs into the ozone State Implementation Plan (SIP) required for the Baltimore nonattainment area by June of 2015. The effort builds off of work that Maryland originated in it's 2010 ozone SIP and the States efforts on the Maryland Greenhouse Gas Emission Reduction Act of 2009 (GGRA). The GGRA requires a State SIP to reduce greenhouse gas emissions by 25% by 2020.

The Maryland pilot is also linked to Maryland's efforts to develop all future SIPs using a multi-pollutant framework to look at all pollutants whenever a single pollutant SIP is being developed. Maryland's multi-pollutant planning approach is discussed later.

The Maryland pilot is a critical part of efforts in Maryland (and builds off of earlier work) to try and better address some of the uncertainties associated with the SIP and attainment demonstration process, specifically the modeling and future year projections. This uncertainty analysis is captured in the SIP process under something called the Weight-of-Evidence (WOE) concept.

Unfortunately, the WOE concept has somehow been misinterpreted as an option to pursue … "when you really can't demonstrate attainment". Maryland strongly disagrees with this interpretation and believes that explicit analyses of uncertainty should be a mandatory element of all SIPs. Maryland considers its effort "expanded" weight of evidence as it goes beyond what is included in EPA guidance, and more explicitly addresses all of the uncertainties associated with building a plan that tries to predict the future.

Maryland's ozone SIP for the 75 ppb standard is due in June of 2015. This pilot project and other preliminary analyses being developed for the SIP represent the very earliest work Maryland has completed to develop that SIP. In the second half of 2014, Maryland will be completing the next phase of the work to develop the 2015 ozone SIP and will be taking a draft SIP, including the credit for EE/RE programs, through a stakeholder process to seek additional feedback from interested parties. In early 2015, Maryland will finalize the proposed SIP and take the final proposal through the more formal public comment and hearing process required by law. The final SIP will be submitted to EPA in June of 2015.

Background

Since the early 1990s, the Maryland Department of the Environment (MDE) has been developing State Implementation Plans (SIPs) for ground level ozone, fine particles and other air pollutants. The State has adopted a very large number of regulatory programs to meet the requirements of the Clean Air Act (CAA). High profile state regulatory initiatives include the Maryland Healthy Air Act (power plants), the Maryland Clean Car

Program (mobile sources) and numerous other control programs developed regionally through the Ozone Transport Commission (OTC).

Despite these aggressive regulatory efforts, Maryland has struggled to attain both the ozone and fine particle standards. To continue to make progress in cleaning the air, Maryland has pushed very hard in two additional areas that are critical to lowering both ozone and fine particle air pollution in the State. These two priority areas are:

- Reducing air pollution that is transported into Maryland from upwind states, and

- Implementing effective "non-traditional" control programs to further reduce local emissions without the traditional "command-and-control" regulatory driver.

This pilot project looks at how one of those non-traditional program areas, effective energy efficiency and renewable energy (EE/RE) programs, can both help clean the air and be included in SIPs as creditable programs.

Air Pollution Transport

Approximately 70 percent of Maryland's ground level ozone problem originates in upwind states. Maryland works in partnership with the University of Maryland College Park (UMD) and other universities to implement one of the East Coast's most comprehensive air quality research programs. This effort uses both modeling and measurements to look at air quality in general, but focuses to a greater extent on the transport of air pollution into the Mid-Atlantic region and Maryland.

The research platform includes numerous measurement efforts, including aircraft, balloons, mountaintop monitors, LIDAR and continuous wind profilers that look specifically at transported air pollution. This research shows that for the new 75 parts per billion (ppb) ozone standard, incoming ozone is already above the standard at certain times.

The primary purpose of this pilot program is not air pollution "transport", although one element of the pilot does look at the potential benefits in Maryland from the implementation of effective EE/RE programs in states that are upwind of Maryland.

For additional information on the MDE research program and the State's efforts on transport see:

- http://www.mde.state.md.us/programs/Air/AirQualityMonitoring/Pages/Mountaintop.aspx

SIP Credit for Innovative, "Non-Traditional Programs"

Over the past 15 years, MDE has been working to include non-traditional control programs in the air quality planning process and in the SIP. In the 1990s, MDE worked to link the States aggressive efforts on “Smart Growth” to the SIP. More recently, in the 2010 time frame, Maryland included benefits from a package of non-traditional programs in the States ozone SIPs for the Washington, Baltimore and Philadelphia 8-hour ozone nonattainment areas.

The package of non-traditional programs included some EE/RE efforts, as well as other voluntary and incentive-based initiatives like the regional Clean Air Partners program, the air quality forecasting program, and a preliminary effort designed to use teleworking and carpooling to reduce vehicle emissions on forecasted bad (code orange and code red) air quality days.

An important aspect of the 2010 effort was the use of “expanded weight-of-evidence” as the best tool for building in the benefits of non-traditional programs into the SIP.

Expanded Weight-of-Evidence

Because of Maryland’s problems with pollutant transport, the State has been very careful about how credit for non-traditional programs should be included in SIPs. Maryland does not believe that an upwind state (or Maryland) should be allowed to receive SIP credit for a non-traditional program until all common sense traditional regulatory programs have been implemented in those states. This concept is at the heart of the “expanded weight-of-evidence” idea.

Addendum 1 provides additional detail on expanded weight-of-evidence and the process that a state should use to demonstrate that it is already implementing all feasible traditional controls including nonattainment RACT and any new regulatory control programs shown to be effective by stakeholders or EPA.

EPA’s current guidance allows for the use of a weight-of-evidence demonstration to support the modeling based attainment demonstration required under the CAA. States are allowed, actually encouraged by EPA, to submit additional technical and policy analyses (weight-of-evidence) that further demonstrates why the control programs in the SIP are likely to provide for attainment by the dates mandated in the law. By allowing states to submit additional weight-of-evidence, EPA is recognizing that the modeling demonstration is uncertain, and encouraging additional analyses to address these uncertainties where possible.

Two examples of such supplemental analysis are described below

- Using measured aloft ozone data to ground truth modeling – In 2010, MDE used it’s data from aloft measurements made by aircraft and ozonesondes to show that the models where not correctly capturing aloft ozone concentrations and that this indicated that the models were underpredicting the ozone reduction potential from power plant controls in upwind areas. The air monitoring data has proven this to be true.

- As part of this pilot, and the next SIP, Maryland plans to use projected reduced energy consumption from EE/RE programs to augment traditional projections of emissions growth using business as usual projection methodologies. Recent data on both EE/RE programs and the increased use of natural gas clearly show that there is a large degree of uncertainty in this area as business-as-usual projections for the energy generation sector made just 5 years ago have proven to be heavily influenced by recent market trends.

Maryland plans to submit a comprehensive expanded weight-of-evidence demonstration that will include three basic elements:

1. Traditional analysis of benefits from regulatory programs that are on-the-books - A baseline demonstration showing the attainment status when all feasible traditional control programs are implemented in Maryland;

2. Transport analysis - A demonstration that combines the controls in the above number 1 with all possible regional transport controls that Maryland believes are required or could be compelled under the CAA; and

3. Non-traditional control program analysis - A demonstration that combines the controls in the above 1 and 2 with projected benefits that can be achieved by non-traditional, non-regulatory control programs.

This pilot project focuses on the EE/RE piece of number 3. Addendum 1 provides additional information on Maryland's Expanded Weight-of-Evidence approach.

Modeling the Benefits of EE/RE Programs

The Maryland/NESCAUM Modeling Platform

Maryland has been working with NESCAUM to build a modeling system or framework to support the State's efforts on multi-pollutant planning and to look at the benefits of EE/RE strategies. The modeling system is designed to look at multiple pollutants at the same time and to look at benefits and costs using a multi-pollutant approach. The modeling system will be enhanced over time and is intended to be the primary tool that Maryland will use to analyze the air quality benefits from EE/RE efforts and to do multi-pollutant planning. The package of models is intended to be used in an expanded weight-of-evidence analysis, which will supplement, but not replace, the SIP-quality modeling required under the attainment demonstration provisions of the CAA.

The basic building block in the modeling system is the NE-MARKAL model. NE-MARKAL can be used to estimate the energy and emission reduction benefits associated with EE/RE strategies. The modeling system also includes the following:

- The CMAQ (Community Multi-Scale Air Quality) model to estimate changes in air quality associated with reduced emissions
- The BenMAP (Benefits Mapping and Analysis Program) model to estimate the health benefits associated with lower concentrations of air pollution and
- The REMI (Regional Economic Models, Inc.) model to estimate economic costs and benefits associated with the strategies being analyzed

MARKAL (an acronym for MARKet ALlocation), or NE-MARKAL is a mathematical model of the energy system of one or several regions that provides a technology-rich basis for estimating energy dynamics over a multi-period horizon. The NE-MARKAL model is a linear programming model, similar to the U.S. Department of Energy's National Energy Modeling System (NEMS) in that it covers multiple energy demand sectors including residential and commercial buildings, transportation, and the industrial sector, as well as the supply side power generation sector.

The NE-MARKAL model provides a tool to estimate how EE/RE programs in Maryland will reduce energy consumption and how that reduced energy consumption will reduce emissions of greenhouse gases, nitrogen oxide (NOx), sulfur dioxide (SO2) and mercury.

The current EE/RE programs being modeled using NE-MARKAL, CMAQ, BenMAP and REMI framework include:

- The Regional Greenhouse Gas Initiative (RGGI)
- The EmPower Maryland energy conservation program
- The Maryland renewable portfolio standard program
- Light-duty vehicle GHG standards
- EV technology deployment
- Vehicle miles traveled reductions consistent with Maryland transit and "smart growth" initiatives
- Low-carbon imports

Addendum 2 provides additional information on the NE-MARKAL model and the other models being used as part of this pilot.

Some of the preliminary results from Maryland and NESCAUM's early work with the modeling platform are provided later in this document.

Analyzing Regional Transport Benefits from EE/RE Efforts in States Upwind of Maryland

This pilot project will also begin to look at the air quality benefits that Maryland could see if effective EE/RE programs are implemented in upwind states. Again, on bad air days, approximately 70% of Maryland's air quality problem originates in upwind states.

EPA has initiated some modeling to estimate how EE/RE efforts in states that are upwind of Maryland will reduce energy consumption and regional emissions of NOx and SO2. Maryland will be using this work and supplemental analyses that builds from the EPA work to model (using CMAQ) the reduced concentrations of ozone and fine particles associated with reduced transport because of effective EE/RE efforts upwind of Maryland. To the extent that resources are available, Maryland plans to also look at two additional regional EE/RE program scenarios to try and capture a highly optimistic (upper bound) and a less optimistic (lower bound) projection of the energy and emission reduction benefits associated with the quickly evolving growth of EE/RE programs across the East.

Maryland is hoping to partner with EPA to link this effort to the preliminary information that is available on the options states have to implement the new GHG reduction requirements for existing power plants under Section 111(d) of the CAA. One of the options that many states are considering is a "system" approach (i.e. a system of emission reduction that is focused on the electricity system as a whole) where limits at power plants coupled with aggressive efforts to implement EE/RE programs can cost-effectively reduce GHG emissions from the power generation sector.

Maryland is a member of the Regional Greenhouse Gas Initiative (RGGI). RGGI is the countries first GHG cap-and-invest reduction program. It has helped dramatically reduce GHG emissions from existing power plants in the 9 state RGGI region (more than a 40% reduction) between 2005 and 2012. Addendum 3 includes the recent RGGI comments on Section 111(d) and includes discussion of a "system-wide" approach for Section 111(d) and the critical role that EE/RE programs have played in RGGI's emission reduction successes.

Addendum 3 also provides more detail on the earlier EPA modeling conducted to look at the benefits from regional EE/RE efforts.

This piece of the Maryland effort is designed to analyze and demonstrate that aggressive regional EE/RE programs or cost-effective "system" based approaches to implement Section 111(d) will not only reduce GHG emissions, but they will also help reduce the transport of criteria pollutants and help states develop "Good Neighbor" SIPs.

The Ozone Transport Commission's EE/RE Initiative

At its Fall meeting in 2012, the OTC finalized a policy paper designed to reduce NOx emissions in the Ozone Transport Region (OTR) by promoting common sense, cost-effective energy retrofits at large commercial buildings.

The policy paper entitled "Promoting Deep Energy Retrofits of Large Commercial Buildings to Reduce Nitrogen Oxide Emissions in the Ozone Transport Region" was adopted on November 15, 2012. It was developed by the Energy Efficiency Workgroup of the OTC's Stationary and Area Source (SAS) Committee.

The workgroup decided to initially focus on the ozone reduction potential from profitable "deep energy retrofits" of commercial buildings. The policy paper (http://www.otcair.org/upload/Documents/Meeting%20Materials/Commercial%20Building%20Energy%20Efficiency%20Status%20Report.pdf) includes the following:

1. Estimates of the magnitude of NOx emission reductions possible in the OTR through profitable deep energy retrofits of large commercial buildings, and

2. A list of several low-cost policy strategies that jurisdictions in the OTR could pursue to promote profitable NOx reductions (including strategies that some jurisdictions are already pursuing).

The OTC policy paper indicates that the NOx emission reduction potential from this cost-effective initiative is large (approximately 36,000 tons of potential NOx reductions each year).

Partly because OTC works with state air quality agencies, and energy efficiency strategies are typically pursued by state and local energy agencies, the strategies listed in the policy paper are not subjected to an in depth analysis. Rather, they are presented as options which air divisions may discuss with their respective states' energy divisions, for further evaluation and possible implementation.

The OTC SAS Committee continues to work on implementation of this initiative. Addendum 4 provides more detail on the OTC EE/RE initiative. Maryland will be including this initiative in its efforts to include EE/RE programs in a multi-pollutant air quality planning process and the next round of SIPs.

Additional Efforts in Maryland to Quantify the Emission Reduction Potential of EE/RE Programs

In 2009, the Maryland General Assembly adopted the Greenhouse Gas Emission Reduction Act (GGRA). The law was sponsored by Maryland's Governor. The law requires the State to adopt and implement a plan to achieve a 25% reduction in greenhouse gas (GHG) emissions between 2006 and 2020. The plan was required to be finalized by the end of 2012. The plan includes a large number of EE/RE efforts being developed and implemented in Maryland. Examples of these programs include:

- The RGGI
- EmPOWER Maryland
- The Maryland RPS program
- Clean car initiatives

- Electric vehicle initiatives
- Green building initiatives
- Lead by example efforts

Because of this law, MDE has worked in partnership with the Maryland Energy Administration, the Maryland Public Service Commission, the Maryland Department of Transportation, the Maryland Department of Planning, the Maryland Department of Housing and Community Development and other State and local partners to generate the best possible emission reduction estimates possible for the Maryland EE/RE programs. The primary focus of this effort has been GHG emission reductions. MDE plans to continue to refine this work and plans to focus more on the NOx, SO2 and mercury reduction estimates that can be built from the baseline energy work used to estimate the GHG emission reductions.

This effort will eventually blend with NE-MARKAL driven modeling work discussed earlier in this document. The current effort with the NE-MARKAL platform was conducted with the preliminary work, completed in 2011, to develop the GGRA plan.

Preliminary Estimates of EE/RE SIP Benefits

The Maryland plan to implement the GGRA includes a chapter on multi-pollutant benefits. The work conducted to develop this chapter was based on preliminary data and information, and to a certain extent, should be viewed as a demonstration project for how to link states GHG emission reduction efforts with CAA SIP requirements that focus on other pollutants.

As part of this work NESCAUM ran the MARKAL and BenMAP models and contracted with the University of Maryland (UMD) to run CMAQ and Towson University Regional Economic Studies Institute (RESI) to run REMI. The complexity of the models and the time and expense needed to contract with experienced modelers is an important concern for agencies considering this approach. The following illustrations depict select output and results from the preliminary work conducted by Maryland and NESCAUM.

Figures 1 and 2 summarizes the potential emission reductions from a selected set of EE/RE initiatives (described earlier) for carbon dioxide (CO2), NOx, SO2 and mercury that resulted from the preliminary NE-MARKAL modeling effort.

Figure 1 summarizes the power sector results.

Figure 2 summarizes the transportation sector results.

MARKAL-modeled Power Sector Emissions Under the GGRA Case Through 2020

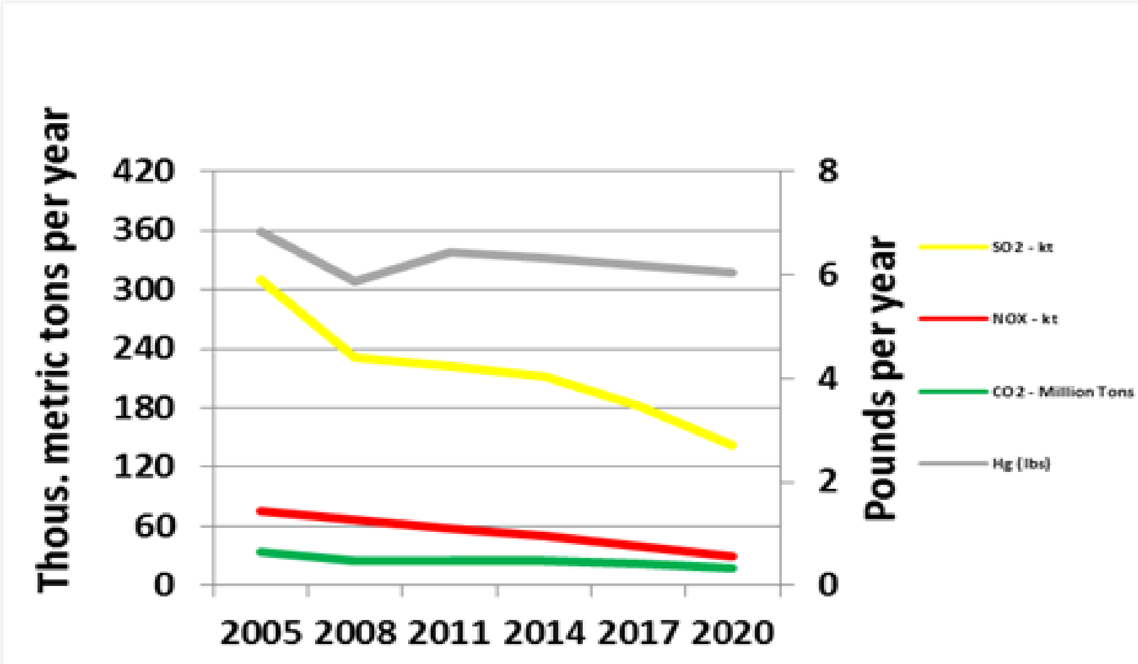
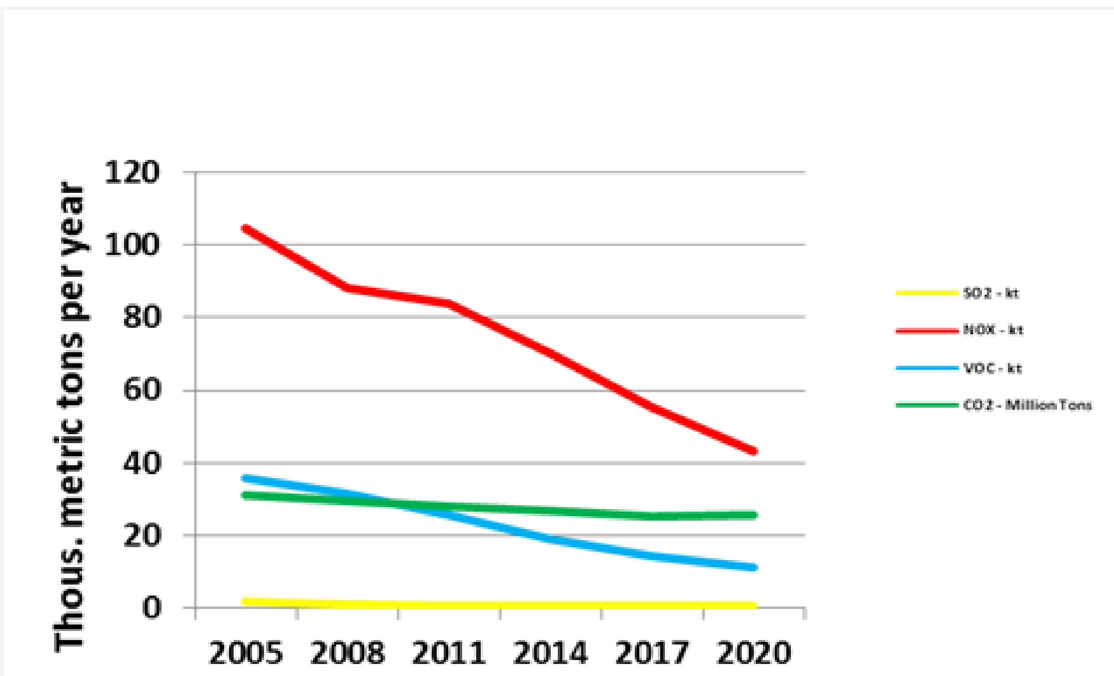


Figure 2 MARKAL-Modeled Transportation Sector Emissions Underthe GGRA Case Through 2020



Figures 3 and 4 summarize the potential for the EE/RE efforts to reduce ambient concentrations and exposure to both fine particulate and ozone air pollution.

Figure 3 - CMAQ Output - Difference Between Average 24-hour Mean PM2.5 Calculated for the GGRA and Reference Cases – Maryland

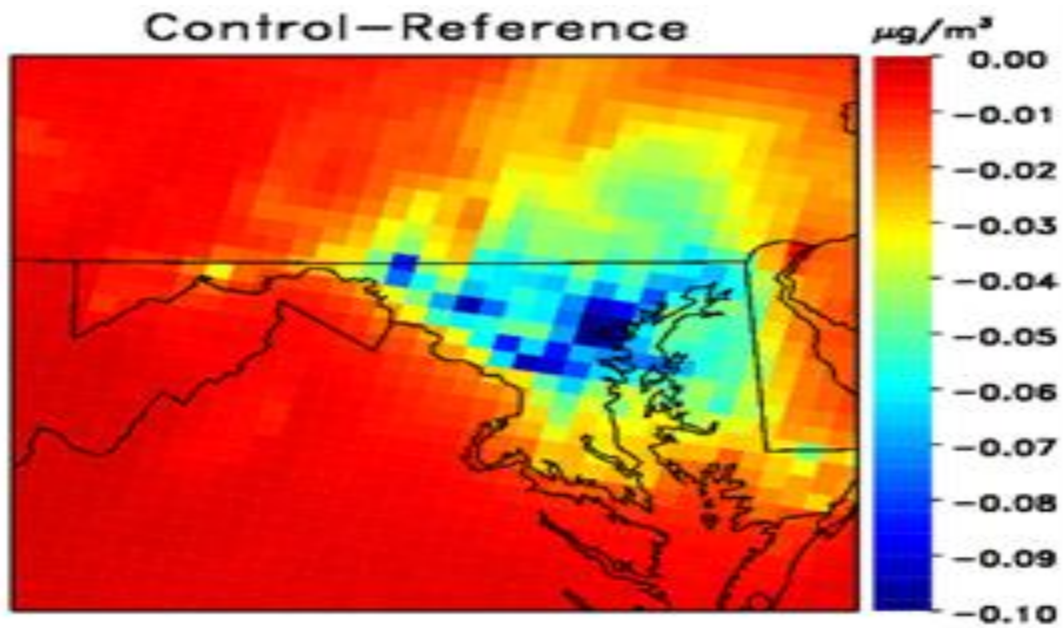


Figure 4 - CMAQ Output – Difference Between Average Maximum Daily 8-Hour Average Ozone Calculated for Control and Reference Cases – Maryland

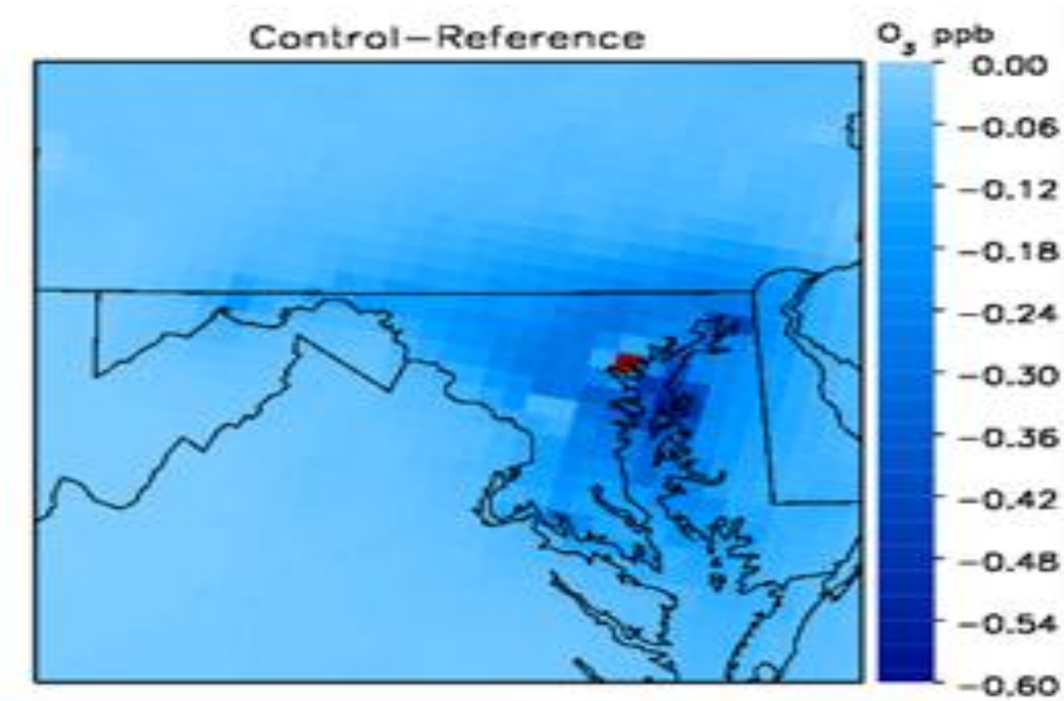


Figure 5 summarizes the health benefit information developed as part of the NE-MARKAL/BenMAP exercise that was part of the initial Maryland/NESCAUM effort.

BenMAP Output – Health Impact Incidence and Valuation, Change from Base to GGRA Case, by State for Ozone

	Incidence						Valuation (millions $)	
		Morbidity						
State (Abbrev.)	Mortality (All Cause)	Acute Respiratory Symptoms	Emergency Room Visits, Respiratory	Hospital Admissions, Respiratory	School Loss Days		Mortality	Morbidity
CT	-	52	-	-	15 - 35		0.2 - 0.3	0.0
DC	-	260	-	0 - 1	76 - 181		1.0 - 1.4	0.0
DE	-	643	-	1 - 3	201 - 479		2.5 - 3.5	0.1
MA	-	12	-	-	3 - 8		0.1	0.0
MD	**3 - 5**	**6,853**	**3 - 6**	**3 - 20**	**2,107 - 5,020**		**24.9 - 35.1**	**0.6 - 0.7**
ME	-	(84)	-	-	(53) – (22)		(0.6) – (0.4)	0.0
NH	-	3	-	-	1 - 3		0.0	0.0
NJ	1	1,806	1 - 2	1 - 6	542 - 1,292		7.0 - 9.9	0.2
NY	2	3,731	3 - 6	2 - 10	1,095 - 2,613		12.2 - 17.2	0.3 - 0.4
PA	2 - 3	2,939	1 - 3	2 - 13	873 - 2,083		13.8 - 19.4	0.3
RI	-	-	-	-	2 - 5		0.0	0.0
VA	1	2,151	1 - 2	2 - 9	676 - 1,613		6.7 - 9.4	0.2 - 0.3
VT	-	(16)	-	-	(10) – (4)		(0.1)	0.0

The economic analysis piece of this effort is still evolving. REMI findings from the preliminary work include the following:

- Over the short-term (5-10 years during technology transition), there are large benefits due to increased spending and investment in new technologies
- Subsequent loss of fuel sector jobs/wages could lead to negative trend in output if the Maryland economy is not “re-tooled” to fit with new opportunities (e.g. clean tech sectors)
- Complementary incentive or subsidy programs could be considered with GGRA implementation (e.g. MD Clean Energy Incentive Tax)

Relationship Between the Pilot Project and Maryland’s SIP Submittals

Maryland is working with NESCAUM on this pilot project to look at how EE/RE programs can be included in SIPs by including the potential EE/RE emissions and air quality benefits in the weight of evidence piece of the attainment demonstration required as part of the SIP. Maryland will continue to investigate means to ensure that we are not predicting reductions that were already taken out of the foretasted emissions.

The EE/RE pilot project, which will conclude in 2015, is just a small piece of a larger effort in Maryland to build EE/RE programs into the air quality planning process using a multi-pollutant framework. Maryland included the preliminary estimates of the potential multi-pollutant benefits as part of the 2012 GGRA plan. In 2015, Maryland will submit updates to the State's SIP for ground level ozone. This plan will also include estimated multi-pollutant emissions reductions, air quality and public health benefits from EE/RE programs. Finally, in the 2018 to 2020 time frame, Maryland will work on a third phase of this effort linked to a new ozone standard, fine particulate and regional haze.

Maryland's approach is to continue to develop the suite of tools being used in the multi-pollutant planning framework and to improve the analyses of the EE/RE benefits each time the State updates a clean air plan.

ADDENDUMS

ADDENDUM 1: Expanded Weight-of-Evidence Explained

Maryland's expanded weight of evidence approach was started on February 16, 2010, with a White Paper titled "What is the Role of "Weight of Evidence"?. This white paper put forward the concept that the attainment modeling should be considered as part of a weight of evidence document that would also include trends analysis, sensitivity modeling and other scientific research. In addition, the White Paper also posed six questions in an effort to generate discussion on this expanded weight of evidence approach. One of questions was "Should several different, but plausible, estimates of growth in the future year emissions be part of the attainment demonstration?" This particular question is important, as it relates directly to climate change programs which are challenging the business as usual assumptions about future energy consumption and growth related to vehicle use.

As a result of this white paper, an OTC workgroup was formed. After several iterations the workgroup agreed upon a set of recommendations for an Expanded Weight of Evidence for Attainment Demonstration[1]. These recommendations were then sent to EPA Office of Air Quality Planning and Standards (OAQPS) for their consideration and possible use in revised Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.

The OTC workgroup basically recommended a two step weight of evidence process be implemented as follows:

- **Basic weight of evidence** to include the traditional data analysis and other supplemental (modeling, analysis, etc) information and

- **Expanded weight of evidence** option, which is only possible after all feasible traditional controls (RACT, stakeholder or EPA suggestions) have been implemented. The reason for including this condition was to stop states from skipping over controls that others have been forced to implement.

The expanded weight of evidence provisions would allow states to do the following: demonstrate through modeling how additional regional controls in other states would help with attainment, use a range of potential future design values for a probability of attainment, use statistical (meteorological adjusted ozone) and other (inventory, sensitivity, etc.) analyses, and use of non-traditional programs (Smart Growth, Energy Efficiency, Renewable Energy/Renewable Portfolio Standards, etc.) with both optimistic and pessimistic assumptions.

In addition, OTC included an option that called for the affected state to work with EPA to determine if a mid-course review and consultation would be required under the expanded weight of evidence provisions.

(1)(http://www.otcair.org/upload/Documents/Correspondence/OTC%20Expanded%20Weight-of-Evidence%20Letter%20and%20Recommendation.pdf)

ADDENDUM 2: Multi-Pollutant Planning in Maryland and the MARKAL, CMAQ, BenMAP, REMI Modeling Platforms

Maryland is implementing multi-pollutant planning in a three-phase approach that corresponds with major policy implementation schedules. Each phase builds on previous analysis and integrates co-benefits derived from reducing emissions.

The initial phase of MPAF is currently under development. Maryland is incorporating the MPAF as part of the Greenhouse Gas Reduction Plan. The Plan supports legislative requirements to reduce greenhouse gas emissions by 25 percent from a 2006 baseline by 2020. The major sources of greenhouse gases, transportation and electricity generation, are also sources of ozone precursors and particle-forming emissions. Initial analysis supports the multi-pollutant approach by identifying co-benefits of ozone and particle reduction associated with lowering greenhouse gas emissions.

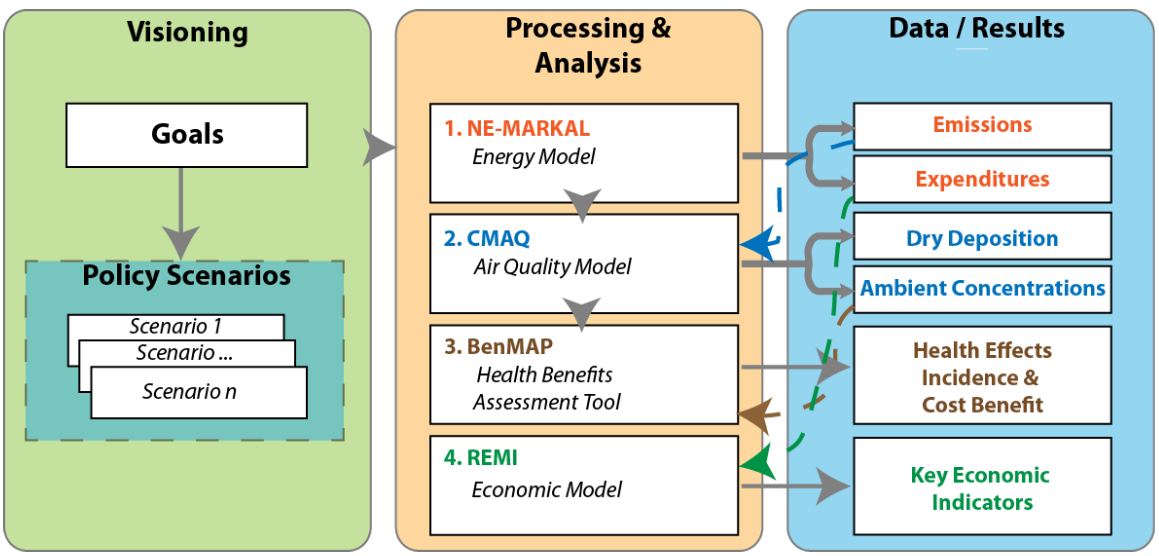
In 2015, Maryland will submit an ozone State Implementation Plan to the U.S. Environmental Protection Agency. This plan will identify policies and programs needed to ensure compliance with the ozone national ambient air quality standard. Over the last 30 years, Maryland has worked to identify and correct emissions sources that contribute to elevated ozone levels. Recent research has associated warming climate trends with increased potential for elevated ozone levels. We believe that by identifying synergistic effects, we can identify those policies and programs that yield the greatest benefits in terms of emissions reductions and that are economically sound.

In the 2020 time frame, Maryland will begin the third phase of MPAF with the submittal of the Fine Particle State Implementation Plan. Fine particles are formed from some of the same compounds that contribute to ozone formation. Building on knowledge gained from our greenhouse gas and ozone control analysis, the State will apply the MPAF in its efforts to identify the most effective controls for fine particles. By linking the co-benefits of reducing greenhouse gases, ozone and fine particles, we believe that we will have designed a process that maximizes pollution reduction in a cost-effective framework.

MULTI-POLLUTANT PLANNING

Multi-pollutant planning is a process that identifies the air quality co-benefits of select policy options. Maryland's approach to multi-pollutant planning is to reduce emissions through an integrated process that maximizes the co-benefits of reduction policies. This process allows for multi-sector analysis and estimates environmental, public health, economic and energy benefits of policies designed to reduce criteria pollutants, toxics and greenhouse gases. The approach, developed by the Northeast States for Coordinated Air Use Management (NESCAUM), is the Multi-Pollutant Analytical Framework (MPAF). Maryland is working with NESCAUM to customize elements of the MPAF to address climate change and criteria pollutant reduction goals through selected policy options.

The MPAF consists of three broad areas of activity: Visioning, Processing and Analysis, and Data / Results. The process is illustrated below.



VISIONING

Visioning is the process to identify a suite of policies and technologies that support clean air and climate change goals. This process is labor intensive and requires close attention. The policy scenarios may be derived from regulatory requirements, long-range planning exercises or the desire to evaluate the implementation of policy/technology combinations in the context of desired outcomes. The products from the visioning process are the development of a set of a reference case (the baseline conditions) and a set of policies to evaluate in comparison to the reference case.

PROCESSING & ANALYSIS

The process and analysis process of the MPAF consists of four models, each designed to provide a set of results focused on key areas of analysis: energy, air quality, public health and the economy. Generally, the models are run in sequence. Output from the MARKAL model feeds CMAQ and REMI. Output from CMAQ feeds BenMAP.

MARKAL (an acronym for MARKet ALlocation), or NE-MARKAL[1] is a mathematical model of the energy system of one or several regions that provides a technology-rich basis for estimating energy dynamics over a multi-period horizon. The NE-MARKAL model is a linear programming model, similar to the U.S. Department of Energy's National Energy Modeling System (NEMS) in that it covers multiple energy demand sectors including residential and commercial buildings, transportation, and the industrial sector, as well as the supply side power generation sector.[2]

MARKAL computes energy balances at all levels of an energy system: primary resources, secondary fuels, final energy, and energy services. MARKAL is a vertically integrated model of the entire energy system. The model aims to supply energy services at minimum global cost by simultaneously making equipment investment and operating decisions and primary energy supply decisions, by region. For example, in MARKAL, if there is an increase in residential lighting energy service (perhaps because more people build houses in a community), either existing generation equipment must be used more intensively or new generation equipment must be installed. The choice of generation equipment (type and fuel) incorporates analysis of both the characteristics of alternative generation technologies and the economics of primary energy supply.

MARKAL computes an inter-temporal partial equilibrium on energy markets. The quantities and prices of the various fuels and other commodities are such that at those prices the suppliers produce exactly the quantities demanded by the consumers. Further, this equilibrium has the property that the total surplus is maximized over the whole horizon. Investments made at any given period are optimal over the horizon as a whole.

The basic components in a MARKAL model are specific types of energy or emission control technology. Each is represented quantitatively by a set of performance and cost characteristics. A menu of both existing and future technologies is input to the model. Both the supply and demand sides are integrated, so that one side responds automatically to changes in the other. MARKAL is a "Least-cost" model that selects that combination of technologies that minimizes total energy system cost.

[1] NESCAUM, with the assistance of the International Resources Group (IRG), has developed a Northeast U.S. version of the MARKAL model based on regional data and in cooperation with energy and air quality divisions of 11 Northeast states and the District of Columbia. This planning tool allows for the analysis of a range of transportation, energy, air quality, and climate programs with a time horizon of 30 years and a focus on the cost and environmental implications of key program design elements.

[2] As opposed to NEMS, however, NE-MARKAL is state-based and regionally specific, with increased regional detail beyond what is currently available in national energy models. Each northeast jurisdiction is represented as its own region within the model and can be analyzed independently or as a part of the regional collective. Thus, the model is particularly good at demonstrating the benefits of regional cooperation and of flexible implementation of air quality and climate programs.
NE-MARKAL is similar to the Integrated Planning Model (IPM), which has been used for several national regulatory program assessments by the U.S. EPA. IPM does have significant regional detail with respect to the power sector; however, the MARKAL model is multi-sector – as opposed to IPM which only covers the power generation sector – and, thus, is capable of analyzing inter-sector tradeoffs among emission reduction programs that may be more or less cost-effective than single sector focused programs. Furthermore, IPM requires that projections for electricity demand be provided exogenously while MARKAL determines the demand endogenously, weighting it against conservation, fuel switching and other options available to the model.

MARKAL does not require -- or permit -- an a priori ranking of abatement measures as an input to the model. The model chooses the preferred technologies and provides the ranking as a result. Indeed, the choice of abatement measures often depends upon the degree of future abatement that is required.

Typically, a series of model runs is made examining a range of alternative futures (over 30 years). The model requires as input projections of energy service demands -- room space to be heated or vehicle-miles to be traveled, for example -- and projected resource costs. Then, a reference case is defined in which, for example, no measures are required to reduce emissions. Reference case estimates of end-use energy service demands (e.g., car, commercial truck, and heavy truck road travel; residential lighting; steam heat requirements in the paper industry) are developed by the user on the basis of economic and demographic projections, for each region in a multi-region formulation of the model. In addition, the user provides estimates of the existing stock of energy related equipment, and the characteristics of available future technologies, as well as new sources of primary energy supply and their potentials.

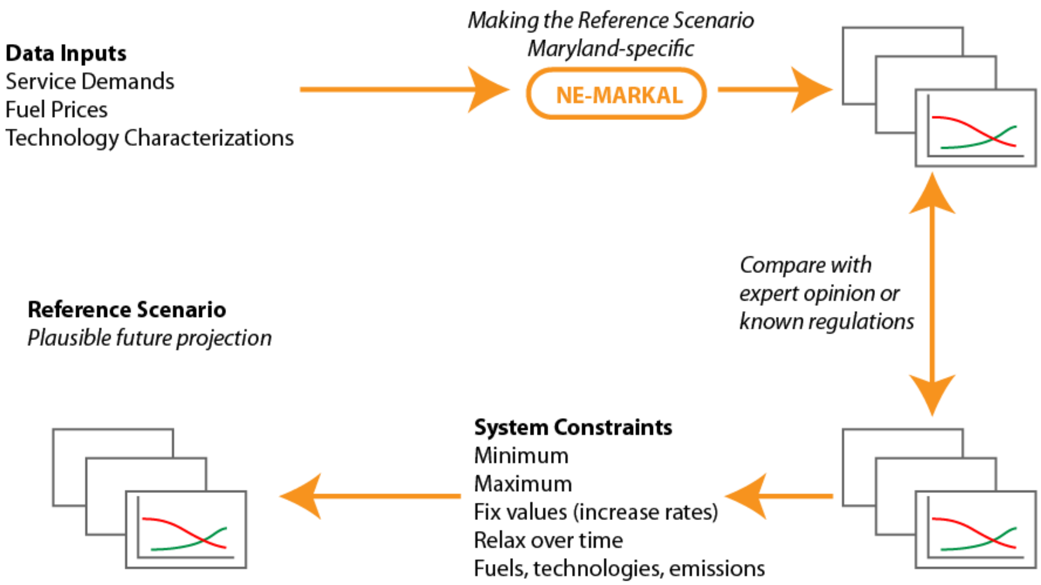
A series of runs is then made with successive reductions in emissions: emissions stabilized at present levels, for example, then reduced by 10 percent, 20 percent, etc., by some future date before being stabilized.

In each case, the model will find the least expensive combination of technologies to meet that requirement -- up to the limits of feasibility -- but with each further restriction the total energy system cost will increase. Thus, the total future cost of emission reductions is calculated according to how severe such restrictions may become. These can be plotted as continuous abatement cost curves. In addition, the marginal cost of emission reduction in each time period is determined.

This is of special interest in establishing abatement policy because it can be interpreted as the amount of carbon tax that would be needed to achieve this level of abatement.
Some uses of MARKAL are to:

- Identify least-cost energy systems
- Identify cost-effective responses to restrictions on emissions
- Perform prospective analysis of long-term energy balances under different scenarios
- Evaluate new technologies and priorities for R&D
- Evaluate the effects of regulations, taxes, and subsidies
- Project inventories of greenhouse gas emissions
- Estimate the value of regional cooperation

Calibrating NE-MARKAL



Energy Calibration

Initial Projections

Historical fuel consumption

Projected fuel consumption

Compared to

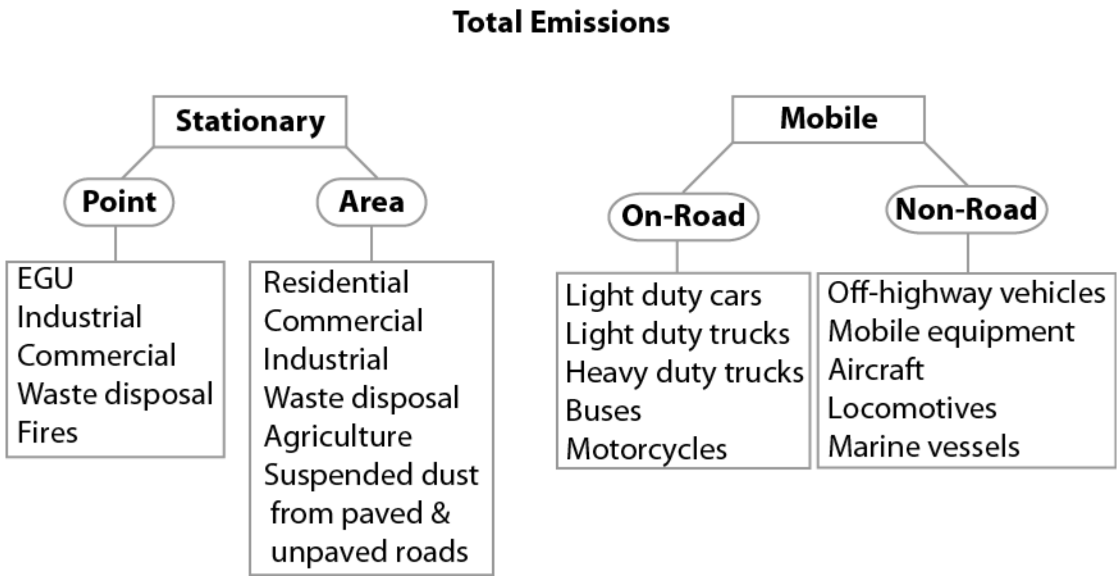
DOE / EIA State Energy Data Survey

National Energy Modeling System

State Energy Plan

- fuel prices
- consumption projections
- generation projections
- existing regulations

Emissions Calibration



MARKAL outputs emissions and expenditures data. The emissions data is sent to the air quality model and the expenditure data is sent to the economic model. Processing emissions data is a 2-step procedure that passes data through SMOKE through CMAQ. The results are expressed in terms of air quality benefits.

The **Sparse Matrix Operator Kernel Emissions (SMOKE) Modeling System**[3] is primarily an emissions processing system designed to create gridded, speciated, hourly emissions for input into a variety of air quality models like CMAQ. SMOKE supports area, biogenic, mobile (both on-road and non-road), and point source emissions processing for criteria, particulate, and toxic pollutants. For biogenic emissions modeling, SMOKE uses the Biogenic Emission Inventory System, version 2.5 (BEIS2) and version 3.09 and 3.14 (BEIS3). SMOKE is also integrated with the on-road emissions model MOBILE6 and MOVES.

The **Community Multi-scale Air Quality (CMAQ)** modeling system has been designed to approach air quality as a whole by including state-of-the-science capabilities for modeling multiple air quality issues, including tropospheric ozone, fine particles, toxics, acid deposition, and visibility degradation. In this way, the development of CMAQ involves the scientific expertise from each of these areas and combines the capabilities to enable a community modeling practice. CMAQ was also designed to have multi-scale

[3] The sparse matrix approach used throughout SMOKE permits rapid and flexible processing of emissions data. Rapid processing is possible because SMOKE uses a series of matrix calculations rather than a less-efficient sequential approach used by previous systems. Flexible processing comes from splitting the processing steps of inventory growth, controls, chemical speciation, temporal allocation, and spatial allocation into independent steps whenever possible. The results from these steps are merged together in the final stage of processing using vector-matrix multiplication. This means that individual steps (such as adding a new control strategy, or processing for a different grid) can be performed and merged without having to redo all of the other processing steps.

capabilities so that separate models were not needed for urban and regional scale air quality modeling.

The target grid resolutions and domain sizes for CMAQ range spatially and temporally over several orders of magnitude. With the temporal flexibility of the model, simulations can be performed to evaluate longer-term (annual to multi-year) pollutant climatologies as well as short-term (weeks to months) transport from localized sources. With the model's ability to handle a large range of spatial scales, CMAQ can be used for urban and regional scale model simulations. By making CMAQ a modeling system that addresses multiple pollutants and different spatial scales, CMAQ has a "one atmosphere" perspective that combines the efforts of the scientific community.

To implement multi-scale capabilities in CMAQ, several issues, such as scalable atmospheric dynamics and generalized co-ordinates that depend on the desired model resolution are addressed. Meteorological models may assume hydrostatic conditions for large regional scales, where the atmosphere is assumed to have a balance of vertical pressure and gravitational forces with no net vertical acceleration on larger scales.

However, on smaller scales such as urban scales, this assumption cannot be made. A set of governing equations for compressible non-hydrostatic atmospheres is available to better resolve atmospheric dynamics at smaller scales. These non-hydrostatic equations are more appropriate for finer regional scale and urban scale meteorology. Because CMAQ is designed to handle scale dependent meteorological formulations and a large amount of flexibility, CMAQ's governing equations are expressed in a generalized coordinate system. This approach ensures consistency between CMAQ and the meteorological modeling system. The generalized coordinate system determines the necessary grid and coordinate transformations, and it can accommodate various vertical coordinates and map projections.

The CMAQ modeling system simulates various chemical and physical processes that are thought to be important for understanding atmospheric trace gas transformations and distributions. The CMAQ modeling system contains three types of modeling components: a meteorological modeling system for the description of atmospheric states and motions, emission models for man-made and natural emissions that are injected into the atmosphere, and a chemistry-transport modeling system for simulation of the chemical transformation and fate.

CMAQ ambient emissions outputs are then routed to BenMAP to assess the public health impacts of various policy approaches to reducing criteria pollutants. BenMAP is a Windows-based computer program that uses a Geographic Information System (GIS)-based to estimate the health impacts and economic benefits occurring when populations experience changes in air quality. BenMAP is used to estimate the health impacts from air quality changes. Some of the purposes for which BenMAP is used include the following:

- Generation of population/community level ambient pollution exposure maps;

- Comparison of benefits across multiple regulatory programs;
- Estimation of health impacts associated with exposure to existing air pollution concentrations;
- Estimation of health benefits of alternative ambient air quality standards;
- Performance of sensitivity analyses of health or valuation functions, or of other inputs; and
- Hypothetical, or "what-if," type analyses.

REMI (Regional Economic Models, Inc.) is used to evaluate the economic impacts of policies and emission reduction goals. The REMI model incorporates aspects of four major modeling approaches: Input-Output, General Equilibrium, Econometric, and Economic Geography. Each of these methodologies has distinct advantages as well as limitations when used alone. The REMI integrated modeling approach builds on the strengths of each of these approaches.

The REMI model at its core, has the inter-industry relationships found in Input-Output models. As a result, the industry structure of a particular region is captured within the model, as well as transactions between industries. Changes that affect industry sectors that are highly interconnected to the rest of the economy will often have a greater economic impact than those for industries that are not closely linked to the regional economy.

General Equilibrium is reached when supply and demand are balanced. This tends to occur in the long run, as prices, production, consumption, imports, exports, and other changes occur to stabilize the economic system. For example, if real wages in a region rise relative to the U.S., this will tend to attract economic migrants to the region until relative real wage rates equalize. The general equilibrium properties are necessary to evaluate changes such as tax policies that may have an effect on regional prices and competitiveness.

REMI is sometimes called an "Econometric model," as the underlying equations and responses are estimated using advanced statistical techniques. The estimates are used to quantify the structural relationships in the model. The speed of economic responses is also estimated, since different adjustment periods will result in different policy recommendations and even different economic outcomes.

The New Economic Geography features represent the spatial dimension of the economy. Transportation costs and accessibility are important economic determinants of interregional trade and the productivity benefits that occur due to industry clustering and labor market access. Firms benefit having access to a large, specialized labor pool and from having access to specialized intermediate inputs from supplying firms. The productivity and competitiveness benefits of labor and industry concentrations are called agglomeration economies, and are modeled in the economic geography equations.

APPLYING THE MPAF IN MARYLAND

Maryland began to multi-pollutant planning with the adoption of the Healthy Air Act in 2006. The Act requires affected coal-fired electricity generating units (EGUs) to reduce emissions of NO_x, SO_2 and mercury by the imposition of caps. This Act also addressed greenhouse gases by requiring the State to participate in the Regional Greenhouse Gas Initiative (RGGI). RGGI is a market-based regulatory program designed to cap greenhouse gas emissions from fossil-fueled fired EGUs. RGGI is a cooperative effort among 9 northeast states that will reduce carbon dioxide (CO_2) emissions from the power sector 10 percent by 2018.

The early successes from the Healthy Air Act and RGGI led Maryland into a multi-year process of exploring the potentials for multi-pollutant planning. The Maryland Department of the Environment (MDE) worked with NESCAUM to develop a conceptual framework and produced a draft report and reference case in 2009. Subsequent work with the Maryland Energy Administration (MEA) and Public Services Commission (PSC) refined the reference case to include better descriptions of Maryland's energy services and demands.

Two concerns motivated the multi-pollutant work: the need to comply with the National Ambient Air Quality Standards and the need to reduce greenhouse gas emissions. Maryland has regulated most sources of criteria pollutants and has reduced ozone and particle precursors dramatically. The 0.75 ozone standard is producing new challenges as we look for ways to further reduce emissions and incorporate these reductions in a State Implementation Plan due in 2015. In addition to the criteria pollutants, Maryland is also obligated by state law to reduce emissions of greenhouse gas emissions 25 percent from a 2006 base by 2020. It makes sense to identify the policies and technologies that yield the greatest co-benefits. In the context of preparing the 2012 Climate Plan, MDE decided to explore the utility of the MPAF for climate planning and to identify potential co-benefits that may be considered as part of a weight of evidence document for the 2015 Ozone State Implementation Plan.

Visioning

The visioning process included representatives from MDE, MEA, PSC and the Maryland Department of Transportation (MDOT). Together, these agencies detailed the emissions reduction goals and the policies that would enable the State to achieve the goal of reducing greenhouse gas emissions 25 percent by 2020.

Major policies like Maryland's Clean Cars Program, RGGI, EmPower Maryland and the Renewable Portfolio Standard were selected for analysis. Implementation technologies were identified and include low carbon fuels, increased wind and solar electricity generation and increased use of hybrid-electric and battery-electric vehicles.

Through an iterative series of meetings and draft reports, the process resulted in the development of a reference case and evaluation scenario, referred to as the "GGRA Case".[4] Elements of the GGRA Case include:

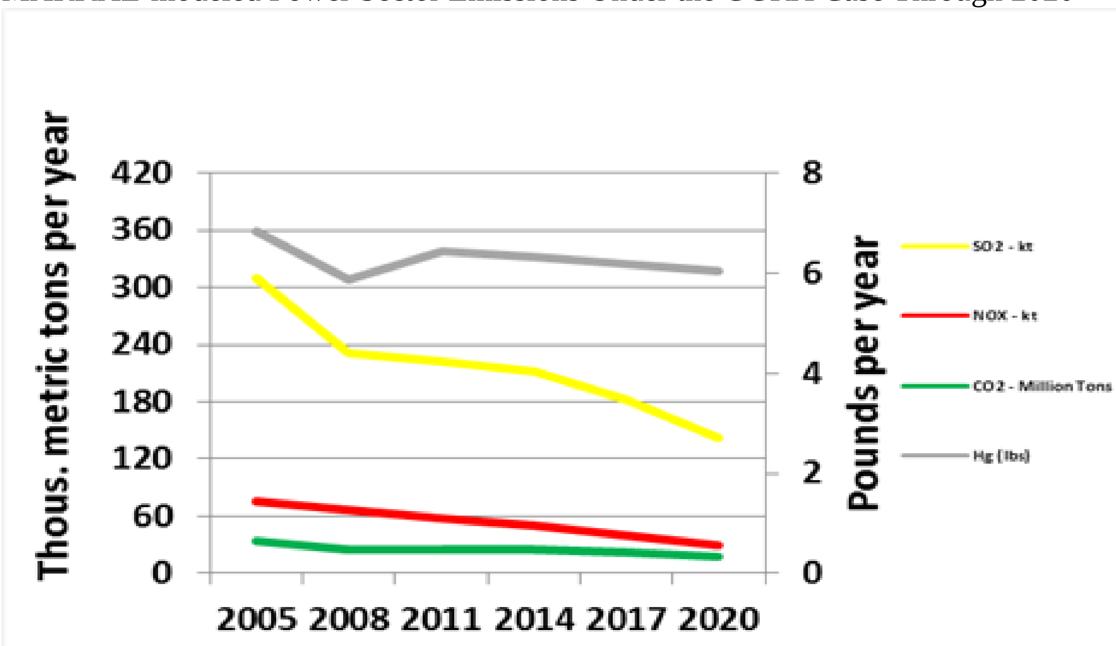
- RGGI relative to a 2011 baseline,

- Renewable portfolio standard as defined by least-cost optimization,
- Light-duty vehicle GHG standards,
- EV technology deployment consistent with low-range of regional clean fuel standards,
- Vehicle miles traveled reductions consistent with transit and "smart growth" plans in GGRA, and
- Conservative EmPower Maryland program.

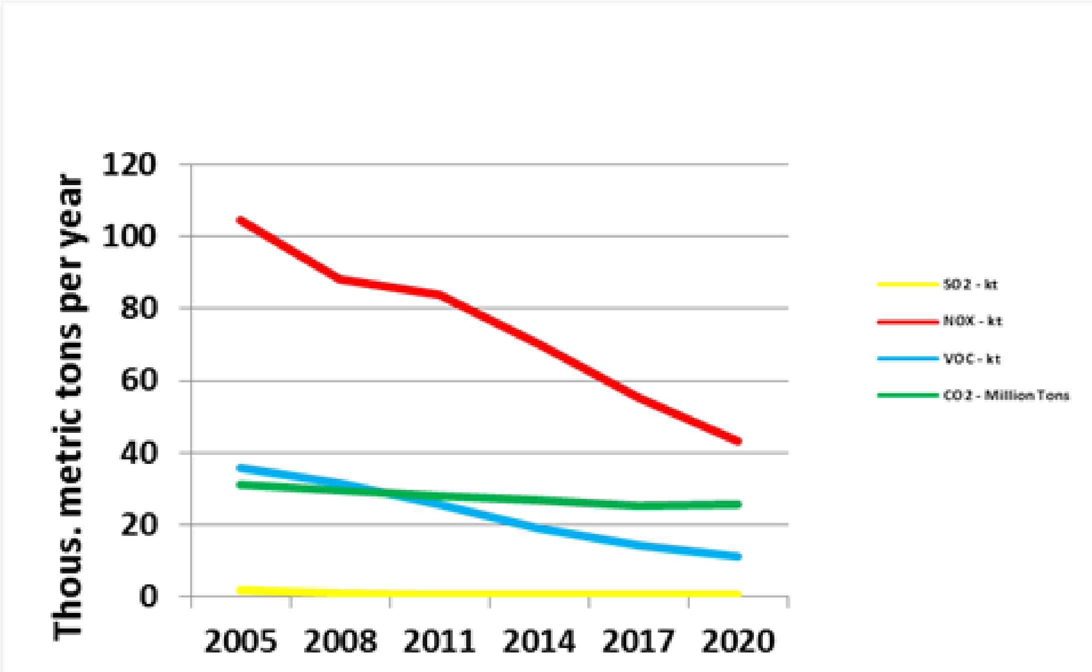
PROCESSING AND ANALYSIS

NESCAUM ran the MARKAL and BenMAP models and contracted with the University of Maryland to run CMAQ and Towson University Regional Economic Studies Institute (RESI) to run REMI. The complexity of the models and the time and expense needed to contract with experienced modelers is an important concern for agencies considering this approach. The following illustrations depict select output and results from the models.

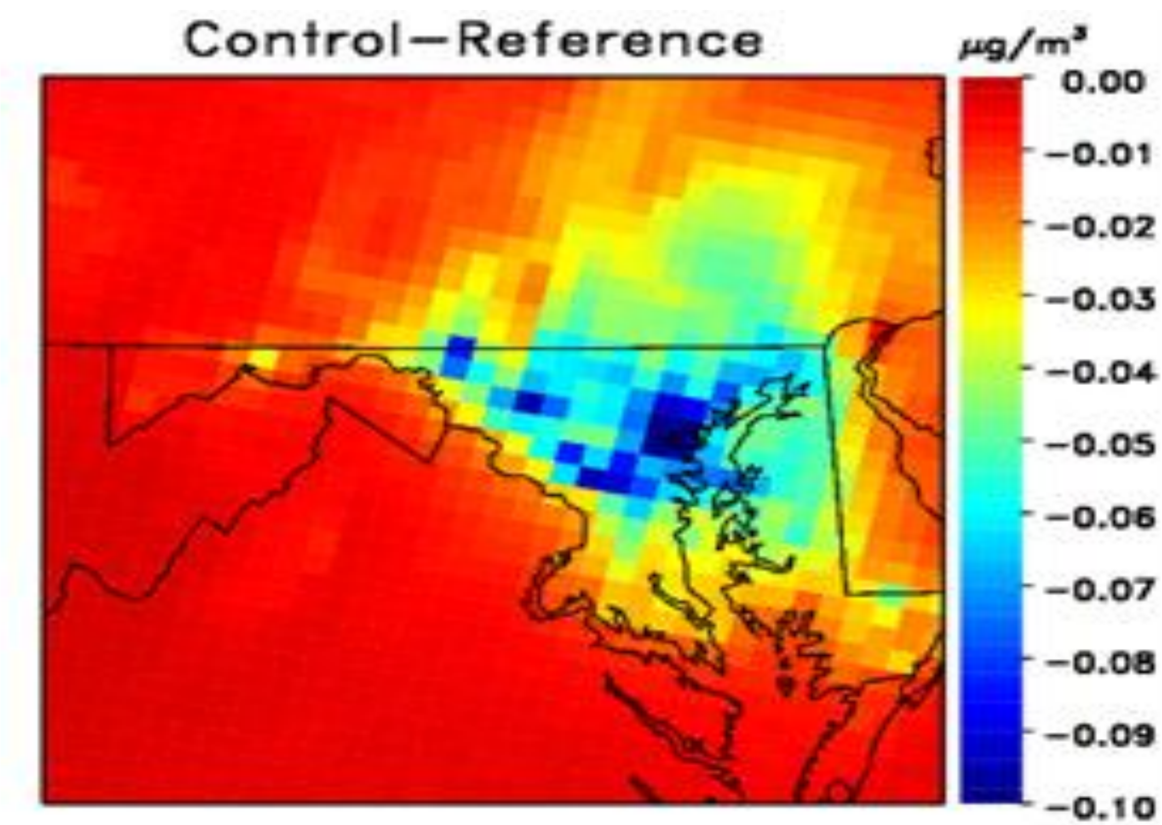
MARKAL-modeled Power Sector Emissions Under the GGRA Case Through 2020



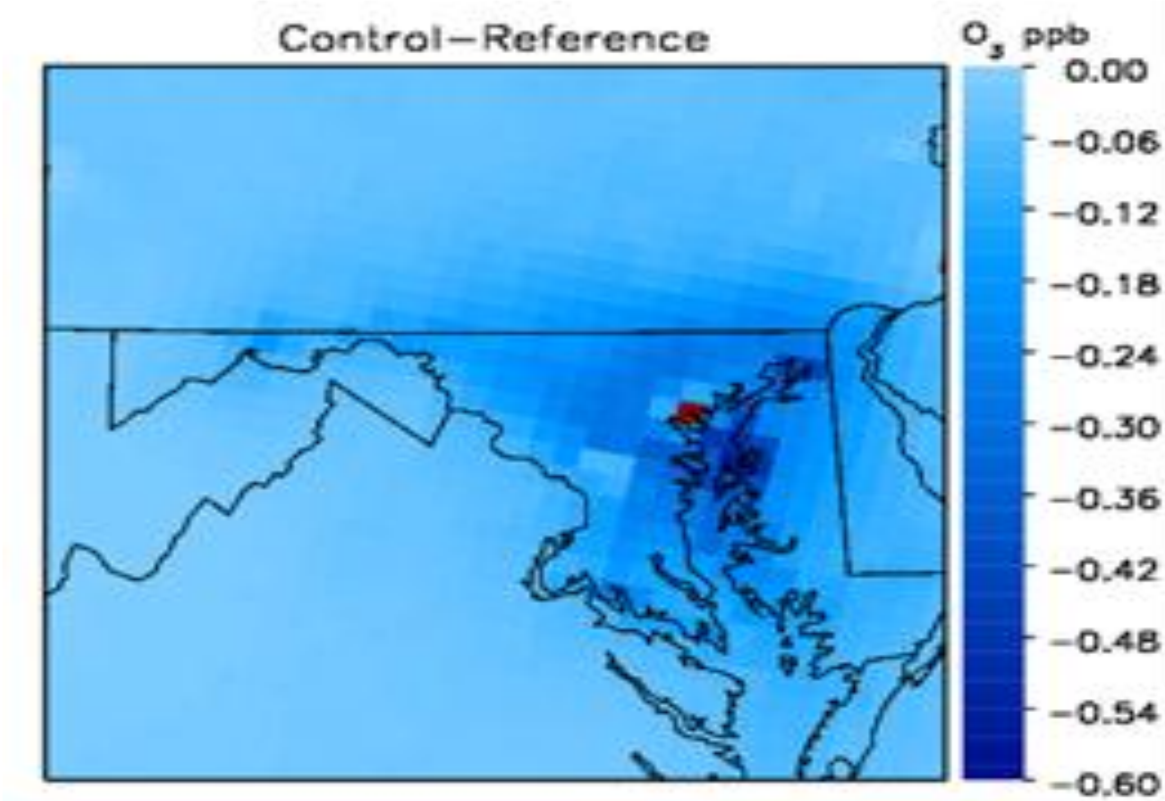
MARKAL-Modeled Transportation Sector Emissions Under the GGRA Case Through 2020



CMAQ Output - Difference Between Average 24-hour Mean PM2.5 Calculated for the GGRA and Reference Cases Maryland



CMAQ Output – Difference Between Average Maximum Daily 8-Hour Average Ozone Calculated for Control and Reference Cases - Maryland



BenMAP Output – Health Impact Incidence and Valuation, Change from Base to GGRA Case, by State for Ozone

State (Abbrev.)	Incidence					Valuation (millions $)	
	Mortality (All Cause)	Morbidity					
		Acute Respiratory Symptoms	Emergency Room Visits, Respiratory	Hospital Admissions, Respiratory	School Loss Days	Mortality	Morbidity
CT	-	52	-	-	15 - 35	0.2 - 0.3	0.0
DC	-	260	-	0 - 1	76 - 181	1.0 - 1.4	0.0
DE	-	643	-	1 - 3	201 - 479	2.5 - 3.5	0.1
MA	-	12	-	-	3 - 8	0.1	0.0
MD	**3 - 5**	**6,853**	**3 - 6**	**3 - 20**	**2,107 - 5,020**	**24.9 - 35.1**	**0.6 - 0.7**
ME	-	(84)	-	-	(53) – (22)	(0.6) – (0.4)	0.0
NH	-	3	-	-	1 - 3	0.0	0.0
NJ	1	1,806	1 - 2	1 - 6	542 - 1,292	7.0 - 9.9	0.2
NY	2	3,731	3 - 6	2 - 10	1,095 - 2,613	12.2 - 17.2	0.3 - 0.4
PA	2 - 3	2,939	1 - 3	2 - 13	873 - 2,083	13.8 - 19.4	0.3
RI	-	-	-	-	2 - 5	0.0	0.0
VA	1	2,151	1 - 2	2 - 9	676 - 1,613	6.7 - 9.4	0.2 - 0.3
VT	-	(16)	-	-	(10) – (4)	(0.1)	0.0

REMI Findings – Trend Over Time

- Over the short-term (5-10 years during technology transition), we see large benefits due to increased spending and investment in new technologies;
- Subsequent loss of fuel sector jobs/wages could lead to negative trend in output if the Maryland economy is not "re-tooled" to fit with new opportunities (e.g. clean tech sectors); and
- Complementary incentive or subsidy programs could be considered with GGRA

ADDENDUM 3: Report on Emission Reduction Efforts of RGGI States and Recommendations for Guidelines under Section 111(d) of the Clean Air Act

Report on Emission Reduction Efforts of the States Participating in the Regional Greenhouse Gas Initiative and Recommendations for Guidelines under Section 111(d) of the Clean Air Act

Introduction

The states participating in the Regional Greenhouse Gas Initiative (RGGI) have successfully achieved substantial reductions in greenhouse gas (GHG) emissions from the power sector in a cost-effective manner, while promoting economic growth and vitality. The experience of the RGGI states provides a particularly relevant demonstration of the effectiveness of a multi-faceted suite of programs in reducing GHG emissions from the power sector. It also illustrates the potential for the power sector to reduce emissions by substantially more than 17% from 2005 levels, which will help the United States to achieve the targeted economy-wide reductions of 17% by 2020.

Experience of the RGGI States in Reducing Emissions[1]

The states involved in RGGI are demonstrating that environmental protection can go hand-in-hand with economic development and job creation. In operation since 2009, RGGI is the first *cap-and-invest* program in the United States – it *caps* GHG emissions from the power sector and reduces those emissions over time. The states participating in RGGI are *investing* the proceeds generated from auctioning emission allowances to further reduce emissions, lower the cost of compliance, and develop the clean energy economy in the region.

The RGGI cap-and-invest program is just one of the tools the RGGI states utilize to reduce emissions. The RGGI states are promoting renewable energy through some of the nation's most aggressive renewable portfolio standard programs and supporting investments in energy efficiency that have reduced the amount of electricity consumed and lowered bills paid by electricity consumers. The RGGI states are also implementing various regulatory programs directed at pollutants other than GHGs that, along with RGGI, are fostering the transition from high-emitting coal and oil to renewable energy and lower-emitting natural gas as a fuel for generating electricity.

1 This section responds to many of the questions posed by EP! under heading number 1 ("What is state and stakeholder experience with programs that reduce CO_2 emissions in the electric power sector?")

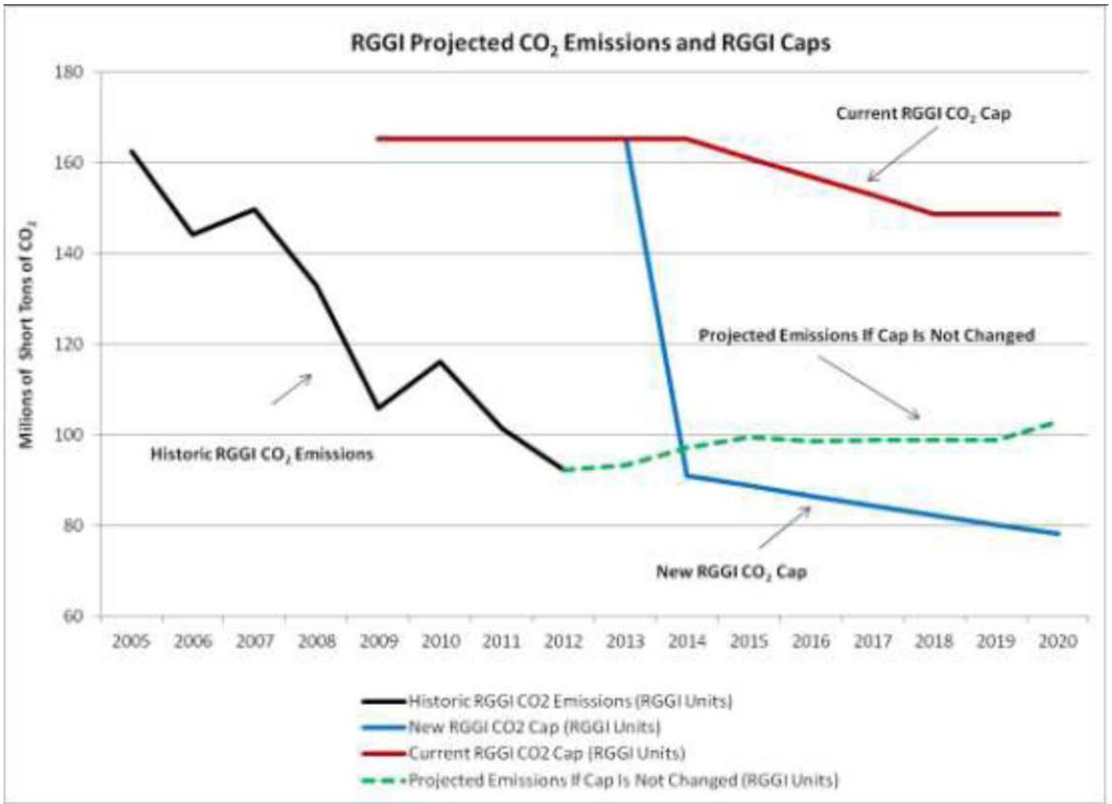
In this context, the RGGI cap-and-invest program plays three integral roles in achieving emission reductions. The declining cap and corresponding change in the cost of allowances provides a market signal that supports fuel switching, on-site efficiency improvements, the retirement of high-emitting plants, the construction of new more efficient plants, and other measures that reduce emissions. The auction mechanism provides a source of funding for complementary energy efficiency and renewable energy investments that further reduce emissions. The enforceable emissions cap ensures that the combined effect of the RGGI program and the suite of supporting policies is to actually reduce emissions to below the cap level.

The experience in the RGGI states shows the magnitude of emission reductions possible from the power sector: a projected 50% decline in tons of carbon dioxide (CO_2) emissions and a fossil fuel-fired generation fleet that is projected to achieve emission rates on par with the recently proposed new source performance standard for new electric generating units. Between 2005 and 2012, CO_2 emissions from the power sector in the nine participating RGGI states dropped more than 40%, from 162.5 million tons in 2005[2] to 92 million tons in 2012. The RGGI states are locking in this reduction by reducing the regional cap to 91 million tons in 2014, and reducing it an additional 2.5% each year thereafter to 78 million tons in 2020. In 2020, the RGGI emissions cap will ensure that regional emissions are 50% below 2005 emission levels (See Figure 1).

Some of this reduction is attributable to the successful energy efficiency programs implemented by each of the RGGI participating states. For example, New York's energy efficiency programs have reduced electricity use in New York by a cumulative total of 6.5% in 2012. As a result, CO_2 emissions associated with New York's electricity use are estimated to be 2.68 million tons lower in 2012 than they would have been otherwise. In the four years since it began in 2009, Maryland's EmPOWER program has reduced electricity consumption by 3.25%, reducing CO_2 emissions by 1.17 million tons. Massachusetts projects that its investment in energy efficiency will accelerate the reduction in electricity demand to approximately 2.5% each year from 2013-15. From 2005 through 2015, these energy efficiency investments will reduce Massachusetts' electricity demand by 17.1%, for a total annual reduction of 3 million tons of CO_2 in 2015. Similarly, Connecticut's energy efficiency programs have reduced electric consumption by over 10% since 2001, resulting in a total reduction of over 2 million tons of CO_2 emissions.

2 http://rggi.org/historical_emissions; https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=search.rggi_summary_report_input&clearfuseattribs=true

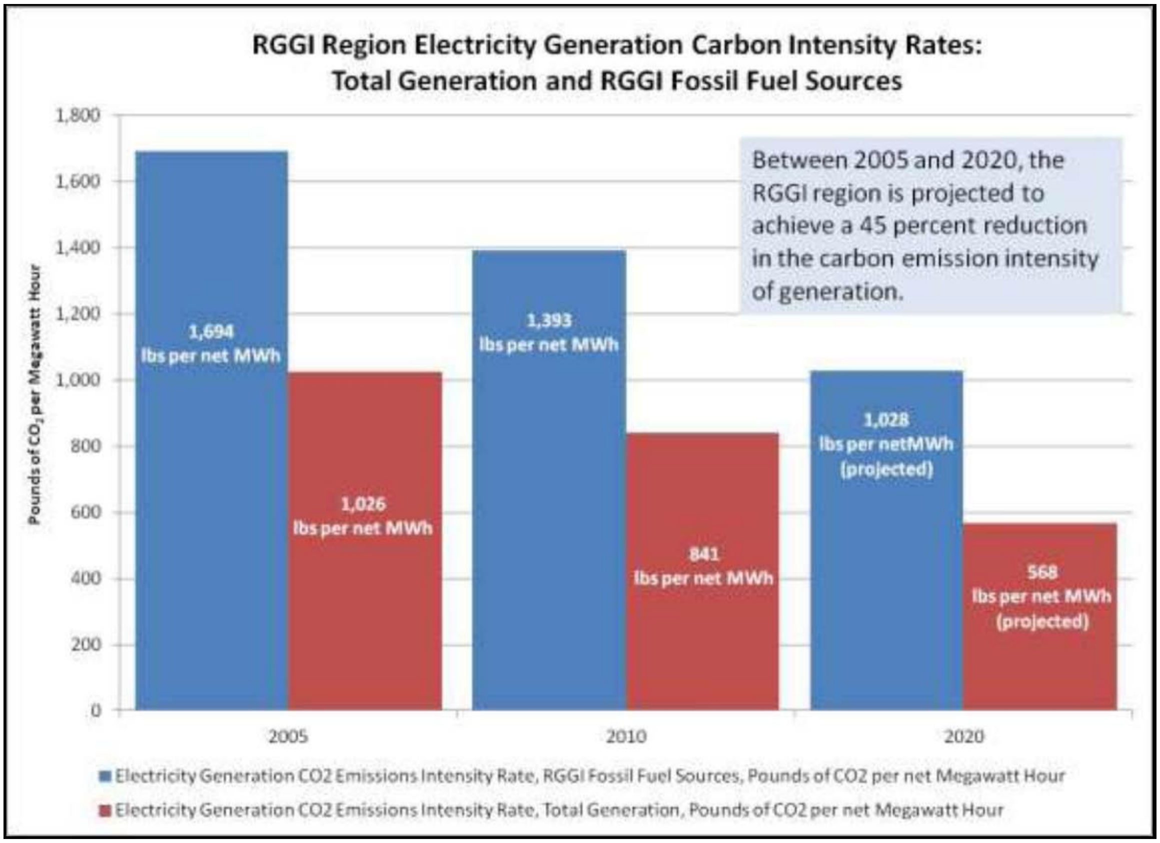
Figure 1: New RGGI Cap and Projected CO_2 Emissions Without Cap Reduction



Much of the reduction in power sector emissions is attributable to better utilization of a cleaner power system, resulting in a substantially reduced system-wide emission rate. Between 2005 and 2010, the overall CO_2 emission rate of the fossil fuel-fired power sector in the RGGI states declined from 1,694 lbs/MWh to 1,393 lbs/MWh (1026 lbs/MWh to 841 lbs/MWh, including zero emission sources).[3] By 2020, modeling of the new RGGI cap indicates that the fossil fleet emission rate will decline further to 1,028 lbs/MWh (568 lbs/MWh for all sources).[4] Thus, in the 15 years between 2005 and 2020, the RGGI states will have achieved a 39% reduction in the emission rate from fossil fuel-fired power plants and a 45% reduction in the emission rate of the entire power sector.

3 From data used to produce: http://rggi.org/docs/Documents/Elec_monitoring_report_2011_13_06_27.pdf
4 http://rggi.org/design/program_review

Figure 2: RGGI Region Electricity Generation Carbon Intensity Rates



This reduction in the emission intensity of electricity generation in the RGGI states is due in part to the ramping up of renewable energy sources, pursuant to state renewable portfolio standards that provide for steep increases in the percentage of renewable energy sold in each state, as the table below illustrates:

Table 1: RGGI State Renewable Portfolio Standards or Goals

Connecticut	27%	
Delaware	25%	2025
Maine	40%	2017
Maryland	20%	2022
Massachusetts	15%	2020
New Hampshire	24.8%	2025
New York	30%	2015
Rhode Island	16%	2019
Vermont	20%	2020

As the foregoing demonstrates, the RGGI states' experience can be an effective model for state programs under section 111(d):

- *It is extremely cost-effective*. RGGI enables compliance through market mechanisms that seek out the least expensive emission reductions across the region.[5]
- *It provides economic benefits*. According to an independent analysis, the RGGI states' investment of auction proceeds from just the first three years of the program (2009-2011) is creating thousands of jobs, reducing energy bills by over $1 billion and adding a net of $1.6 billion to the economies in the RGGI states.[6]
- *It aligns with the regional nature of the electricity grid*. The nation's regional electricity grids allow electricity to flow from the cheapest, most efficient producer to meet consumer demand, wherever located. As a result, generation and emissions within a region may not always trend in unison, such that emission increases in some locations due to market fundamentals may be offset by emission decreases elsewhere. The RGGI cap ensures that emissions decrease across the region, even as it allows increases in some locations in order to reap the benefits of more efficient sources in those locations.
- *It provides a simple, transparent, verifiable compliance system*. It can be difficult to document and verify the emission reductions attributable to programs that support renewable energy and energy efficiency. Under RGGI, the emissions are limited by the allowances that are distributed, providing certainty that the projected emission reductions will be achieved, including reductions attributable to energy efficiency and renewable energy.

The RGGI market-based model for achieving emission reductions is a well-established system of emission reduction. It is based on the models for reducing the pollutants that cause acid rain and ozone that are embodied in Title IV of the Clean Air Act and in the nitrogen oxide

5 This is consistent with recent analysis of the Organisation for Economic Co-operation and Development (OECD) that concludes that carbon markets are a highly efficient mechanism to mitigate carbon emissions. *See* OECD, Climate and Carbon, Aligning Prices and Policies, OECD Environment, Policy Paper, October 2013. 6 The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States, *Review of the Use of RGGI Auction Proceeds from the First Three-Year Compliance Period*. The Analysis Group, November 15, 2011.

http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf trading program established by EPA in 1995 and 2003. But RGGI improved on those models by auctioning allowances and using the proceeds from those auctions to support complementary efforts to further reduce emissions and decrease compliance costs, such as investment in renewable energy and energy efficiency. This innovation has reduced the cost of complying with the cap and provided net economic benefits to the economies of the participating states.

Implications of RGGI for Development of EPA Guidelines under Section 111(d)[7]

EPA should recognize that the RGGI model is an effective system of emission reduction for GHG emissions from the power sector that combines various policy tools with an enforceable cap. Under the RGGI regional cap, the RGGI states will achieve a 50% reduction in CO_2 emissions from the power sector from 2005 levels by 2020. This reduction in emissions is projected to be realized in part through a 45% reduction in emission rates across the electricity system in the participating states, while the rest of the reductions come from complementary policies that reduce demand. Relying on an emission budget trading system, the RGGI states are ensuring that this level of reduction will in fact be achieved. The specific lessons of the RGGI experience include the following:

1. ***A system of emission reduction that is focused on the electricity system as a whole achieves the greatest emission reductions.***

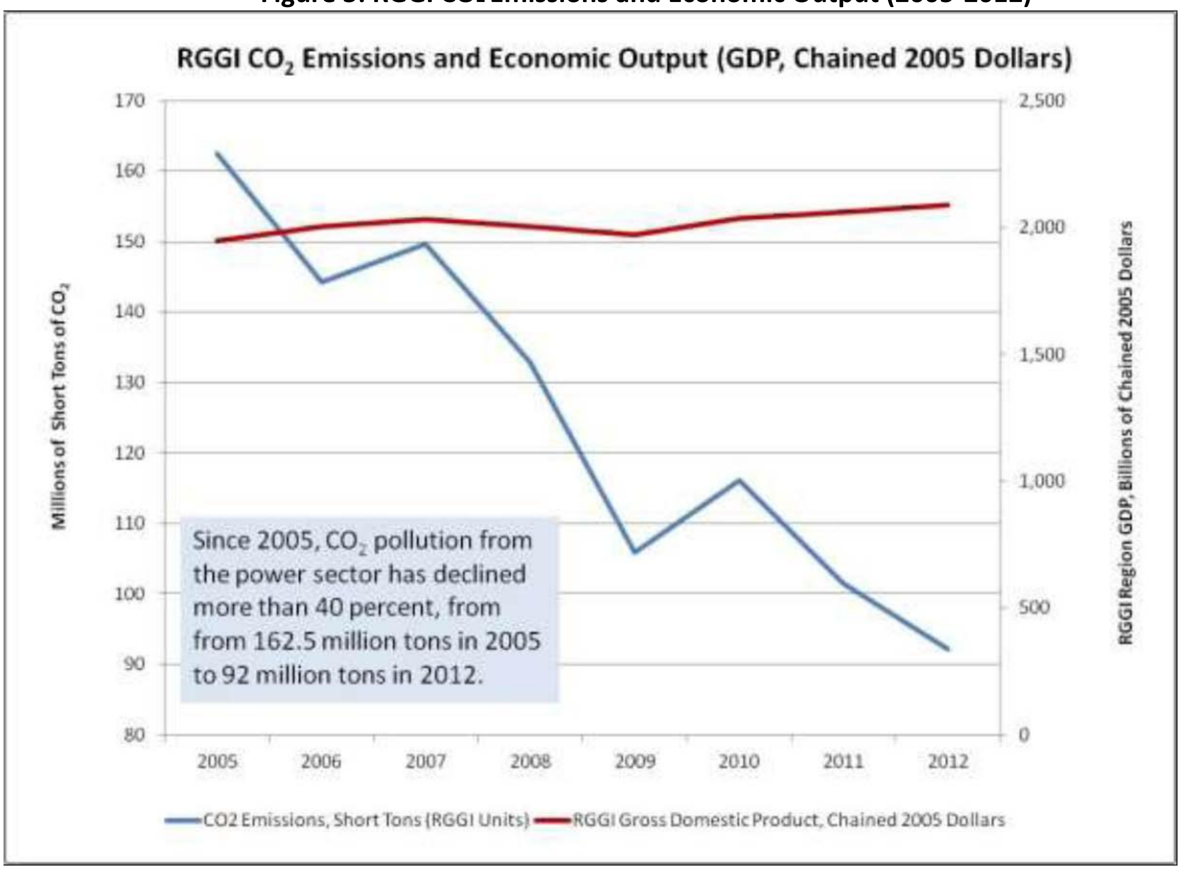
The RGGI states implement a suite of programs to pursue the best opportunities for emission reductions from the power sector. Programs within the system of emission reduction adopted by each RGGI state, such as energy efficiency goals and renewable energy standards, do not require emission reductions at any specific plant but focus on system-wide emission reductions. The price signal provided by the cost of RGGI allowances raises the relative cost of higher-emitting plants, leading to increased generation at lower-emitting, more efficient plants, even as overall system-wide emissions have declined substantially. A system-based approach is not only best-suited to realize the emission reduction potential of cleaner energy supplies and energy efficiency, it fits precisely within section 111(d)'s mandate to EPA to develop guidelines for states to implement the "best system of emission reduction."

7 This section responds to EP!'s questions under heading number 2 ("How should EP! set the performance standard for state plans?")

2. *The RGGI states are demonstrating the feasibility of reducing emissions by 50%.*

Since 2005, CO_2 emissions from the power sector have declined more than 40% across the RGGI region, as energy efficiency programs have contributed to reduced demand and generation has shifted from coal and oil to gas and renewable power. Some states, like New York, achieved this level of reduction even though the energy system was already relatively clean in 2005, with nearly half of electricity provided by carbon-free sources. Even greater reductions should be achievable in states that rely more heavily on coal because of the low-cost alternatives that remain available. By reducing the cap to approximately 50% below 2005 levels by 2020, the RGGI states are ensuring that this transition to a lower-emitting power sector will continue. The RGGI states are achieving this reduction while continuing to grow the regional economy by more than 7% since 2005.[8]

Figure 3: RGGI CO_2 Emissions and Economic Output (2005-2012)



8 Bureau of Economic Analysis (BEA), Gross Domestic Product by State (chained 2005$); http://www.bea.gov/regional/index.htm

As mentioned above, the reinvestment of auction proceeds is contributing to this economic growth and analyses prepared for the RGGI states predict that over $8 billion and more than 125,000 job-years will be added to the RGGI states' economies as a result of the cap reduction through 2040.[9]

3. ***An emissions cap is a reliable system for monitoring and verifying compliance.***

For states that rely on a suite of policies to reduce emissions, like the RGGI states, an emissions cap is a simple but rigorous method of ensuring and verifying that the policies have achieved the emission reductions targeted. Significantly, even though the required emission reductions are achieved on a regional basis, the point of compliance is with the source. Because sources cannot emit more than the number of allowances they hold at the relevant compliance deadline, the RGGI system ensures compliance. Verification is simple and routine: at the end of each compliance period, the amount of allowances in each source's compliance account must be adequate to cover that source's emissions. The measurement of CO_2 emissions at sources covered by the cap is easily accomplished utilizing existing emissions monitoring equipment and protocols already in place at these sources, and covered sources report CO_2 emissions in accordance with 40 CFR Part 75. If a source does not have adequate allowances to cover its emissions, enforcement can be taken directly against that source. Because of the simple and straightforward nature of determining whether the cap is met, budget trading programs obviate the need for EPA or states to conduct a complex analysis to determine whether a state meets its compliance requirements, as described below.

4. ***Regional systems of emission reduction best reflect the regional nature of the electrical grid.***[10]

A program that corresponds with the borders of an electricity grid is potentially more efficient than programs that are constrained by state borders. If EPA only allows for compliance on a state-by-state basis, without regard to the scope of the electricity system, it may create inefficiencies and unnecessary complications for EPA, states, and regulated sources. A regional program like RGGI helps to ensure that the most cost-effective emission reductions occur across the region. For example, since the program was commenced, generation has shifted from coal-fired plants within the six state New England region covered by ISO New

9 http://rggi.org/design/program_review 10 This subsection responds to questions about how EPA should account for the regional nature of the electricity grid.

England to natural gas and renewable sources located elsewhere in that region. Indeed, emissions in Rhode Island actually increased because it is home to some of the more efficient natural gas-fired power plants in the region that had excess capacity. If Rhode Island's generation had been constrained by a Rhode Island-specific cap, one or more of the coal-fired plants that closed elsewhere in New England may have had to remain open to meet demand, thereby increasing emissions and costs to consumers.

Even if a program that encompasses an entire regional program is not feasible, a multi-state regional program like RGGI provides greater efficiency by allowing for the most cost-effective emission reductions among the states participating in the program.

Recommended Principles for EPA Guidelines[11]

The RGGI states offer the following recommendations for EP!'s development of guidelines for state programs that would deliver the emission reductions needed as cost-effectively and equitably as possible.

1. EPA's Guidelines should achieve meaningful nationwide emission reductions.

In structuring its guidelines, EPA should take account of the emission reductions that are being achieved from the electricity system nationwide through a variety of programs, including RGGI and California's similar program, investments in energy efficiency, renewable energy programs, and switching to lower-carbon fuels, and also consider the potential for contributions from available technologies that are not yet widely deployed in the United States, such as offshore wind and carbon capture and sequestration technology. EPA should recognize that the best system of emission reduction considers the electricity system as a whole, and utilizes all the opportunities for reducing emissions from this system.

Conceptually, the methods of reducing emissions from the fossil fuel-fired electricity system can be grouped into two categories. The first category consists of systems of emission reduction that reduce the amount of electricity needed from fossil fuel-fired power plants, such as energy efficiency programs that reduce the demand for electricity, demand-side

11 This section responds generally to EP!'s questions under heading numbers 2 ("How should EP! set the performance standard for state plans?") and 3 ("What requirements should state plans meet, and what flexibility should be provided to states in developing their plans?").

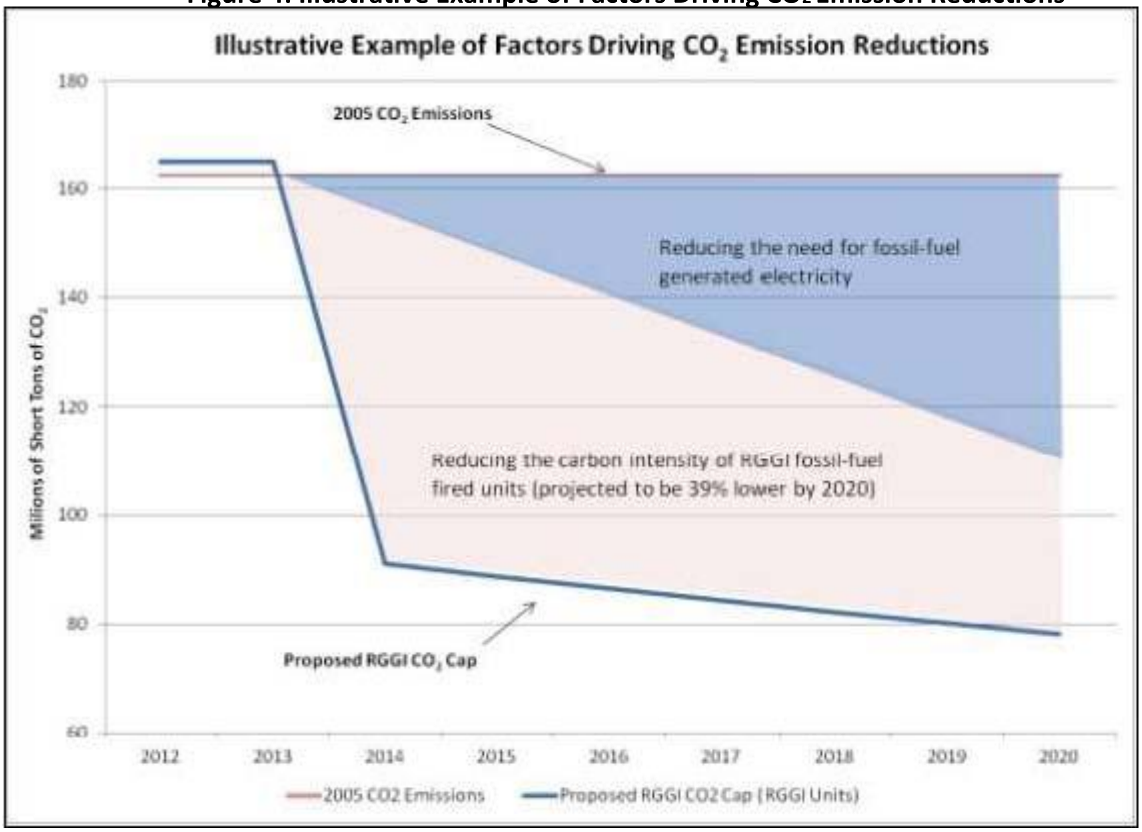
management, and investments in renewable energy that displace fossil fuel-generated electricity. Second, emissions can be reduced by lowering the carbon intensity of the electricity generated by fossil fuel-fired power plants. This is done through shifting generation from high-emitting plants to new or under-utilized lower-emitting plants, and using the latest technology to reduce emissions at existing plants.[12]

Combined, these two categories, or *wedges,* of emission reductions can be substantial. The RGGI states' 40% emission reduction is due to a suite of actions that address both *wedges*, including the RGGI mechanism, investments in energy efficiency and other demand-side programs, support for renewable energy, and regulatory programs directed at criteria air pollutants and air toxics that have reduced the amount of electricity generated by higher-emitting plants. These programs have combined with market forces that have supported a major shift in electricity generation from coal-fired to natural gas-fired plants to transform the regional electricity system in the past eight years.

By investing in energy efficiency and renewable energy and shifting generation to more efficient plants, other states and regions should be able to approach the level of performance that the RGGI states are already demonstrating. EPA should evaluate whether and when this level of performance can be achieved throughout the United States using the various tools at the disposal of the states. While it may take longer for some regions of the nation to achieve comparable levels of performance, EPA should structure the emission guidelines to require that states make significant progress in the next decade toward achieving the reductions and performance level demonstrated by RGGI to be readily achievable by the best systems of emission reduction.

12 Currently available options for reducing carbon dioxide emissions through measures implemented "on-site" at existing fossil fuel-fired power plants have the potential to reduce emissions from individual power plants by 20% or more, especially if used in combination. In addition to improving the efficiency or "heat rate" of the plant, these options include, but are not limited to, co-firing or re-powering with lower-carbon fuels such as sustainable biomass and natural gas; utilizing renewable energy sources such as solar power to provide supplemental steam heating; implementing combined heat and power (CHP) systems at plants near industrial facilities or district heating systems; and carbon capture technology.

Figure 4: Illustrative Example of Factors Driving CO_2 Emission Reductions



2. EPA should provide equitable treatment to early movers.

Many states, including the RGGI states, have already made substantial progress in reducing emissions from their power sector. EPA should structure the guidelines in a way that recognizes this progress and provides equitable treatment to those states. EPA should avoid any approach that imposes inequitable or disproportionate burdens on early mover states and fails to recognize their substantial progress. For example, requiring an equivalent percentage reduction for state A, which has already achieved most cost-effective reductions, and state B, which has taken little action and finds many inexpensive emission reduction opportunities still available, would effectively disadvantage state A for having taken early action.

One approach that EPA should consider is setting a single emission intensity target (e.g., a system-wide average of 1100 lb/MWh) that would apply to each state, individually or as part of a region. That approach would require all states to reduce emissions but it would be equitable to those states that have already made progress toward meeting the emission intensity target. EPA could consider providing more time to states that have more work to do to meet the target.

3. EPA should allow states to use a mass-based system of compliance.

A mass-based approach has a number of advantages, including simplicity and its ability to accommodate many emission reduction strategies, including energy efficiency and renewable power, and add-on controls should they become technically and economically viable. An emission rate target, in contrast, does not easily provide credit for energy efficiency investments that reduce energy demand without reducing the emission rate of the units operating. Thus, requiring the regulated fossil fuel-fired power plants to meet a specific emission rate, or achieve a set reduction in their emission rate, does not credit investments in energy efficiency.

Therefore, EPA should allow states to utilize a mass-based system of compliance, applied to the energy system as a whole. Indeed, if EPA does not establish mass-based targets in its guidelines, it should provide the states with clear direction in developing mass-based emission budgets based on emission rates designated by EPA. That direction could include designation of factors (e.g., rate of economic growth) and consistent data sources that would allow for conversion of an emission rate target into an emission budget.

4. EPA should allow states to demonstrate compliance on a regional basis.

EPA should allow and encourage compliance on a regional basis, while providing individual states the opportunity to determine how to achieve compliance with each state's emission budget within its state implementation plan. Under a mass-based regional system of compliance like RGGI, states would pool their individual state emission budgets and comply with those emission budgets on a regional basis, while still allowing for enforcement by states against their own sources that do not have sufficient allowances. As long as the overall regional emissions cap complies with the guidelines, it should be immaterial to EPA how the participating states elect to apportion the regional emissions cap among the states. Although a particular state's actual emissions could theoretically exceed its individual state emission budget in a particular year, this should not affect EP!'s willingness to accept a regional program as a pathway for compliance. As long as the regional program demonstrates that emissions from sources within the region will collectively meet EP!'s emission guideline, it can still serve as the basis for each state's implementation plan.

A regional program has the benefit of addressing some of the interstate issues raised by EPA in its questions. For example, under a state-by-state approach, if an energy efficiency policy in State A leads to a reduction in emissions in neighboring State B, State A cannot necessarily take direct credit for those emission reductions outside its borders in its section 111(d) implementation plan. Likewise, because State B would have no basis for enforcing State !’s energy efficiency program, State B cannot necessarily include State !’s efficiency policy in its plan. For any state that is part of a multistate electricity grid, it may be challenging to make a rigorous demonstration that investments in energy efficiency or renewable energy result in any quantifiable level of emission reductions within the state. On the other hand, a regional program that encompasses both the state that invests in efficiency and the state in which emissions decline as a result would avoid these complications. In a regional budget trading program, emission reductions anywhere in the region reduce the overall demand for emission allowances, as regulated sources require fewer allowances for compliance. As a result, the cost of allowances, or the cost of complying with that regional emissions cap, is reduced.

Thus, allowing regional compliance can avoid market distortions that would result in less than optimal policy decisions. For example, a state that is not participating in a regional program might choose not to invest in energy efficiency or renewable energy if it would not be able to fully credit the benefits of doing so in its section 111(d) compliance plan. Instead, it might choose to make less than optimal investments in fuel-switching or plant-specific improvements in order to ensure that the emissions of its power plants are reduced. The result would be less than optimal allocation of limited resources and less reduction of emissions for a given level of effort. EPA should avoid that inefficient outcome by supporting (but not requiring) the development of regional compliance plans

5. EPA should permit states to demonstrate compliance on a multi-year basis.

Emissions across an electricity system can vary between years depending on factors outside the ability of plant operators to influence, including weather, economic conditions, and unexpected shutdowns. EPA can require a more substantial level of cost-effective reductions if it allows states to average emissions over a multi-year period and enables states to bank, or carry-over, early reductions. Unlike other pollutants that may have short-term impacts, the environmental harm caused by CO_2 and other GHG pollutants have much longer periods of impact. Therefore, allowing compliance on a multi-year basis would not reduce the environmental benefits of the program.

The RGGI program uses a three-year compliance approach. The RGGI states' experience is that this approach has the benefit of allowing sources to take advantage of multi-year compliance strategies. By allowing sources three years, the regulated units have flexibility to address variations in emissions, unexpected shutdowns, or uneconomic dispatch orders, without impacting the enforceability or environmental effectiveness of the program's requirements.

6. EPA's should provide clear guidelines for a rigorous demonstration of equivalency of state programs.[13]

EPA should provide clear direction to the states regarding demonstrating equivalency of state programs. EP!'s guidelines should identify the tools that states can use to demonstrate that state emission reduction programs will achieve equal or greater reductions in pollution than the base standards set by EPA. For a mass-based budget trading program like RGGI, that process is straightforward. As long as EPA provides a mechanism that enables states to potentially have an annual mass-based emissions budget under section 111(d), then determining whether a regional budget trading program like RGGI is equivalent to EP!'s emission guideline will be a simple matter. In particular, the participating states will have to demonstrate that the annual regional emissions cap under the regional program achieves emission reductions equal to or greater than those allowed by EP!'s guidelines.

To evaluate programs that are not mass-based, EPA should build on current program evaluation guidance such as the "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans" or the "State and Local Energy Efficiency Action Network. 2012. *Energy Efficiency Program Impact Evaluation Guide.*" These guides describe the terminology, structures, and approaches used for evaluating energy and demand savings as well as avoided emissions and other non-energy benefits resulting from energy efficiency programs that are implemented by local governments, states, utilities, private companies, and nonprofits. These guides provide context, planning guidance, and discussion of issues that determine the most appropriate evaluation objectives and best practices approaches for different efficiency portfolios. By using standard evaluation terminology and structures and best practices approaches, evaluations can support the adoption, continuation, and expansion of effective efficiency actions for consistent inclusion in State Plans.

13 This section responds to EP!'s questions under heading number 3 ("What requirements should state plans meet, and what flexibility should be provided to states in developing their plans?").

7. *EPA should ensure that state plans are enforceable.*

EPA should require state plans to demonstrate that the requirements are legally and practically enforceable. Under a budget trading program like RGGI, enforceability, measurement, and verification are already incorporated into the program in a straightforward manner. Based on consistent regulations adopted in each RGGI state, sources subject to RGGI are required to obtain and hold a sufficient amount of allowances by the relevant compliance deadline to cover emissions over the relevant compliance period. Under the existing terms of RGGI states' respective implementing regulations, this regulatory requirement is generally incorporated as a condition of each source's operating permit. Thus, RGGI is enforceable directly against individual sources by the state where the sources are located, and the failure of a source to hold sufficient allowances constitutes violations of the state's program and of the source's permit. Under an approved section 111(d) plan, this obligation of each individual source to comply with RGGI would become a federally enforceable condition of an individual source's Title V permit. !t the end of the compliance period, the "true-up" process, in which states deduct allowances to cover sources' emissions, provides verification that the emission reductions included as part of the participating states' section 111(d) plans are actually achieved.

State plans that rely on a suite of strategies including energy efficiency, renewable energy, and changes in dispatch should be encouraged, as long as a mechanism is available to ensure that the promised emission reductions are achieved. If the emission reductions anticipated from those strategies are encompassed within a federally enforceable emission budget program, the various strategies themselves would not have to be federally enforceable.

Conclusion

The states participating in RGGI have demonstrated that significant emission reductions are feasible through a suite of clean energy activities, complemented by an enforceable emissions cap. EPA should consider this record of success in developing guidelines for state plans that require and empower states to achieve meaningful reductions through a comprehensive package of activities, including market-based emission budget programs like RGGI.

ADDENDUM 4: EPA Modeling of Benefits from Regional EE/RE Efforts

The intention of this addendum is to present links to information specific to modeling results for EE/RE efforts in Maryland and the region. Only a brief summary of the modeling conditions and the resulting benefits are presented here; full details on the criteria used in setting up the modeling runs and the results are available at the respective links.

In March 2012, the EPA released a draft of the projected benefits from existing state and regional EE/RE programs. With guidance from NESCAUM and EPA, additional state and regional scenarios will be selected by MDE for further modeling, and, in combination with weight of evidence (WOE), a range of projected impacts, or reductions in energy demand and consumption, from these scenarios will be developed. These reductions, ranging from the most conservative (low impact) to the least conservative (high impact) will be converted to reductions in NOx and SO2 emissions from EGUs. This range of projected reductions will be evaluated using WOE to show RFP towards attainment in the Baltimore ozone nonattainment SIP.

The MDE intends to use existing results from IPM runs, with initial scenario identification, selection and application to be run beginning in the First Quarter 2013. As the results of the scenarios are received, a more focused identification and selection process will be used in identifying the state or regional programs for additional testing.

The following webpage, which was updated on 9/14/2012, includes an abundance of information on the development of EE/RE policies. Some of the text from the web page has been copied here:

Projected Impacts of Existing State Energy Efficiency and Renewable Energy Policies
http://epa.gov/statelocalclimate/state/statepolicies.html

This page presents an EPA analysis of projected energy savings and demand impacts of existing State energy efficiency and renewable energy (EE/RE) policies. EPA anticipates that its methods and projected energy impacts may be useful to states preparing State Implementation Plan (SIP) submittals to meet the National Ambient Air Quality Standards (NAAQS) for ozone and particulate matter. States can also use this information to assess the energy impact estimates in their air quality management plans and greenhouse gas mitigation plans.
This analysis covers 29 States with EE/RE policies that are adopted in state law and codified in rule or utility regulators' order, but that are not reflected in the Energy Information Administration's Annual Energy Outlook (AEO) 2010 electricity demand projections. Impact estimates are provided for:

- Energy-efficiency policies that reduce electricity demand in key end-use sectors by encouraging the use of more energy efficient equipment, technologies and practices.

- Renewable Portfolio Standard (RPS) policies where States have increased requirements for renewable energy generation beyond what is documented in AEO 2010.

The energy (MWh) and demand (MW) impacts presented here do not reflect comments received from states and other stakeholders in the summer of 2011. EPA plans to release that information in the coming months.

Four additional links within this webpage provide details on:

1. The background and methodology of the project,
2. State-by-state summary pages,
3. State policy characterization and annual energy savings, and
4. Peak energy savings.

1. Background and Draft Methodology

http://epa.gov/statelocalclimate/documents/pdf/background_and_draft_methodology.pdf

- Provides a project overview and describes objectives for the analysis. This document also includes a detailed description of the draft methodology, including policy definitions, data sources, sample equations, and reference tables.

A copy of the first page of the Background document is copied here:

STAFF DRAFT – DO NOT CITE OR QUOTE

Background and EPA's Draft Methodology for Estimating Energy Impacts of EE/RE Policies

I. Introduction

To help states examine the role for EE/RE policies and programs in their SIPs/TIPs, EPA developed a draft methodology and estimated the electric-sector impacts of existing energy efficiency and renewable energy (EE/RE) policies. EPA's draft methods and analysis covers "on the books" EE/RE policies that are adopted in state law and codified in rule or order, but that are not reflected in the Energy Information Administration's Annual Energy Outlook (AEO) 2010 electricity demand projections.

EPA anticipates that its methods and impact estimates may be useful to states preparing SIP/TIP submittals to meet the National Ambient Air Quality Standards (NAAQS) for ozone and other pollutants.

This appendix describes the methodology EPA used to develop those energy savings estimates, provides an overview of the information EPA is making available, and outlines potential uses for the information.

Within the document are additional details referring to IPM (see page 17):

State-level peak savings were estimated as the hourly load impact of energy efficiency programs during the state's peak hour. In the absence of state-specific information on the timing of the peak, the peak hour for each state was assumed to be the same as the peak hour for the Integrated Planning Model (IPM) region in which it largely sits (based on population) in EPA's Base Case.

"Model region" refers to the geographic regions defined for the "EPA Base Case using IPM® v.4.10," a projection of electricity sector activity that takes into account only those Federal and state air emission laws and regulations whose provisions were either in effect or enacted and clearly delineated at the time the base case was finalized in August 2010. The peak hour is taken from load shapes used in EPA's Base Case using IPM®, which are compiled by aggregating EIA-714 data to the model region level.

> US Environmental Protection Agency (EPA) (2010). *Documentation for EPA Base Case v.4.10 Using the Integrated Planning Model.* August 2010. Available online at http://www.epa.gov/airmarkt/progsregs/epa-ipm/docs/v410/Chapter1.pdf

2. State by State Summary Pages
http://epa.gov/statelocalclimate/documents/pdf/State-by-StateSummaryPages.pdf

Provides a one-page snapshot of each state's energy savings results (GWh) on an annual and cumulative basis for the years, 2010, 2012, 2015, 2020. This file also includes estimates of future renewable energy sales for states that adopted or revised their RPS beyond what is assumed in AEO 2010.

A single page summary table for each of the 29 states is presented, with a brief description of the conditions and assumptions used. The summary for the State of Maryland has been copied here. All results are still draft.

MARYLAND

In February 2011, EPA estimated the future impacts of Maryland's energy efficiency and renewable energy (EE/RE) policies that were adopted in state law and codified in rule or order as of December 2010. EPA is now seeking feedback from Maryland state agencies on the draft results presented below. Once this feedback is received, EPA will make appropriate and feasible changes and provide a final version to states interested in evaluating the emission impacts of EE/RE policies in their air quality plans. For more information and details on submitting feedback, see http://www.epa.gov/statelocalclimate/state/statepolicies.html.

Assumptions

EERS: Reduction in per capita electricity consumption of 15% by 2015, based on 2007 consumption

Ratepayer-Funded Programs: Not incremental to EERS

RGGI-Funded Programs: Not incremental to EERS

RPS: Not incremental to AEO2010 Forecast

(GWh, unless otherwise noted)	2010	2012	2015	2020
Energy Efficiency Savings				
Energy Efficiency Resource Standard (EERS)				
Annual	930	935	943	-
Cumulative	930	2,798	5,619	5,619
Ratepayer-Funded Programs				
Annual	-	-	-	-
Cumulative	-	-	-	-
RGGI-Funded Programs				
Annual	-	-	-	-
Cumulative	-	-	-	-
Embedded in AEO2010 Forecast				
Annual	14	14	15	-
Cumulative	14	42	86	86
Incremental to AEO2010 Forecast				
Annual	916	921	928	-
Cumulative	916	2,756	5,533	5,533
Incremental to AEO2010 Forecast (% of Reference Case)				
Annual	1.5%	1.4%	1.4%	0.0%
Cumulative	1.5%	4.3%	8.4%	8.1%
Electricity Sales				
Reference Case	63,122	64,202	65,857	68,709
State-Adjusted Case	62,206	61,446	60,324	63,177
Renewable Energy Sales				
Renewable Portfolio Standard	-	-	-	-
Incremental to AEO2010 Forecast	-	-	-	-
Incremental to AEO2010 Forecast (% of State-Adjusted Case)	0.0%	0.0%	0.0%	0.0%

Note: Please see the *Energy Savings Quantification* Excel workbook for further information.

In working with the EPA and NESCAUM on this pilot project to investigate the application of potential EE/RE programs to reduce energy demand, single state scenarios and regional scenarios will be run. State summaries for only 29 states were available. Of these 29 states, 17 are located to the east of the Mississippi River: Connecticut, Delaware, Florida, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont and Wisconsin. State summaries for an additional 9 states east of the Mississippi River were not available: West Virginia, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee and Kentucky.

In summary, savings from energy efficiency for the 17 states east of the Mississippi River for which summaries were available is provided here; additional details are available at the web page. http://epa.gov/statelocalclimate/documents/pdf/State-by-StateSummaryPages.pdf

Estimated Future Impact of EE/RE Policies for Select States

STATE		2012	2015	2020
Connecticut	Annual	493	500	511
	Cumulative	1,505	2,996	5,528
Delaware	Annual	9	13	18
	Cumulative	27	65	149
Florida	Annual	968	1,042	0
	Cumulative	2,604	5,700	9,402
Illinois	Annual	966	952	952
	Cumulative	2,757	5,611	10,369
Indiana	Annual	581	1,082	0
	Cumulative	1,248	3,996	9,852
Maine	Annual	180	302	318
	Cumulative	336	1,141	2,696
Maryland	Annual	949	958	0
	Cumulative	2,840	5,705	5,705
Massachusetts	Annual	1,324	1,333	1,348
	Cumulative	3,278	7,268	13,980
Michigan	Annual	989	988	989
	Cumulative	2,222	5,187	10,130
New Hampshire	Annual	94	97	97
	Cumulative	276	564	1,047
New Jersey	Annual	917	919	920
	Cumulative	2,403	5,158	9,752
New York	Annual	1,281	1,031	0
	Cumulative	4,072	7,655	7,655
Ohio	Annual	1,188	1,490	2,959
	Cumulative	3,050	7,367	17,766
Pennsylvania	Annual	1,386	0	0
	Cumulative	2,778	4,174	4,174
Rhode Island	Annual	166	228	230
	Cumulative	430	1,081	2,227
Vermont	Annual	175	177	181
	Cumulative	521	1,050	1,947
Wisconsin	Annual	769	1,064	1,073
	Cumulative	1,404	4,444	9,792
Total		12,435	12,176	9,596
		31,751	69,162	122,171

Note: all results expressed in gigawatt hour (GWh)

The following sections:

3. State Policy Characterizations and Annual Energy Savings and Generation Estimates, and
4. Peak Energy Savings Summaries,

were used in the preparation of the State-by-State Summary Pages (discussed above).

3. State Policy Characterizations and Annual Energy Savings and Generation Estimates

http://epa.gov/statelocalclimate/documents/excel/state_policy_characterizations.xls

Provides a detailed description of each state's energy efficiency policies, as well as energy savings estimates on an annual and cumulative basis (GWh) for the years 2010-2020. This file also describes RPS policy details and provides annual and cumulative renewable energy sales (in GWh) for states that revised their RPS policies beyond what is assumed in AEO 2010.

A copy of the main page of the work sheet, which describes the multiple inputs, has been copied here. Each colored "block" refers to a separate worksheet in the workbook, which when appropriate, contains state specific information.

Workbook Contents: The contents of this workbook include a master summary of results, a policy-impacts section, and a supporting-information section. The tabs in "all caps" provide policy-specific impact data by state, and the tabs in "lower case" contain policy details and background information, as follows:

Workbook Tab	Description
MASTER SUMMARY	Master summary of annual energy impacts from all energy efficiency and renewable energy (EE/RE) policies by state.
EERS SAVINGS	Summary of annual energy savings from state-level energy efficiency resource standards (EERS).
EERS State Policy Details	Details and policy characteristics of state EERS policies, including policy assumptions, applicable regulated entities, and state-specific calculation assumptions.
RATEPAYER AND RGGI SAVINGS	Summary of annual energy savings from state-level Regional Greenhouse Gas Initiative (RGGI) and ratepayer funding policies.
RATEPAYER SPENDING SAVINGS	Summary of annual energy savings from state-level ratepayer funding policies, with details and policy assumptions used to determine total spending and savings.
RGGI SPENDING SAVINGS	Summary of annual energy savings from state-level RGGI funding policies, with details and policy assumptions used to determine total spending and savings.
RPS GENERATION	Summary of annual renewable energy generation from state-level renewable portfolio standard (RPS) policies that are not already captured in AEO 2010 reference case forecast.
RPS State Policy Details	Details and policy characteristics on state RPS policies, including policy targets, applicable regulated entities, and state-specific calculation assumptions.
EE Savings Embedded in AEO2010	Supporting information, including details on the energy savings assumed to be "embedded" or already captured in the 2010 Annual Energy Outlook (AEO 2010) forecast of electricity demand.
EE Savings Sample Calculation	Sample equations for calculating business as usual electricity sales (BAU), annual savings, cumulative savings and adjusted demand savings

Brief descriptions of the methodology used to estimate policy impacts are provided in the relevant tabs, along with key definitions and other policy-specific information. For a more detailed description of the methodology (including references and citations), please see the "Background and Draft Methodology" http://www.epa.gov/statelocalclimate/state/statepolicies.html document provided on EPA's website.

4. Peak Energy Savings Summaries

http://epa.gov/statelocalclimate/documents/excel/LoadImpactShapesandPeakSavingsQuantification.xls

Provides estimates of annual peak savings (in GW) for 2010, 2012, 2015 and 2020, as well as hourly demand impacts for each year in states with relevant energy efficiency policies.

The peak energy savings for the 29 states are calculated and presented separately, and then summarized on the main page of the workbook.

PEAK SAVINGS (GW)

DRAFT RESULTS AS OF March 15, 2011 - DO NOT CITE

Peak savings results reported below are the estimated hourly load impacts of energy efficiency policies during each state's peak hour. These impacts are based on cumulative energy savings from policies that are not captured in the *AEO2010* electricity-demand forecast.

State	2010	2012	2015	2020
ARIZONA	-	0.4	1.3	3.1
ARKANSAS	-	0.1	0.2	0.2
CALIFORNIA	0.2	0.7	1.1	1.9
COLORADO	0.1	0.2	0.5	0.7
CONNECTICUT	0.1	0.2	0.4	0.7
DELAWARE	0.0	0.0	0.0	0.1
FLORIDA	0.2	0.6	1.4	2.2
HAWAII	0.0	0.1	0.2	0.4
ILLINOIS	0.1	0.5	1.0	1.8
INDIANA	0.1	0.4	1.2	2.9
IOWA	0.1	0.3	0.4	0.4
MAINE	-	0.1	0.3	0.7
MARYLAND	0.3	1.0	2.0	2.0
MASSACHUSETTS	0.2	0.8	1.8	3.5
MICHIGAN	0.2	0.8	2.0	3.8
MINNESOTA	0.3	0.8	1.5	2.7
MONTANA	0.0	0.0	0.0	0.0
NEW HAMPSHIRE	0.0	0.0	0.0	0.1
NEW JERSEY	0.2	0.6	1.3	2.4
NEW MEXICO	0.0	0.1	0.3	0.3
NEW YORK	0.2	0.7	1.2	1.2
OHIO	0.2	0.9	2.3	5.5
OREGON	0.0	0.1	0.1	0.1
PENNSYLVANIA	-	1.0	1.5	1.5
RHODE ISLAND	0.0	0.1	0.3	0.6
TEXAS	0.0	0.0	0.1	0.3
VERMONT	0.0	0.1	0.2	0.3
WASHINGTON	0.0	0.1	0.4	0.8
WISCONSIN	-	0.2	0.8	1.8
TOTAL*	2.6	10.8	23.5	42.0

*Total peak impacts are calculated as the sums of non-coincident peak savings across states, i.e., peak savings did not occur during the same hour in each state.

States located east of the Mississippi River

IPM Modeling

The MDE intends to use existing results from IPM runs, with initial scenario identification, selection and application to be run beginning in the First Quarter 2013.

EPA's IPM Base Case v.4.10
September 1, 2010 – EPA announced a Federal Register Notice of Data Availability (NODA) supporting the Proposed Transport Rule.
Updated 9/8/2010
http://www.epa.gov/airmarkt/progsregs/epa-ipm/BaseCasev410.html

This webpage has a link to a very useful document, which provides details on Base Case v.4.10. The table of contents for this document is copied here.

Documentation for EPA Base Case v.4.10

To learn more about EPA Base Case v.4.10 assumptions, updates, changes, and enhancements, see the links below.

Top of Page

Of particular interest in this document are:

- General information on IPM, and what data entry
- Existing environmental regulations for SO2, NOx and CO2
- State specific environmental regulations (MD: Healthy Air Act)
- New Source Review Settlements (MD: Morgantown and Chalk Point)
- Renewable Portfolio Standards in EPA Base Case v.4.10 (Appendix 3-6)
- Trading and Banking Rules in EPA Base Case v.4.10
- Proposed Transport Rule results using EPA's IPM Base Case v.4.10

IPM Analyses of the Cross-State Air Pollution Rule (CSAPR)
http://www.epa.gov/airmarkt/progsregs/epa-ipm/docs/v410/Guide_to_IPMv410_Input_and_Output_Files.pdf

Analysis of the Final Cross-State Air Pollution Rule
On July 6, 2011, the EPA Administrator signed a Notice of Final Rulemaking for the Cross-State Air Pollution Rule (CSAPR). EPA analyzed the impact of the final CSAPR on the U.S. electric power sector using version 4.10_FTransport of the Integrated Planning Model (IPM). From this page you can download documentation for IPM

v4.10_FTransport, the NEEDS database of electric generation unit records used in the modeling, and the IPM run results files.

The information on this webpage reflects changes to the IPM Base Case v.4.10 after receiving comments from stakeholders.

ADDENDUM 5: Maryland's Efforts Based On OTC Energy Efficiency Status Report (December 19, 2012)

Purpose: Implement a voluntary energy efficiency program involving public and private sectors that is projected to generate in initial startup and implementation phase, approximately 1.2 tons/day NOx reductions by 2015 in Maryland. Increased reductions are expected in later stages of implementation.

Maryland will apply the recommendations of the OTC status report "Promoting Deep Energy Retrofits of Large Commercial Buildings To Reduce Nitrogen Oxide Emissions" and develop along with other member states and EPA, a low cost program to reduce energy consumption at commercial buildings. The status report lists several low-cost policy strategies that jurisdictions in the OTR could pursue to promote profitable NOx reductions. Commercial building deep energy retrofit projects have recently achieved profitable energy reductions of 38 percent to 70 percent, with profitability demonstrated by simple payback periods as low as three years. High profitability often begins with planning a retrofit at a time when the heating/ventilation /air-conditioning, or HVAC, system will be replaced. Then, replacing windows with highly insulating windows and implementing other energy efficiency measures allows the purchase of a smaller HVAC system, at lower capital and operating costs. These profitable deep energy retrofit projects achieve year-round energy reductions, including reductions in air conditioning demand during the ozone-season.

<u>Data Collection and Reporting</u>

Maryland will work with OTC, EPA and stakeholders on an efficient and automated form of collecting data on energy use by large commercial buildings and making it publicly available. Experience gained from New York City's approach, requiring owners of large commercial buildings to measure and report their energy use will be applied in Maryland. New York City requires owners of large non-residential and residential buildings to upload data into an Internet-based database tool developed by the U.S. Environmental Protection Agency called Energy Star Portfolio Manager that is used to track and assess energy and water use relative to similar buildings. Maryland will attempt to reduce the time lag between data collection and reporting. It is expected that energy service companies will use the data to market their services and offer energy-saving retrofits.

Maryland will be working with stakeholder to verify that the data is submitted by building owners and operators.

<u>Financing</u>

Credit assistance plays a significant role in implementing energy efficiency programs. Leading initiatives and approaches will be reviewed for potential application in Maryland. Data collection and reporting effort coupled with property assessed clean energy financing and program services to municipal and commercial property owners throughout the state would be a significant help. These measures will ensure that energy efficiency and renewable energy projects help property owners in reducing energy consumption and save costs.

Benchmarking

Economical approach to benchmarking involves the utilization of Portfolio Manager. Maryland will apply the Portfolio Manager for benchmarking purposes. The U.S. EPA’s online energy benchmarking system, is a tool that enables building owners to track energy use in their buildings and compare a building’s energy performance against similar buildings. Portfolio Manager is used by building owners nationally as a tool to track and evaluate energy and water consumption, develop energy management goals over time, and identify strategic opportunities for cost savings. The U.S. Green Building Council references Portfolio Manager as the measurement tool to verify energy performance under the Leadership in Energy and Environmental Design (LEED) for Existing Buildings, Operations and Maintenance standard.

Portfolio Manager energy performance is reported as a score on a scale of one (1) to one hundred (100) relative to similar buildings nationwide, or as an Energy Use Intensity (EUI) result when the data on similar buildings is not sufficient to allow for a comparative statistical classification. Portfolio Manager is capable of accounting for the impact of local weather variations, as well as for changes in key physical and operating characteristics of building type. From data for on-site fuel combustion, purchased electricity, and heating and cooling data, Portfolio Manager can calculate building greenhouse gas emissions such as carbon dioxide, methane, and nitrous oxide. Portfolio Manager also tracks energy and water use trends as compared with the costs as a versatile tool.

Implementation of Recommendations

1. Monitor and implement leading regional approaches and programs in the region.

2. Review the data that is scheduled for release regarding the energy footprint of buildings and compare to the next report of 2013 and develop cost effective program based on the results.

3. Develop the method to calculate NOx emissions reduced based on electricity consumption using the tool within EPA's forthcoming Energy Efficiency and Renewable Energy in SIPs Manual.

4. Maryland will develop examples of NOx reductions and electricity consumption to help make a more solid connection between energy efficiency programs and ozone SIP.

5. The energy generation and utilization will be more closely and directly linked in the ozone transport and high energy demand day efforts in view of the compelling economics of reducing NOx emissions through energy efficiency programs.

6. Energy efficiency will be used more widely based on the example of boiler MACT program with the additional benefit of potential SIP credits.

7. Maryland will work in cooperation with other regional organizations such as NESCAUM, MARAMA, member states, EPA and technology developers on EE and SIP credit.

ADDENDUM 6: Maryland's Efforts to Quantify GHG (and other) Emission Reduction Benefits from EE/RE Programs

Recent Maryland Energy Sector Analysis
Maryland Energy Trends

This is an analysis of the effectiveness of current energy policies such as the RPS and EmPOWER to see how much GHG emissions they would reduce. It also looks at general fuel switching from coal to natural gas that has happened in the PJM marketplace independent of specific policies. The current policies are analyzed in the Table 1. GGRA was the original analysis. SAIC was done by a consulting group for MDE last year. MEA is Maryland Energy Administration analysis, and CCAN is the Chesapeake Climate Action Network, an environmental stakeholder.

The analysis of the impact of changing certain policies is in Table 2. BLQ and WDS are black liquor and wood waste, respectively. These are currently qualifying technologies in RPS, and this enhancement tries to measure what would happen if you remove them from the RPS and replace them with cleaner wind power. The Enhanced policy assumes the removal of these technologies from the RPS, but also increases the RPS from 18% to 25% and increases EmPOWER (energy efficiency) from 15% to 20%. The BAU adjustment changes the assumptions in the GGRA business as usual forecast. Finally, the CCAN proposal is CCAN's enhanced policy recommendation.

Table 1.Reduction Potential From Current Policies

Reduction Potential - Current Policies	GGRA	SAIC	MEA	CCAN
BAU Forecast Changes				
Original 2020 BAU	58.79	58.79	58.79	58.79
Updated 2020 BAU	54.42	54.42	54.42	54.42
Original 2006 Baseline	42.18	42.18	42.18	42.18
Updated 2006 Baseline	42.74	42.74	42.74	42.74
Forecast Impact (2020 delta - 25% of 2006 delta)	**4.51**	**4.51**	**4.51**	**4.51**
Program Reductions				
RGGI	17.71	8.33	0.00	0.00
EmPower	7.27	3.65	11.15	7.30
RPS	6.78	3.40	7.36	5.50
Fuel Switching	0.00	0.00	6.84	3.70
Imported Power	2.75	1.53	0.00	0.00
GHG New Source	4.84	2.31	0.00	0.00
Other	0.16	0.14	0.00	0.00
Total Independent Reductions	39.51	0.00	25.35	16.50
Combined Scenario Reductions	**30.97**	**19.36**	**20.07**	**16.10**
Net GGRA Reduction Anticipated from Energy	30.97	30.97	30.97	30.97
Forecast Impact Reductions	4.51	4.51	4.51	4.51
Combined Scenario Reductions	30.97	19.36	20.07	16.10
Gap in Reductions	**-4.51**	**7.10**	**6.40**	**10.36**
Actual 2006 Emissions	42.18	42.18	42.18	42.18
Actual 2011 Emissions	37.80	37.80	37.80	38.80
Forecasted 2020 Emissions	23.45	35.06	34.36	38.32
Forecasted Reduction % 2006-2020	44.4%	16.9%	18.5%	9.1%

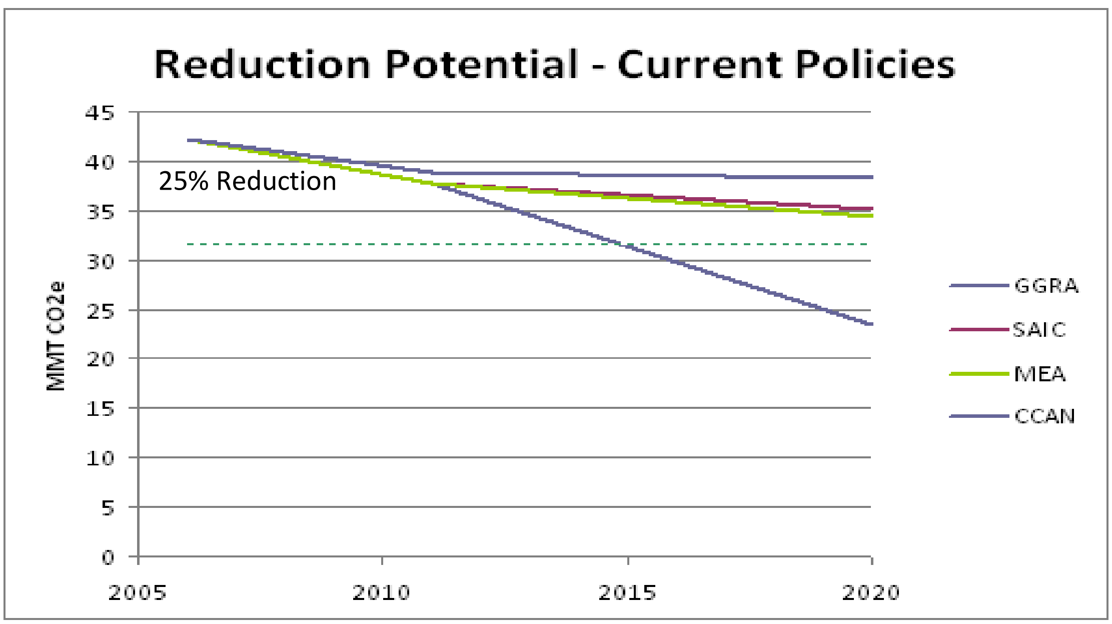
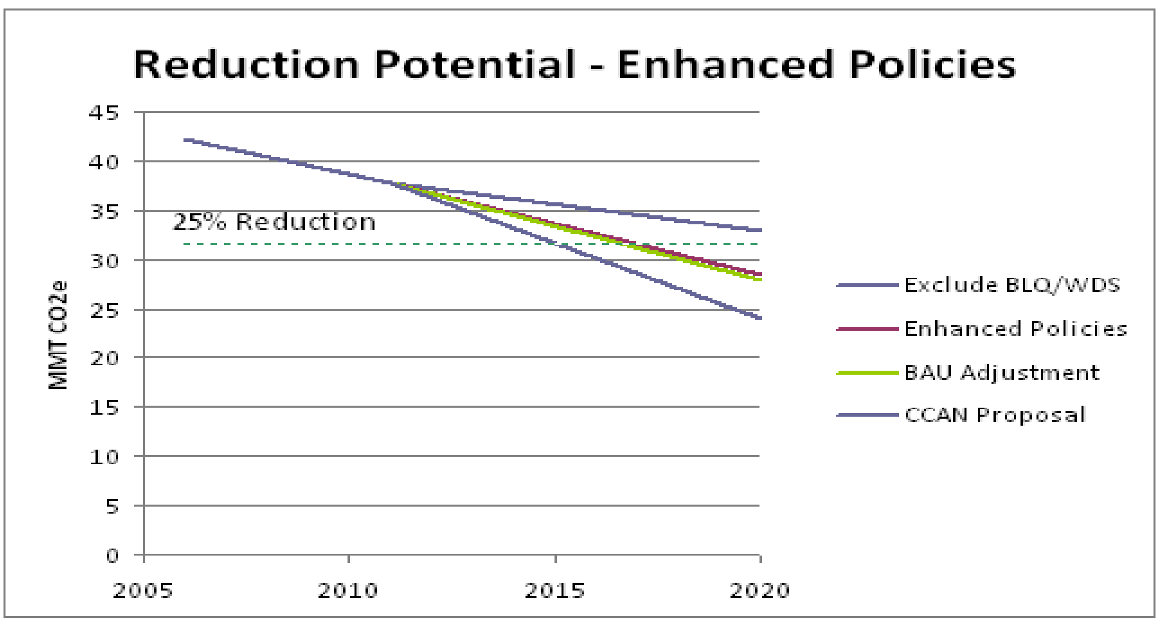


Table 2. Reduction Potential From Enhanced Policies

Reduction Potential - Enhanced Policies	Exclude BLQ/WDS	Enhanced Policies	BAU Adjustment	CCAN Proposal
BAU Forecast Changes				
Original 2020 BAU	58.79	58.79	58.79	58.79
Updated 2020 BAU	54.42	54.42	53.87	54.42
Original 2006 Baseline	42.18	42.18	42.18	42.18
Updated 2006 Baseline	42.74	42.74	42.74	42.74
Forecast Impact (2020 delta - 25% of 2006 delta)	**4.51**	**4.51**	**5.07**	**4.51**
Program Reductions				
RGGI	0.00	0.00	0.00	0.00
EmPower	11.15	14.33	14.33	21.10
RPS	8.88	12.69	12.55	7.60
Fuel Switching	6.84	6.84	7.06	3.70
Imported Power	0.00	0.00	0.00	0.00
GHG New Source	0.00	0.00	0.00	0.00
Other	0.00	0.00	0.00	0.00
Total Independent Reductions	26.87	33.86	33.94	32.40
Combined Scenario Reductions	**21.44**	**25.97**	**26.00**	**30.40**
Net GGRA Reduction Anticipated from Energy	30.97	30.97	30.97	30.97
Forecast Impact Reductions	4.51	4.51	5.07	4.51
Combined Scenario Reductions	21.44	25.97	26.00	30.40
Gap in Reductions	**5.02**	**0.49**	**-0.10**	**-3.94**
Actual 2006 Emissions	42.18	42.18	42.18	42.18
Actual 2011 Emissions	37.80	37.80	37.80	37.80
Forecasted 2020 Emissions	32.98	28.45	27.86	24.02
Forecasted Reduction % 2006-2020	21.8%	32.5%	33.9%	43.0%



Notes:

1. All the difference between the original and updated BAU is applied to the energy sector g
2. Current Policy assumes 15% EmPower target is hit by 2020 and that PJM energy is 30% NG by 2020
3. Exclude BLQ/WDS removes those technologies from RPS, but otherwise leaves % RPS and EmPower unchanged
4. Enhanced Policy assuems 20% EmPower by 2020, 25% RPS by 2020, and no black liquor or wood waste allowed
5. BAU Adjustment is based on Enhanced Policy and reverts coal to its historic average and petroleum to 2006 baseline

ADDENDUM 7: Overview of 2015 Ozone SIP-related Multi-Pollutant Analysis Work

For Maryland's ozone SIP, due in 2015, MDE has already begun work to develop its weight-of-evidence demonstration. Starting in May 2013, MDE engaged NESCAUM, Towson University's Regional Economic Studies Institute, and University of Maryland/College Park to assist in a multi-pollutant analytical exercise--with updated assumptions from the Greenhouse Gas Reduction Act Plan of 2012--in an effort to: (1) integrate energy efficiency into Maryland SIP planning; and (2) explore how reductions from energy and energy efficiency programs could be credited for SIP planning purposes. This effort will take approximately 18 months, consistent with other SIP planning and analytical exercises.

For this effort, NESCAUM will update the NE-MARKAL model and reference case, update Greenhouse Gas Reduction Act Plan policy scenarios, build policy scenarios to incorporate ozone strategies being considered for SIP purposes and that are appropriate for NE-MARKAL modeling, and conduct NE-MARKAL analyses. Outputs of the NE-MARKAL modeling will be pre-processed and provided to Towson University's Regional Economic Studies Institute so that economic analysis can be conducted using the REMI model. NE-MARKAL outputs will also be pre-processed and provided to University of Maryland/College Park for air quality modeling, using the CMAQ model, can be conducted for two policy scenarios. The CMAQ outputs will be used by NESCAUM as inputs into the BenMAP tool to conduct health assessments. The results from these analytical efforts will be used to develop a multi-pollutant narrative for use in the ozone SIP as well as for a progress report on Greenhouse Gas Reduction Act Plan of 2012 (also due in 2015).

Multi-Pollutant Analysis Work Completed

- Analytical Plan

- An initial analytical plan and timeline for the multi-pollutant analysis has been developed. This entailed consultation and coordination with multiple

Maryland agencies and other project partners. The plan outlines anticipated tasks and analytical approaches for the energy, air quality, economic, and health benefits analyses. For example, for the NE-MARKAL energy analysis, the plan outlines steps necessary to update and recalibrate the NE-MARKAL model, revisit and update or refine the characterization of specific policies from the last phase of assessment, and identify the base analytical runs needed for Ozone SIP planning purposes; for the air quality portion of the analysis, the plan currently identifies the CMAQ base year, the number of meta-scenarios to be run, the temporal bounds of the CMAQ model simulations, and emissions processing approach. The plan serves to delineate the overall project schedule, and will be updated throughout the project as MDE's analytical needs become more defined.

NE-MARKAL Model Updates

The NE-MARKAL base year was updated from 2002 to 2005, and the model timeframe was extended from 2029 to 2053. This effort required extrapolating time-dependent data inputs in each sector of the model to conform to the new modeling timeframe. Examples of time-dependent data that were extrapolated in this effort included: (1) energy demands; (2) fuel prices; (3) fuel share constraints; and (4) technology investment costs. Specific updates were also made within the energy supply, power plant, commercial and residential, and transportation sectors of the model.

- Reference Case Updates and Assessment of Initial Calibration

  The preliminary reference case, projected to 2053, was updated, incorporating the core model updates. The modeled results were compared with observed historical trends through 2011, and with baseline forecasts through 2053 made by the U.S. Department of Energy's Energy Information Administration in its Annual Energy Outlook. Model performance and areas of inquiry for completing the calibration were assessed.

- Start Developing Policy Scenarios

  For purposes of this analysis, MDE is assessing the ozone co-benefits of a subset of Greenhouse Gas Reduction Act Plan policies. MDE ascertained the policies of greatest interest and then worked with NESCAUM to assess which policies were most appropriate to model in NE-MARKAL. Partner agencies are involved in determining how the policies should be defined and how best to characterize them for modeling. Twelve to 16 policies are currently being considered for the analysis.

Upcoming Multi-Pollutant Analysis Tasks and Targeted Dates for Completion

Note that targeted Dates for Completion are in parentheses.

- Complete Development of Policy Scenarios and Meta-scenarios (3/3/14)
- Conduct NE-MARKAL Policy Analysis Modeling (3/3/14)
- Review Economic Analytical Approach and Format NE-MARKAL Outputs for Economic Analysis (3/15/14)
- Conduct Emissions Processing for the Air Quality Analysis (4/1/14)
- Conduct REMI Economic Analysis (5/1/14)
- Conduct SMOKE Modeling (6/1/14)
- Conduct CMAQ Modeling for Reference and Future Cases (9/1/14)
- Assess the Potential Need for Additional Refined NE-MARKAL Modeling (ongoing, through 9/1/14)
- Conduct the Health Benefits Analysis (11/1/14)
- Draft the Multi-pollutant Narrative and Discuss Possible Future Analyses (12/1/14)
- Finalize the Multi-pollutant Report for Inclusion in the Ozone SIP (12/31/14)

Activities to Support SIP Crediting for Energy Efficiency and Renewable Energy Programs

The multi-pollutant analytical work being conducted from May 2013 through December 2014 will culminate in a multi-pollutant narrative and analytical report for inclusion in Maryland's ozone SIP. That report will describe and highlight the modeled results of implementing a suite of energy programs, i.e., the technology shifts with associated costs and/or savings that lead to changes in emissions, air quality, public health outcomes, and macro-economic indicators. It will also describe the key assumptions and caveats, limitations of and opportunities resulting from this integrated analytical approach, as well as recommended analyses that could inform future work. While this work requires considerable effort, it is anticipated that its results will be useful not only for ozone SIP development purposes, but for climate and other programmatic uses.

All of the tools that MDE is using for this analysis, including MARKAL, are tools that U.S. EPA has used for analysis in various contexts. Discussions to date with EPA indicate that the use of NE-MARKAL for characterizing energy programs within a SIP context will be accepted.

Attachment

OTC Energy Efficiency Status Report : Promoting Deep Energy Retrofits of Large Commercial Buildings To Reduce Nitrogen Oxide Emissions In the Ozone Transport Region

Ozone Transport Commission Energy Efficiency Workgroup
Status Report 08-15-12

Overview: In June 2011, the Ozone Transport Commission (OTC) members charged the OTC with evaluating the potential for energy efficiency strategies to reduce ozone levels in the Ozone Transport Region (OTR), and recommending an appropriate strategy or strategies. In September 2011, the OTC's Stationary and Area Sources Committee launched the Energy Efficiency Workgroup to fulfill the OTC's charge. The workgroup decided to initially focus on the ozone reduction potential from profitable "deep energy retrofits" of commercial buildings.

Purpose of this report: This report: 1) estimates the magnitude of NOx emission reductions possible in the OTR through profitable deep energy retrofits of large commercial buildings; and 2) lists several low-cost policy strategies that jurisdictions in the OTR could pursue to promote these profitable NOx reductions (including strategies that some jurisdictions are already pursuing).

Partly because OTC works with state air quality agencies, and energy efficiency strategies are typically pursued by state and local energy agencies, the strategies listed here are not subjected to an in depth analysis. Rather, they are presented as options which air divisions may discuss with their respective states' energy divisions, for further evaluation and possible implementation.

NOx Reduction Potential from Profitable Deep Energy Retrofits

Potential for profitable NOx and ozone reductions from commercial building energy efficiency: Commercial building deep energy retrofit projects have recently achieved profitable energy reductions of 38 percent to 70 percent, with profitability demonstrated by simple payback periods as low as three years.[5] High profitability often begins with planning a retrofit at a time when the heating/ventilation/air-conditioning, or HVAC, system will be replaced. Then, replacing windows with highly insulating windows and implementing other energy efficiency measures allows the purchase of a smaller HVAC system, at lower capital and operating costs.

These profitable deep energy retrofit projects achieve year-round energy reductions, including reductions in air conditioning demand during the ozone-season. Reducing air conditioning demand reduces electricity demand, thus reducing electric generating unit emissions of nitrogen oxides (NOx) - an ozone precursor.

[5] http://retrofitdepot.org/TrueStories (a website of the Rocky Mountain Institute).

Potential magnitude of NOx reductions from deep energy retrofits of large commercial buildings in the OTR: The spreadsheet analysis presented at the end of this paper in Attachment 1 shows a potential annual reduction of 36,000 tons of NOx emissions from deep energy retrofits of large commercial buildings in the OTR. The spreadsheet analysis is designed to be self-explanatory, with data and assumptions presented in the top portion of the analysis (along with data sources), and estimated NOx reductions in the bottom portion. The Excel version of the spreadsheet, which shows the formulas used in the bottom portion of this analysis, is available from the OTC upon request.

Policy Options to Promote NOx Reductions from Profitable Deep Energy Retrofits

To date the OTC Energy Efficiency Workgroup has become aware of the following low-cost strategies to promote NOx reductions from profitable deep energy retrofits:

Collecting data on energy use by large commercial buildings and making it publicly available:

New York City has taken this approach, requiring owners of large commercial buildings to measure and report their energy use.

New York City requires owners of large non-residential and residential buildings to "upload data into an Internet-based database tool developed by the U.S. Environmental Protection Agency [called Energy Star Portfolio Manager] that is used to track and assess energy and water use relative to similar buildings". New York City will make the data publicly available after a time lag—for example, on September 1, 2012 for non-residential private buildings.[6] David Bragdon, head of New York City's Office of Long-Term Planning and Sustainability, expects that energy service companies will use the data to market their services and offer energy-saving retrofits.[7]
New York City also requires owners of large buildings to conduct energy audits and "submit energy efficiency reports to the Department of Buildings that include both an energy audit report and a retro-commissioning report."[8]

Although cities are probably better suited than states for verifying that building owners submit energy use data (because each city maintains databases of properties in the city, for property tax and other purposes), state energy offices could assist cities in their states to develop the capability to collect and make available building-level energy data.

Credit assistance: Offering credit assistance could be a low-cost option for a city or state, depending on how the credit assistance is structured—including, for example, whether the city or state can borrow at a lower interest rate than it can lend for such projects. The New York City Energy Efficiency Corporation offers credit assistance for

6 http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY16R&re=1&ee=1
7 "Energy Efficiency: Plenty of data, many confused landlords," CNNMoney online, November 21, 2011
8 DSIREUSA web page for New York City, cited above

retrofit projects.[9] On June 15, 2012, Daniel P. Malloy, the Governor of Connecticut, signed into law a revised property-assessed clean energy statute (C-PACE) allowing the State's newly formed "Green Bank", the Clean Energy Finance and Investment Authority (CEFIA) to offer properly assessed clean energy financing and program services to municipal and commercial property owners throughout the State of Connecticut. Connecticut's approach (C-PACE) is exciting because CEFIA will play a central role in developing statewide program guidelines that municipalities will agree to follow when joining. CEFIA is also empowered by the legislation to provide financing for projects.

Program measures to ensure that energy efficiency and renewable energy projects help property owners and local governments achieve their goals of saving costs, safeguarding the environment, and creating jobs.[6] Currently, 28 states, plus DC authorize PACE. PACE-enabling legislation has been adopted by 27 states (Hawaii had existing authority). A map of States with PACE programs can be downloaded from: http://www.dsireusa.org/solar/solarpolicyguide/?id=26

Property-assessed clean energy (PACE) financing is one option whereby the city **or state** lends the property owner funds for the retrofit project, and the property owner pays back the loan through an incremental charge on the property tax bill. If the building is sold, the incremental charges must be paid by the building's new owner, until the loan is paid off. Typically the city requires due diligence, including an energy audit, before approving the PACE loan. There has been a controversy over which debt obligation takes seniority in the event of foreclosure —the original mortgage on the property, or the PACE debt. For buildings that have no mortgage, however - as is the case for many commercial buildings - this would not be an issue.

<u>Building ratings</u>: State and local governments across the country are adopting policies to reduce energy use in commercial buildings through both required policy measures and voluntary campaigns. For example, the Massachusetts Department of Energy Resources is launching a building energy labeling program, which will be akin to the miles-per-gallon ratings for cars. The program is designed to "provide clear and actionable energy information about a building's potential energy performance, increase the value of good energy performance in the marketplace, and lead ultimately to greater uptake of efficiency investments."[7] More information on State and Local policy development in the U.S. can be found at: http://www.imt.org/performance-policy/us-policies, and a detailed list of policies and incentive programs leveraging Portfolio Manager, EPA's ENERGY STAR measurement tracking tool can be found at:
http://www.energy
star.gov/ia/business/government/State_Local_Govts_Leveraging_ES.pdf

Efforts to adopt policies to reduce energy use in commercial buildings are taking place in other countries as well. For example, the Australian Government has graded buildings on their energy efficiency, with grades of A, B, or C. The Government will only rent space in buildings graded "A." One observer has noted that this grading scheme

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[9] "Energy Efficiency: Plenty of data, many confused landlords," cited above
[6]http://www.ctcleanenergy.com/Home/tabid/36/Default.aspx

influenced both commercial tenants, many of whom sought office space with a high grade, and property owners, many of whom sought to improve their grade by improving their building's energy efficiency.[8]

Recommendations

1. OTC's energy efficiency workgroup recommends a commitment to monitor the implementation of New York City's Green Buildings and Energy Efficiency program and other similar leading programs.

2. Specifically, commitment is needed to review the data that is scheduled for this Fall regarding the energy footprint of buildings that report. Since this will be the first report, a comparison can only be made with the next report of 2013.

3. This year's report will help develop the method to calculate NOx emissions reduced based on electricity consumption using the tool within EPA's forthcoming Energy Efficiency and Renewable Energy in SIPs Manual. This is expected to be a significant number based on the estimates of the workgroup.

4. Examples of NOx reductions and electricity consumption need to be created to help make a more solid connection between energy efficiency programs and ozone SIP.

5. The energy generation and utilization should be more closely and directly linked in the ozone transport and high energy demand day efforts in view of the compelling economics of reducing NOx emissions through energy efficiency programs.

6. Energy efficiency could be used more widely based on the example of boiler MACT program with the additional benefit of potential SIP credits.

7. OTC provides a large forum for energy efficiency initiatives and therefore significant NOx reductions. The pace of developments is such that the workgroup firmly believes that best outcomes can come about in cooperation with other regional organizations such as NESCAUM, MARAMA, member states, EPA and technology developers and independent efforts as well.

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[7] http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/ee-for/business-institutions/energy-labeling-for-commercial-buildings.html

[8] David Cote, Chairman and CEO of Honeywell, speaking at the Center for American Progess's Rountable Discussion on Energy Efficiency Leadership, "Unlocking Investment in Smart and Higg-Performance Buildings," November 17, 2011

Attachment 1

- Spreadsheet analysis estimating potential magnitude of NOx reductions from deep energy retrofits of large commercial buildings in the OTR

Attachment 2

- Number of Office Buildings in the OTR (Source: CoStar Group, Ms. Kristen Joy)

Attachment 3

- Number of Energy Efficient Buildings in the OTR

Attachment 1 - Estimating Magnitude of NOx Reductions from Deep Energy Retrofits in the Ozone Transport Region

Table 1 - Data and Assumptions

Data Element	Value	Units	Source
Commercial, governmental and institutional building space in Mid-Atlantic and New England states in 2003	12,900,000,000	square feet	http://www.eia.gov/emeu/cbecs/cbecs2003/officereport/office1.html
Percentage of U.S. commercial, governmental and institutional building space in large buildings (over 50,000 square feet) in 2003	48%		http://www.eia.gov/emeu/cbecs/cbecs2003/officereport/office1.html
Percentage of Mid-Atlantic and New England commercial, governmental and institutional building space in large buildings (over 50,000 square feet) in 2003	48%		Assumed to be the same percentage as for the U.S. as a whole
Median U.S. electricity usage in commercial, governmental and institutional building space in 2003	11.5	kilowatt-hours per square foot	http://www.eia.gov/emeu/cbecs/cbecs2003/officereport/office2.html
Average Mid-Atlantic and New England electricity usage in office buildings in 2003	11.5	kilowatt-hours per square foot	Assumed to be the same as the *median* for the U.S. as a whole
Average percentage reduction in energy use in profitable "deep energy retrofits"	42%		http://retrofitdepot.org (a website of the Rocky Mountain Institute)--average of the 2 profitable projects: Empire State Building and a retail franchise chain

Average percentage reduction in electricity consumption from profitable "deep energy retrofits" in the Ozone Transport Region	42%		Assumed to be the same as the average reduction in annual *energy* use for the deep energy retrofit projects cited above

Note: Average emissions per kWh across the OTC states, using state-level data from "Source Energy and Emission Factors for Energy Use in Buildings," National Renewable Energy Laboratory, 2007, pp. 27-28 (http://www.nrel.gov/docs/fy07osti/38617.pdf)

Table 2 - Estimates of Potential Energy Reductions & NOx Reductions in OTR (based on data and assumptions above)

Data Element	Value	Units
Commercial, governmental and institutional space in large buildings (over 50,000 square feet) in the Ozone Transport Region (Mid-Atlantic and New England states)	6,211,111,111	square feet
Electricity usage in large OTR in commercial, governmental and institutional space large buildings	71,427,777,778	kilowatt-hours per year
Potential reduction in electricity usage from deep energy retrofits of office space in large commercial, governmental and institutional space buildings in the Ozone Transport Region	29,642,527,778	kilowatt-hours per year
Potential reduction in NOx emissions from deep energy retrofits of commercial, governmental and institutional space in large buildings in the OTR	35,980	tons per year
Average NOx emissions in the Ozone Transport Region from electricity generation/consumption	2.43E-03	pounds per kilowatt-hour

Attachment 2 - Number of Office Buildings in OTR

Source: CoStar Group, Ms. Kristen Joy

State	Number of Buildings	Number of Office Buildings
DC	**10,767**	**2,368**
DE	**7,803**	**1,697**
MA	**61,595**	**11,913**
MD	**51,497**	**10,684**
ME	**15,720**	**2,761**
NH	**14,178**	**2,666**
NJ	**93,617**	**18,630**
PA	**105,809**	**23,571**
RI	**14,063**	**2,437**
VA	**70,580**	**14,055**
VT	**2,397**	**506**

Attachment 3 - Number of Energy Efficient Buildings in OTR

State	Number of Energy Star Certified Buildings
CT	65
DC	154
DE	31
MA	200
MD	114
ME	15
NH	66
NJ	120
NY	327
PA	248
RI	36
VA	274
VT	10

Appendix D: EE/RE in SIPs Policy Issues, Memorandum to EPA from NESCAUM on Behalf of the Case Study States, March 27, 2013

NESCAUM
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Northeast States for Coordinated Air Use Management
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Phone 617-259-2000 Fax 617-742-9162
Arthur N. Marin, Executive Director

MEMORANDUM

TO: Julie Rosenberg, U.S. EPA/OAP/CPPD
FROM: Leah Weiss, NESCAUM
DATE: March 27, 2013
RE: Issues Arising from Case Studies Applying and Evaluating EPA's Roadmap to Incorporate Energy Efficiency/Renewable Energy in State Implementation Plans

NESCAUM submits this memorandum on behalf of the states that are developing case studies using EPA's *Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans* (Roadmap). As detailed in our project progress memorandum of January 9, 2013, Massachusetts, New York, and Maryland are assessing how they might include energy efficiency and/or renewable energy (EE/RE) programs in State Implementation Plans (SIPs) using one of the three new pathways presented in the Roadmap.[1] NESCAUM has been leading the project since October, 2012, with additional expertise provided by the Regulatory Assistance Project.

Incorporating EE/RE into SIPs is a high priority for EPA and states. The purpose of this memorandum is to formally articulate concerns and issues that have arisen as the participating states begin using the Roadmap, as well as some recommended solutions. The states have devoted -- and will continue to devote -- significant resources to "road-testing" the Roadmap. They seek assurance that EPA will work to expeditiously resolve the issues raised in this memorandum. This would provide a degree of certainty for states as they develop SIPs, as well as regional consistency as EPA Regional Offices begin evaluating EE/RE-related SIP submittals. It could also foster greater interest for states not currently considering including EE/RE programs in their SIPs.

We are pleased that dialogue with EPA on each of these issues has begun. We understand that EPA is also working to identify its own list of potential policy issues and develop responses. We appreciate EPA's coordinated approach for this project, and look forward to continuing discussions in the coming months with the Office of Atmospheric Programs, the Office of Air Quality Planning and Standards, and the Regional Offices to facilitate in-depth exploration and resolution of these issues.

1. Clarify EPA's expectations regarding the location of emissions reductions associated with EE/RE programs.

There is concern that EPA may be looking for greater specificity about the location of emissions reductions for EE programs than it does for mobile or area source control measures. We

[1] The fourth pathway, innovative and emerging measures, was the basis for EPA's guidance on EE in SIPS, issued in 2004.

understand that this may be an appropriate analytical starting point in some cases, given historical reliance on electric sector modeling that specifies individual plant emissions. However, it is clearly not appropriate in all cases. The states recommend that EPA examine and adopt an approach for addressing the location of EE/RE program emissions reductions that is similar to how area and mobile source programs are treated within SIPs.

EPA does not expect states to specify the exact geographic location of emissions reductions for area or mobile source control measures in SIPs, yet states are responsible for achieving those reductions. The states involved in the Roadmap project intend to demonstrate that analyses using techniques that generalize the location of emissions reductions, similar to those that have been used for mobile source modeling and area source program assessments, are a viable approach for EE/RE programs. This approach balances the need for accountability and flexibility. States are well aware that emissions reductions from EE/RE must be real, permanent, and enforceable, and must occur in locations that contribute to air quality improvements consistent with demonstrating attainment of the NAAQS.

Attributing energy savings and emissions reductions to specific EGUs, as the Roadmap appears to require, is not achievable with any degree of certainty aside from a comprehensive retrospective analysis using an electricity dispatch model. Attributing energy savings and emissions reductions to specific locations or EGUs is even more challenging when considering a portfolio of EE/RE programs implemented across a locality, state, or region. There is also concern that a location-based approach could preclude states and EPA from obtaining the significant benefits of regional EE/RE programs being implemented or considered in some areas.

2. Evaluate and then provide guidance on acceptable applications of MARKAL and other energy models for assessing the benefits of EE/RE programs.

With the advent of the Roadmap, EPA will need to consider the appropriateness of various analytical tools to assess energy programs within the SIP context. The states would like EPA to begin reviewing the Market Allocation (MARKAL) energy model now in order to decide how it may be used as an analytical tool for assessing the benefits of EE/RE programs within the SIP context.

Some states have been working with NE-MARKAL, the northeast version of MARKAL, to quantify potential avoided emissions associated with a suite of EE programs in proof-of-concept exercises, and they have used the results within a broad weight-of-evidence context. For the Roadmap project, the New York State Department of Conservation (NYSDEC) is generating results for statewide EE programs using a calibration of the NE-MARKAL model from a study completed in 2011. NYSDEC does not currently have an ozone attainment SIP requirement, and is thus creating hypothetical SIP documentation for this project. Maryland Department of Environment (MDE) is using NE-MARKAL to quantify potential avoided emissions from a suite of state EE/RE programs. MDE has NE-MARKAL runs from a 2012 analysis that will be available for examination by EPA. It also plans to update the model and generate additional runs for its 2015 Ozone SIP.

The states and EPA regional offices will need guidance on appropriate uses of MARKAL and other analytical tools (e.g., for screening, assessing, and/or quantifying, EE/RE programs). With ozone SIPs due in 2015, it would be helpful for states to have this guidance in the near future. In addition, EPA should explore how it could build upon the current capabilities of MARKAL and similar analytical tools to make them more accessible and/or tailored for representing and/or quantifying state and regional EE/RE programs for SIP purposes.

3. Evaluate an expanded weight-of evidence approach.

The states would like to explore with EPA whether employing an expanded weight-of-evidence approach could allow for SIP crediting under certain conditions, and whether this approach raises any policy concerns within the Agency.

For the Roadmap project, MDE is using an expanded weight-of-evidence approach for assessing and presenting the benefits of EE/RE programs in its SIP. This approach is based on the Ozone Transport Commission's expanded weight-of-evidence approach, outlined in a June 17, 2011 letter to EPA.[2] It builds considerably upon the Roadmap's weight-of-evidence pathway by using traditional air quality modeling coupled with less traditional assessment tools. It also takes a multi-pollutant approach that assesses trade-offs across sectors. The Roadmap specifically states that the weight-of-evidence pathway does not offer SIP credit, but an expanded approach to weight-of-evidence may achieve supportable, quantifiable results. The states request that EPA assess options for and provide guidance on an expanded approach.

4. Clarify the purposes and limitations of EPA's Power Plant Emissions Calculator and Hourly Marginal Emissions Tools and the level of specificity required for SIP purposes.

The states would like EPA to clearly state in the Roadmap and accompanying materials that the Power Plant Emissions Calculator (P-PEC) and the Hourly Marginal Emissions Tool are for planning or screening purposes and not for quantifying programs within a SIP.

The tools seem to imply a level of precision about the location and timing of emissions reductions (i.e., at the EGU and hourly levels) that is not achievable. Moreover, the assumption built into P-PEC that that emissions reductions will always occur within the Emissions & Generation Resource Integrated Database (eGRID) subregion where the EE/RE program is located is problematic, particularly for states that import much of their electricity. In addition, the tools require updates and inputs that might not be possible for states to provide.

[2] Letter to Chet Wayland and Scott Mathias, EPA/OAQPS, from the Ozone Transport Commission. June 17, 2011. See: http://www.otcair.org/upload/Documents/Correspondence/OTC%20Expanded%20Weight-of-Evidence%20Letter%20and%20Recommendation.pdf

For the P-PEC, the documentation states that, without modification by states, the tool is best used for retrospective analysis of EE and solar programs. States would need to make substantial updates to use the tool for forecasting emissions reductions of EE and solar programs. States would need to update the tool's eGRID emission factors (which were last updated in 2012 to include 2009 emissions data), capacity factors, and list of currently operating power plants. Such an effort may make the tool inaccessible to states with limited resources, access to data, and capacity for making such adjustments. We recommend that EPA explore how updates could be made without the burden falling solely on states.

For the Hourly Marginal Emissions Tool, it appears that states must have an understanding of how an EE/RE program is anticipated to affect hourly energy demand. This level of detail would be difficult for many states to achieve with limited resources and capacity, especially when considering portfolios of EE/RE programs that would reduce load at different times of day and in different seasons. We recommend that EPA provide a clearinghouse or reference manual of EE programs and their corresponding estimated impacts on hourly load so that all states could use this tool.

We are concerned that the level of specificity suggested by the Hourly Marginal Emissions Tool could mean that EPA is expecting from states hourly information about energy savings and emissions reductions for SIP quantification purposes. Such a level of specificity exceeds the requirements for other programs, such as mobile or area source control measures in the SIP context. We hope this is not the case, and would like clarification on this. We also recommend that EPA build an application within the tool that provides data at a more SIP-appropriate (e.g., seasonal) level.

5. Provide states with information on the magnitude of EE/RE needed to achieve certain levels of reductions.

The states urge EPA to educate states about the magnitude of EE/RE needed to achieve meaningful emissions reductions. This would include the environmental and economic benefits of a portfolio approach to EE (i.e., a suite of programs) and technical information on energy savings associated with sample EE measures. This would also include the benefits of thermal efficiency programs that target reductions of on-site natural gas and oil use. Accounting for the energy savings and emissions benefits associated with a suite of programs that reduce electricity and heating fuels can be complex, and thus guidance on accounting for a portfolio approach that includes acceptable methods would be helpful in fostering their inclusion in SIPs, as appropriate.