ANALYSIS GROUP
ECONOMIC, FINANCIAL and STRATEGY CONSULTANTS

Crediting Greenhouse Gas Emission Reductions from Energy Efficiency Investments

Recommended Framework for Proposed Guidance on Quantifying Energy Savings and Emission Reductions in Section 111(d) State Plans Implementing the Carbon Pollution Standards for Existing Power Plants

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DISCLAIMER

This is not an official document. This document was prepared for the Environmental Defense Fund by the Analysis Group, and contains a suggested framework for EPA guidance regarding the development of state plans that allow emission reductions resulting from energy efficiency to be used for compliance with Carbon Pollution Standards for Existing Power Plants.

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Foreword

Demand-Side Energy Efficiency as a Vital Tool For Achieving Significant Reductions in Carbon Pollution From the Power Sector

Demand-side energy efficiency (EE) is a vast, widely available, and highly cost-effective mechanism for reducing emissions of carbon dioxide (CO_2) and other harmful pollutants from the power sector – and it is a resource that we cannot afford to overlook as EPA develops historic Carbon Pollution Standards for existing power plants under section 111(d) of the Clean Air Act.

Section 111(d) contemplates a robust partnership between EPA and the states, in which EPA establishes "emission guidelines" for existing power plants reflecting the "best system of emission reduction," and the states develop plans for achieving emission reductions at least equivalent to the emission guidelines. In order to fully mobilize the benefits of EE, EPA will likely need to provide practical guidance to the states on how to rigorously and efficiently account for the climate benefits of EE in state plans implementing and enforcing the carbon pollution standards. Such a framework should be environmentally rigorous, cost-effective, and practical to implement, while also recognizing and building on the considerable progress by state and regional entities to develop sophisticated evaluation, measurement and verification (EM&V) approaches for EE investments. The enclosed document, developed by Analysis Group on behalf of Environmental Defense Fund (EDF), describes one potential approach to such a framework.

The potential for EE to reduce energy demand and avoid CO_2 emissions has been confirmed by a number of authoritative studies. An exhaustive 2009 analysis by McKinsey & Company, for example, analyzed the potential to deploy hundreds of already-available technologies in buildings and industrial processes. This study found that the country's total end-use energy consumption could be reduced by 23% by 2020 relative to a business-as-usual scenario, relying only on measures that pay for themselves over time.[1] Energy savings on this scale would mitigate carbon pollution from the power sector by approximately 700 million tons CO_2-equivalent per year, at an investment cost of just 1.5 cents per kilowatt-hour (kWh) saved.[2] A 2010 report by the National Academy of Sciences reviewed a number of studies of EE in residential and commercial buildings, and similarly found that a 25-30% energy savings for the building sector as a whole could be achieved over the next 20-25 years, at a cost of just 2.7 cents per kWh saved.[3] Neither of these major reports took into account prospects for even deeper savings from whole-building retrofits and advanced building design – indicating that, if anything, these estimates reflect conservative estimates of EE potential.

Many states and utilities have already taken action to realize this enormous opportunity for consumer savings and climate protection. Twenty-six states around the country – including states in the Midwest, Southwest, West Coast, and the Northeast – have adopted energy

[1] Hannah Choi Granade et al., *Unlocking Energy Efficiency in the U.S. Economy* v (2009).
[2] *Id.* at v, vii (converting average measure cost of $4.40/mmBTU to kWh).
[3] America's Energy Future Panel on Energy Efficiency Technologies, *Real Prospects for Energy Efficiency in the United States* 7-8 (2010).

efficiency standards or targets for their utilities. Investment in consumer-funded EE programs increased to nearly $6 billion in 2012, representing a 28% increase in just three years. And incremental electricity savings reported by the states reached 22 million MWh in 2012, equivalent to about 0.6% of retail sales – with 14 states reporting savings of more than 1% of retail sales.[4] A recent report by the Georgetown Climate Center contains numerous case studies of states and utilities that have successfully implemented EE programs to reduce greenhouse gas emissions and save customers money.[5]

As state and regional entities have gained experience with EE programs, the methods used for measuring and verifying energy savings and emission reductions have similarly matured. Over the last two decades, at least fourteen states and several regional transmission organizations (RTOs) and regional partnerships have developed M&V protocols for quantifying energy savings.[6] Reflecting growing confidence in these techniques, verified energy savings are now widely used as the basis for critical regulatory proceedings and market functions, including utility ratemaking[7] and regional forward capacity markets.[8] And although M&V practices continue to vary widely among states and utilities,[9] serious efforts have been undertaken to develop consensus as to best practices and standardized protocols. These initiatives include the Department of Energy's Uniform Methods Project; the International Performance Measurement and Verification Protocol and associated professional certification program; regional technical initiatives such as the Northeast Energy Efficiency Partnership and Pacific Northwest Regional Technical Forum; and the evaluation guides and studies produced by the State and Local Energy Efficiency Action Network (SEE Action).

EPA itself has also undertaken valuable efforts to support the use of EE as a tool for driving emission reductions and improvements in air quality. Most recently, EPA has developed an extensive "Roadmap" providing guidance to the states on how to integrate renewable energy and EE programs into state implementation plans to meet national air quality standards.[10] Several states are now pilot-testing this Roadmap, building on the experiences of other states and air quality regions that have previously incorporated emission reductions from renewable energy and EE into their state implementation plans. EPA is also developing modeling tools to allow for

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[4] American Council for an Energy Efficient Economy (ACEEE), *2013 State Energy Efficiency Scorecard* 19, 27, 30-31 (Nov. 2013).

[5] Georgetown Climate Center, *Reducing Carbon Emissions in the Power Sector* (citing, among other examples, an EE program by National Grid that benefits 1.8 million customers and saves 660,000 tons of CO_2 per year; .

[6] *See* Steven Schiller et al., *National Energy Efficiency Evaluation, Measurement and Verification (EM&V) Standard: Scoping Study of Issues and Implementation Requirements* 51 (State & Local Energy Efficiency Action Network, Apr. 2011).

[7] Thirty states currently have or are implementing a performance incentive rewarding utilities for EE investments. ACEEE, *2013 State Energy Efficiency Scorecard* at 37.

[8] Two major federally-regulated regional transmission organizations (RTOs), PJM Interconnection and the New England Independent System Operator (ISO-NE), allow EE resources to bid on a level playing field with traditional generating resources in specialized markets that ensure the long-term ability of the power grid to meet demand. Moreover, both organizations have adopted manuals for measuring and verifying EE resources with sufficient reliability to be counted as a capacity resource. *See* State & Local Energy Efficiency Action Network, *Energy Efficiency Program Impact Evaluation Guide* 7-5 (Dec. 2012).

[9] *See generally* Mike Messenger et al., *Review of Evaluation, Measurement and Verification Approaches Used to Estimate the Load Impacts and Effectiveness of Energy Efficiency Programs* (Lawrence Berkeley National Laboratory, Apr. 2010); Martin Kushler et al., *A National Survey of State Policies and Practices for the Evaluation of Ratepayer-Funded Energy Efficiency Programs* (ACEEE, Feb. 2012).

[10] EPA, *Roadmap for Incorporation Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans* (July 2012).

detailed projections of power sector emission reductions resulting from EE and renewable energy investments.[11]

Given the demonstrated advantages of EE as a strategy for reducing carbon pollution, EDF believes it is crucial that the Carbon Pollution Standards for existing power plants fully mobilize emission reductions from EE investments. Because of EPA's role in reviewing and approving state plans, EPA guidance on how these plans should account for electricity savings — and emission reductions associated with those savings — will greatly facilitate the utilization of EE as a compliance tool.

The following document, developed by Analysis Group on behalf of EDF, sets forth one potential vision for the structure and content of such guidance. The potential framework below outlines possible approaches to a number of factors, including:

- the respective roles of EPA and the states in quantifying and accounting for energy savings and associated emission reductions;
- basic elements that should be included in state plans;
- tools to assist state regulators in preparing satisfactory state plans, building from successful state M&V protocols that already exist;
- approaches to adjusting or "discounting" energy savings to conservatively account for uncertainty; and
- Options for critical policy design issues such as the timing of crediting emission reductions from EE investments.

The document reflects suggestions and improvements based on extensive outreach to a wide variety of public and private sector experts. We hope this document will serve as a useful resource for policymakers and contribute to ongoing stakeholder discussions on appropriate methods for integrating emission reductions from EE into the Carbon Pollution Standards. Please direct any feedback on this document to Tomás Carbonell or Megan Ceronsky at EDF.

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[11] *See* John Shenot, *Quantifying the Air Quality Impacts of Energy Efficiency Policies and Programs* 4, 6 (Aug. 2013).

Recommended Framework for Proposed Guidance On Quantifying Energy Savings and Emission Reductions in Section 111(d) State Plans Implementing the Carbon Pollution Standards for Existing Power Plants

I. Purpose and Introduction

Investment in end-use energy efficiency (EE) can directly and cost-effectively avoid emissions of CO_2 from power plants by reducing the total generation needed to meet end-use electricity demand. The purpose of this document is to provide a clear and workable pathway by which states can establish satisfactory compliance strategies for the Carbon Pollution Standards for existing electric generating units (EGUs) involving the installation of energy efficiency (EE) measures and programs to avoid CO_2 emissions from the power sector. The approach to energy efficiency measurement and verification (M&V) outlined in this document can help capture the significant potential for EE to contribute to highly cost-effective reductions in CO_2 from the power sector; it also recognizes the wide diversity across the U.S. in EE programs and the measurement and verification of EE savings. This document – loosely structured in the form of a suggested guidance document – establishes the roles of various entities (i.e., the EPA, states, compliance entities,[12] and EE providers), and identifies recommended approaches to the administration of EE compliance activities where a state chooses to take advantage of this opportunity. This guidance assumes that states may allow for compliance through EE investments.

This guidance is focused on:

(1) the development of state plans to allow for the use of EE in compliance;

(2) the responsibilities of compliance entities, EE providers, states, and EPA;

(3) processes to measure and verify energy savings associated with EE investments;

(4) quantification of CO_2 emission reductions associated with EE savings; and

(5) processes to improve upon EE monitoring and verification over time, as EPA and the states gain experience with this program.

This guidance reflects the advanced state of EE M&V approaches that have been implemented in states and organized electricity markets around the country, as well as the diversity of EE programs and M&V approaches that exist today. Consistent with this diverse landscape, this guidance does not mandate a single approach to EE M&V. Instead, it describes multiple pathways by which states can validate EE savings in an environmentally rigorous way (building on existing programs and approaches), and highlights key decision points for states. It also

[12] The term "compliance entities" refers to entities that are subject to CO_2 emission standards or obligations under a section 111(d) state plan implementing the Carbon Pollution Standards.

identifies a consistent and detailed approach to converting validated energy savings to CO_2 emission reductions, using "off-the-shelf" power system modeling tools.

In order to provide a clear picture of responsibilities, the information in the guidance document is organized by functional entity – that is, what are the roles of EPA, states, and others?

Specifically, the guidance is presented in two main sections:

1. *For EPA* – Modeling, calculations, and administrative procedures that would be followed by EPA to:
    a. Establish – and revise over time –minimum monitoring and verification standards and approaches states may adopt to allow emissions avoided through energy efficiency measures or programs to be used for compliance with CO_2 performance standards or control requirements in § 111(d) state plans;
    b. Qualify certain EE measures and programs for automatic assignment of Energy Savings Values (ESV) in kilowatt hours (kWh) saved per measure or program installation; and
    c. Calculate the equivalent Avoided Emission Rate (AER) in pounds (lbs.) of CO_2 reduced per kWh of energy saved in a given year from specific categories of measures and programs in specific states or regions.
2. *For states that choose EE as a compliance option* – minimum requirements in state plans related to (a) state actions, activities and resources related to administration of state plans that include EE as a compliance option, and (b) M&V requirements and pathways to be included in such plans, and be followed by entities using EE for compliance. These requirements are designed to:
    a. Ensure state adoption of energy savings values and avoided emission rates established by EPA;
    b. Specify the state's selected approach(es) to M&V, and associated M&V obligations for compliance entities and EE service providers within the state;
    c. Require commitment of sufficient resources for the primary implementing agency, in terms of personnel and/or revenues to ensure reliable administration and oversight of state M&V requirements;
    d. Identify procedures for periodic review and revision of M&V requirements to reflect changes in EPA guidance and evolution of state experience and expertise in oversight of EE M&V programs; and
    e. Establish filing and reporting requirements related (prospectively) to the filing of M&V plans, and (retrospectively) M&V reports confirming installations and documenting savings outcomes as measured and verified through approved M&V activities.

EPA and state requirements and procedures in this guidance allow for state and regional flexibility, and provide for a graduated evolution of M&V standards by:

1. Allowing for the energy savings and associated avoided CO_2 emissions from EE programs to be used to meet CO_2 compliance obligations, with adjustments to savings as needed and appropriate to reflect the degree of certainty associated with measurement and verification approaches and results;
2. Providing states the flexibility to choose from a range of approaches to M&V program requirements reflecting the diversity of experience with EE and M&V across states; and

3. Supporting an on-going forum to collect and disseminate (and, where appropriate, update this guidance to reflect) best-practice approaches to energy efficiency M&V that may be adopted in state plans over time.

The framework outlined in this guidance will be potentially useful for any state plan that relies on EE as a resource for achieving equivalency with EPA's emission guidelines, and that requires an administrative mechanism for explicitly quantifying EE-related emission reductions. This framework has clear applicability to state plans that establish a target emission rate for existing fossil fuel-fired power plants, and that seek to "credit" emission reductions from EE towards compliance with that emission rate. States that implement other types of emission reduction policies, such as state-wide emissions trading programs, may also find that this framework is useful in administering EE incentive programs or for crediting EE-related emission reductions that take place in other jurisdictions but are attributable to EE investments within the state.

The sections that follow (1) provide an overview of the context for this guidance; (2) describe the regulatory structure for allowance of EE as a CO_2 compliance option, and for its evolution over time; (3) describe the procedures and approach by which EPA could calculate the avoided emission rates for categories of EE measures and programs, and establish energy savings values for certain programs and measures that qualify for the assignment of prospectively-certified "deemed" savings, and (4) set forth the suggested initial guidance on approaches to state and compliance entity M&V efforts in order for states to include EE as a compliance mechanism in state plans for addressing the CO_2 emissions of existing EGUs.

II Overview and Regulatory Structure

Context

EPA is establishing standards for emissions of greenhouse gases (GHG) from new, modified and existing EGUs in the U.S. under Section 111(b) and (d) of the Clean Air Act (CAA). With respect to the application of Section 111(d), EPA will issue guidance to states identifying the emission reductions that must be secured by state standards and compliance options for implementation of standards for existing EGUs. States, in turn, will have a degree of flexibility to establish state plans that implement the standards through a number of compliance approaches and mechanisms.

Investment in energy efficiency to achieve reductions in power sector emissions is one means by which cost-effective emission reductions could be secured under Section 111(d) Carbon Pollution Standards for existing power plants.[13] This guidance is intended to set minimum expectations for, and support development of, satisfactory state plans that include EE as a compliance mechanism and that incorporate project or program-specific quantification of EE impacts on emissions.[14] As discussed elsewhere in this document, some types of state plans (such as state-wide emissions trading programs) may not require such project or program-specific quantifications.

Regulatory Structure

The purpose of this guidance is to identify mechanisms by which states can verify reduced energy use and associated avoided emissions from EE investments, in order to allow the avoided emissions to be used to demonstrate compliance with the Carbon Pollution Standards – either as tradable instruments or in some other manner provided by the state plan. The implementation of such a mechanism to establish proof of EE for compliance will require a process for determining energy saved through EE investments, and the emissions avoided per unit of energy saved.

This section outlines the structure of this process, including (a) guidance development and emissions modeling by EPA, (b) state plan development and compliance demonstration, and EE M&V oversight and certification by states, and (c) the development, implementation, and/or reporting of M&V plans and outcomes by compliance entities, third party providers of EE services, or others involved in EE administration. This section provides an overview of the potential responsibilities, actions and reporting requirements of the entities involved.

<u>Potential EPA Responsibilities and Associated Timelines</u>

EPA would have the responsibility to approve provisions of state plans that allow for EE to be used as a compliance tool with respect to CO_2 requirements on EGUs. Specifically, for each state

[13] EE is not the only option states will have to achieve compliance; while there may be other approaches proposed by states, stakeholders, and/or EPA (e.g., emission trading), this paper is focused only on EE as a compliance option.

[14] In this guidance document, the term "energy efficiency" refers to reduction in *end-use* electricity demand due to the implementation of programs and installation of measures in residential, commercial, or industrial facilities.

that wishes to include EE as a compliance option, it will need to adopt or propose an EE M&V process consistent with this guidance, or in any revised guidance issued by EPA over time. While this initial guidance may be sufficiently robust to ensure that EE savings, and associated emission reductions, are at least equivalent to obtaining specific stack-based reductions in emissions, it must be recognized that the measurement and verification of EE savings will continue to evolve over time as more states gain experience and EE programs and measures expand. Consequently, in addition to providing foundational guidance, EPA should support the continued development of M&V best practices over time. The process for fostering evolution of EE M&V practices is set forth in Appendix A.

EPA Determination of Programs or Measures that Qualify for the Application of Deemed Savings Values, and the Assignment of Load Reduction Profiles to Categories of EE Programs and Measures

There are at least two categories of savings measurement and characterization where deep experience with EE M&V over time provides valuable information to simplify and lower the costs associated with demonstrating EE savings and associated emission reductions. These are (1) the development of "deemed savings" values or calculation methods,[15] and (2) load reduction profiles for specific EE measures, programs, or program categories. EPA can also identify areas where recent historical M&V data and information on deemed savings and the load reduction profiles of EE programs may be relied upon in the M&V plans of compliance entities, and in the state plans for states that allow EE as a compliance option.

As the experience with measurement and verification of EE savings grows in many states and regions, so too does the confidence in the level of savings that result from certain EE measures or programs. For some EE measures or programs where the overall level of savings per installation is well known or has been established to a relatively high degree of certainty through past implementation, measurement and verification, and/or where adjustments are applied to address any residual uncertainty, state plans may be able to rely on "deemed savings" methods for savings calculations. Deemed savings methods have been developed, and continue to be developed, by a number of regional M&V efforts, states and M&V practitioners, and often already incorporate adjustment of assumed savings to address uncertainties in measurement or verification. Relying on such deemed savings where they are sufficiently robust can minimize program costs and efforts while providing the level of assurance needed as a basis for compliance demonstrations. The use of deemed savings does not eliminate the need for M&V plans that verify and measure, for example, the number of measures installed; it can, however, simplify the level of measurement and sampling efforts required in quantifying energy savings from a given number of installations.

Similarly, state-required M&V processes and regional efforts to characterize the level and nature of EE savings have begun to develop ever more granular representations of not just *how much* energy is saved from various categories of EE programs, but also *when* it is saved. For example, EE programs to replace air conditioners with more efficient models experience the vast majority of savings during the summer, and during the day. Lighting programs, in turn, generate more savings in the evenings (which are longer in the winter). Load reduction profiles identify the time

[15] Deemed savings values are stipulated levels of energy savings for commonly-implemented EE measures, based on historical data; deemed calculation methods are standardized algorithms that require basic location-specific inputs (such as climate information) to yield a stipulated savings value. For simplicity, this guidance refers to both methods as "deemed savings."

(time of day, day of week, and season) during which EE measures reduce electricity usage, and can therefore be combined with commonly-used power system dispatch modeling to identify which plants are on the margin at that times that EE savings accrue, and therefore what emissions will be avoided by reducing load through EE. The matching of "when" savings occur with reduced generation by specific power plants (that is, those plants that are "on the margin") is a critical element of quantifying reductions; but one that can be accomplished using well-tested power system modeling tools. In short, while M&V programs must measure the total annual *quantity* of energy saved, it is important to also identify *when* savings occur, in order to precisely capture the emission reduction impact associated with programs savings. The concept of load reduction profiles and their link to power system dispatch modeling is summarized in more detail in Appendix B.

EPA could serve as a national clearinghouse for those EE measures for which deemed savings may be used for compliance, and for reviewing load reduction profiles to be used in modeling emission reductions. In serving these functions, EPA could simplify the process compliance entities and third-party EE providers follow to document savings, and the M&V requirements required by states. In addition, EPA collection of load reduction profile data is essential to modeling of CO_2 reductions for EE programs, as described below. For this purpose, EPA could initially recognize load reduction profiles that distinguish broadly among relevant segments of time – such as impacts on weekday/weekend load, peak/off-peak times of day, and winter/summer load. These simplified "load buckets" are adequate for making conservative estimates of EE-related emission reductions, although EPA should to collect more granular load reduction profile data where and when that information is available.

In developing or reviewing these data, EPA could rely as much as possible on existing state and regional deemed savings and load reduction profile data, but may also need to supplement this with additional review and analysis. In this sense, the deemed savings and load reduction profiles results will vary not just by program or measure type, but also by region. EPA could develop its initial set of load reduction profiles as part of its initial modeling effort, and develop the initial set of deemed savings estimates by the end of the first program year. Both deemed savings and load reduction profile information should be updated on an annual basis.

With respect to load reduction profiles, states will need to identify a process for identifying the appropriate load reduction profile to apply for a given EE program or measure. Where EPA has not yet established a load reduction profile for a specific measure, or the measure as implemented in a specific state would generate a different load reduction profile than the one established by EPA,[16] a state could propose a load reduction profile (with supporting documentation) as a part of the state plan or a subsequent filing.

EPA Modeling of Equivalent Avoided Emission Rates

In order to use EE to comply with a state's requirements for reductions in emissions of CO_2 at existing EGUs, either regulated EGUs or (if a state so allows) independent third-party EE providers will need to cause the installation of EE measures or programs, and measure/verify the energy savings that result from such installations. The final step is the translation of energy savings (in MWh) from specific EE programs into CO_2 reduced (in lbs) over time as a result of such installations. Doing this requires program- or measure-specific *equivalent avoided emission*

[16] For example, whole-building retrofits or retrocommissioning projects may require collection of metered data in order to establish a load reduction profile.

rates, expressed in units of pounds of CO_2 reduced per MWh saved for assumed or asserted program/measure load reduction profiles. These numbers (so-called "avoided emission rates" or "AERs") should be calculated annually by EPA using power system dispatch modeling, and measure- or program-based LRPs.

AERs should be generated annually by EPA, based on hourly marginal emission rates using power system dispatch modeling, and will vary along a number of dimensions:

- AERs will *vary by region, state,* or service territory, with the relevant regions defined by appropriate power system boundaries. For example, regions such as New England have clearly-defined power system boundaries, fluid wholesale markets, and coordinated generating resource dispatch operations. Consequently, the emissions reduced by one MWh saved at a given point in time will likely be similar regardless of where an EE investment takes place within the region. Consequently, states in such regions will likely have the same or similar AERs for the same program/measure categories. In other parts of the country with different resource mixes and power system constraints, a different set of AERs would apply.
- AERs will *vary by EE program category*, depending on the each category's load reduction profile (discussed above). For example, the emissions avoided per MWh saved by an EE program whose savings accrue primarily on summer weekdays will be different than those whose savings accrue primarily on winter nights. This is because the generating units operating on the margin differ between these two scenarios: On a winter night in a given region the power plant operating on the margin, whose output is reduced due to efficiency savings, might be an efficient natural gas-fired, combine cycle facility. On a summer afternoon, the marginal unit in the same power region might be an inefficient oil-fired steam turbine. The emission rates of these two units can be very different, and so the rate at which emissions of CO_2 are reduced by EE program savings at these times can differ significantly. The load reduction profile of an EE program or measure will be used in conjunction with the power plant dispatch model to determine the appropriate AER reflecting the timing of savings.
- Finally, AERs will *vary over time,* as a function of changing energy and peak load levels, generating resource addition and attrition, and underlying market fundamentals (e.g., fuel prices) that affect power plant dispatch outcomes in each region. For this reason, EPA should annually run a power system dispatch model, using updated load reduction profiles to the extent available, to update regional- and program-category AERs.

It is possible to model the AERs for EE measures and programs with various levels of granularity. The most precise characterization of emissions avoided would be through an hourly representation of energy savings in combination with hourly power system dispatch. The least precise representation would be to simply use annual average power system emission rates and EE program savings. Taking the latter approach almost certainly misses very important differences associated with the daily and seasonal variations in accrual of EE savings and marginal power system emission rates. However, in many states and regions, and for many EE programs and measures, LRPs have not been developed on an hourly basis. Nevertheless, as noted above, information at a medium level of granularity – i.e., representation of the portion of savings that accrue seasonally, day/night, on/off peak, weekday/weekend – can be translated into hourly savings representations for integration into dispatch models as needed.

EPA would be responsible for conducting (or contracting for) power system modeling, and developing and incorporating in the dispatch modeling the LRPs for categories of EE programs to the greatest level of resolution feasible each year. This will involve the following steps:

- Annually reviewing LRPs for categories of EE measures and programs, and updating them to the extent that new information suggests adding new or changing existing LRPs. The basis for LRPs will be existing measurement and verification results from EE programs, as collected and published – or proposed – by states and/or regional entities;
- Annually conducting power system dispatch modeling to establish AERs for each relevant region, using the best (i.e., most granular) representation of LRPs for categories of EE measures and programs;
- Annually publishing the AERs by region and program category; and
- Identifying areas to review for improving LRP and AER modeling in the coming year. EPA should convene and seek the assistance of a technical support group as needed to help review and update LRPs, and for vetting input assumptions for the power system dispatch model.

Administrative Responsibilities of States and Compliance Entities

State Oversight Function

States will have the primary responsibility for administration of state plans, subject to EPA guidance, review, and approval. State oversight of EE as a compliance option and the form and adequacy of EE M&V programs flow from a number of decisions and program design elements:

- In the context of CO_2 performance standards on existing EGUs, states will have the option, but will not be required, to include as a compliance mechanism investment in or administration of EE measures and programs. If a state chooses to include EE as a compliance mechanism, it will need to meet certain administrative, substantive, and reporting requirements consistent with this guidance, and any additional EPA requirements related to EE as a compliance mechanism.
- Specifically, states will need to ensure that sufficient resources are committed to be able to effectively and reliably administer a plan allowing for EE as a compliance mechanism.
- States may also need to establish new authorities through order, rule or legislation if needed to administer the program, oversee M&V efforts by entities that participate in the EE program, and/or establish formal agreements with the state's Public Utilities Commission (PUC).

Establishing and Updating State Plans

This Guidance document contains a number of pathways and options for states to establish EE as a compliance option in the context of CO_2 controls on existing EGUs. Prior to the first compliance year, any state that chooses to adopt EE as a compliance option will need to take a number of steps related to development and approval of the state plan, and will need to include specific provisions and/or select specific options related to the EE M&V compliance approach, as described further below. Elements that will need to be incorporated in state plans could include:

- adopt initial EE M&V requirements that provide at least the level of confidence/certainty in energy savings results as those set forth in this guidance;
- establish the process/procedures the state will follow to set forth new requirements for EE M&V over time (e.g., as EPA revises the content of this guidance, or otherwise as new information emerges on the implementation of EE in the state);
- adopt EPA determinations made related to the AERs to be applied to categories of programs implemented within the state;

- present the required content of EE M&V plans and reports that must be filed for EE compliance measures, and outline the state process for certifying energy savings and avoided CO_2 emissions. The plan will also need to detail the obligations of compliance entities or third party EE providers with respect to EE implementation and M&V, filing requirements, and the consequences of failing to meet the plan's EE M&V requirements; and
- identify and describe possible pathway(s) for monitoring and verification plans and reports, as detailed in the next section.

III Elements of Energy Efficiency Monitoring and Verification Approaches

Overview

This guidance presents basic elements of a satisfactory state plan for a state that elects to use EE as a compliance mechanism to meet EPA's CO_2 performance standards for existing power plants. The provisions contained herein are designed to be tailored to a wide variety of M&V approaches that may be taken by states, while building the necessary data, experience and expertise over time to allow for continued refinement of EE programs and M&V approaches.

The standards presented in this guidance are meant to be *minimum* requirements. State requirements for EE as a compliance option can exceed those contained in this guidance – meaning a state may require more detailed or more comprehensive approaches to M&V in order for EE to be used for compliance within its state. Whether or not state provisions related to EE M&V are sufficient will be determined as part of EPA's review of filed state plans.

The next two sections present minimum EE M&V standards. The first section presents elements or requirements that should be included in all state plans, regardless of the specific M&V approach proposed by the state. The second section describes three broad types of M&V approaches, or "pathways," that may be incorporated into a state plan. These pathways are not mutually exclusive, meaning that a state plan may recognize any or all of these pathways as acceptable approaches to M&V. For each pathway, this guidance specifies basic elements that must be included in state plans, as well as factors to consider with respect to adjusting energy savings to account for uncertainty.

Common Elements

Compliance Demonstration Requirement and Associated Filings

The premise of allowing investment in EE as a compliance option is that it reduces the need for generation within the state or region in question, and so reduces power sector emissions of CO_2. States will require demonstration of compliance with the performance standard in consideration of actual and estimated data, through prospective and retrospective filings with the state agency responsible for implementing the Carbon Pollution Standards. These elements are discussed in the sections that follow.

Compliance Demonstration

This guidance contemplates that states will issue or generate a credit, in tons of avoided CO_2, for emission reductions achieved through installation of EE measures or programs. If the state so chooses, such credits can take the form of tradable instruments that can be issued directly to the entity responsible for the EE measures, and can be bought and sold by compliance entities or third parties. Compliance entities can claim such credits directly (through utility-sponsored investments in EE, for example), or can obtain the credits from other compliance entities or third parties, as provided for in the state plan.

For states that adopt a rate-based emission standard (in lb/MWh) for existing EGUs, these credits can be subtracted from stack emissions of CO_2 to represent an *equivalent* level of emissions from the CE's facility. If a compliance entity wishes to fully meet its CO_2 reduction obligations through EE investments, it will need to cause the installation of EE measures and programs (or purchase credits) in sufficient quantities meet the program's performance standard. Thus, the compliance entity will need to consider its annual level of energy output (MWh), the total MWh of demand reduced through EE measures and programs, and the AERs associated with EE measures and programs.

State plans that adopt different policy mechanisms for achieving carbon pollution reductions – such as state-wide emission caps or "portfolios" of existing policies – may find different ways to use the crediting approach outlined in this guidance. For example, states that have adopted emissions trading programs may create "set-asides" of allowances to incentivize EE investments, as was authorized under previous Clean Air Act emissions trading programs. In such states, the crediting mechanism outlined here may be a useful basis for allocating those set-aside allowances. In addition, states that seek credit for emission reductions that take place in other states as a result of their EE investments may find this framework to be a useful mechanism for quantifying such credit.

The total credits awarded for a given program or measure will be based on energy savings, adjusted to account for uncertainty associated with the selected measurement and verification approach. However, there are a number of factors to be considered in quantifying energy savings, related to where and when EE savings can accrue to the benefit of compliance entities.

Timing

The first relates to the *timing* of recognition of energy savings from the installation of EE measures and programs. This is an important element of the compliance demonstration because EE measures and programs installed in one year continue to generate savings in subsequent years.

EPA's default approach for crediting the accrual of energy savings over time seeks to balance several objectives, including: (a) providing compliance entities or third party providers of EE services with a degree of certainty at the time the EE investment decision is made with respect to the value of EE investments from a compliance perspective; (b) recognizing investments in long-lived EE measures that generate substantial energy savings over time, while avoiding "over-crediting"; and (c) simplifying program administration.

Recognizing these objectives, the default approach reflects several key premises. First, in order to provide greater compliance certainty, credit for reductions in CO_2 over the lifetime of a measure or program will be taken in the year that the installation happens. Second, to ensure environmental rigor, the assumed lifetime of savings from measure or program installations should be truncated over a time period that falls short of actual expected lifetimes to reflect a number of significant uncertainties, including (a) increasing uncertainty in the level and persistence of savings over time, and (b) the increasing degree of uncertainty in the AER values assigned to estimate CO_2 reductions associated with future savings, given the wide array of assumptions that go into modeling power system dispatch and customer usage.

In consideration of these items, the calculation of energy savings for the purpose of compliance shall have the following timing elements

- Estimated and measured savings from measure and program installations shall be represented as an *annual average* savings based on the M&V approach selected for compliance, over the expected life of the measure or program.
- The initial period for crediting of EE savings shall be truncated at 5 years; that is, total energy savings from the installations for the purpose of compliance demonstration shall equal five times the annual average savings.
- This total energy savings credit from EE installations shall be multiplied by the EPA AER for the relevant program category to arrive at a total CO_2 emission reduction applied for compliance in the year of installation.
- If the state plan so provides, a compliance entity or third party EE provider may seek to renew the crediting period for a long-lived measure or program after the initial five-year period has elapsed. Renewal of crediting is contingent on the compliance entity or third party EE provider evaluating the persistence of savings from the measure or program, using an accepted protocol for assessing persistence that is documented in the compliance entity or third party EE provider's M&V plan. State plans that allow renewal of crediting periods should include provisions ensuring that energy savings are not credited for a period or quantity that exceeds the reasonable expected level of savings and lifetime of a given measure or program.

Location

A second key design element relates to *where* a CE or third party EE provider may undertake to install EE measures or programs. In order to simplify administration of EE crediting and assure adequate state oversight, each state plan submitted pursuant to this guidance must ensure that credit for emissions avoided through EE is awarded only to EE measures and programs undertaken *within that state.* A state plan may not provide for crediting of avoided emissions for EE programs and measures undertaken in other states. As experience is gained with this program and systems for tracking the crediting of avoided CO_2 emissions are developed, EPA should review and consider the possibility of expanding the geography of acceptable EE investments.

Baselines

Energy savings are measured relative to a counterfactual "baseline" scenario under which the EE measure or program was not undertaken. As a result, determining the baseline level of energy demand is a key factor in quantifying energy savings. Current practices with regards to baselines vary among states and utilities. Some programs establish baselines with reference to applicable building codes or appliance standards; others use baselines reflecting "common practice" or historical energy consumption; and some use large-scale statistical analyses to compare energy demand among program participants to that of a control group.

This guidance acknowledges this diversity of practice and recognizes that appropriate baselines may vary depending on the type of project or program. State plans that incorporate EE should be explicit regarding the choice of baseline that will be used for the various M&V approaches reflected in the state plan, and provide a reasoned basis for any baselines that do not reflect generally appropriate approaches. For projects involving new construction or upgrades in building systems or appliances that have reached end-of-life, it is generally appropriate to use the more stringent of common practice or applicable codes/standards. By contrast, historical energy

consumption may be appropriate as a baseline for projects that involve accelerated replacements or upgrades of equipment and facilities that are not yet at the end of their useful lives.

Recommended Compliance Filings

Credit for avoided emissions from EE measures and programs must be certified by the state agency responsible for implementing the Carbon Pollution Standards. Any entity wishing to receive certification of avoided emission credits will need to make two annual EE filings with the state. The first is the filing of an EE Compliance Plan, the second is the EE Compliance Demonstration. The recommended contents of each are described below:

Energy Efficiency M&V Compliance Plan (filed prospectively)

- An overview of the approach to achieving avoided emissions through energy efficiency programs or measures;
- Description of specific measures and programs that are expected to be implemented, and a projection of the quantity to be installed;
- If applicable, an identification of the energy efficiency services company(ies) that will carry out EE installations, or a description of the process by which the company will select EE vendors
- Expected energy savings to result from EE installations;
- Adjustment of EE savings based on the M&V approach used and the state's assigned discount factors; and
- Complete EE M&V plan consistent with the M&V requirements of the state plan, including specific approach(es) taken.

Energy Efficiency M&V Compliance Demonstration (filed retrospectively)

- A report comprehensively documenting savings based on implementation of the approved M&V plan;
- Description of any modifications to program implementation (i.e., measures or programs installed, numbers of installations, etc.) relative to that specified in the compliance plan;
- If applicable, a description of variations between expected and realized savings on a program-by-program basis
- If applicable, identification of the energy efficiency services company(ies) that carried out installations, and any differences between expected and actual energy service companies used
- Adjustment of actual EE savings based on the M&V approach used and the state's approved adjustment factors

Adjusting Energy Savings to Account for Uncertainty

As discussed earlier in this guidance, there is a diversity of approaches to EE across the states in general, as well as approaches to measurement and verification of savings resulting from EE investments. In addition, there are states and regions that are actively working towards common standards and approaches to M&V. However, it is not possible at this time to point to a single set of M&V approaches that can easily or appropriately be applied consistently across all states. Part of this is due to the fact that EE M&V continues to evolve rapidly and change as investment in EE expands, and part of it simply reflects the wide variation across states and regions in power system and EE customer characteristics, electric load shapes, weather, and other factors.

While this level of uncertainty and variation exists, it is also clear that there is a substantial body of knowledge, history and data to support measurement and verification of EE savings with a high degree of confidence, provided uncertainty is taken into account in the process of measuring and verifying savings. Our inclusion of EE as a compliance mechanism reflects this deep and diverse set of experience, and the confidence that investment delivers quantifiable savings and real reductions in emissions of CO_2.

In the next section we present three broad pathways for M&V of EE programs and measures that states may allow CEs and third party EE providers to use in compliance plans and demonstrations. States may choose to allow one or more of these pathways for demonstration of EE savings, or may propose an alternative M&V approach that is consistent with the state's ongoing measurement and verification of existing EE programs. Regardless of the pathway(s) selected, states will be expected to specifically evaluate the robustness of the M&V approach(es) allowed, and in consideration of this apply appropriate adjustments to ensure a high degree of confidence that actual energy savings at least meet the value certified for compliance. EPA understands that in many cases such adjustments are already included in deemed savings values or calculations, or in evaluations carried out by utility regulators.

Where data is available, states could allow the use of statistical methods to determine the degree of uncertainty associated with a given program or measure. Whether or not statistical methods are used, each state shall assess and describe in its proposed state plan how it determined an appropriate adjustment factor. Relevant criteria that should be discussed in making this assessment include:

- The amount of time and number of programs across states for which the M&V approach has been used;
- Historical evaluations of the statistical certainty around savings estimates generated using the M&V approach;
- The degree of consistency in results generated using the M&V method in question;
- Whether the program whose savings are being measured generally involves the same or similar measures installed in each location, or site-specific determinations of a variety of end-use efficiency measures;
- The degree to which the M&V approach involves or has involved site-specific measurement of key parameters, as opposed to relying only on engineering estimates;
- Assessments by state, regional or national agencies, collaboratives and/or organizations about the degree of certainty associated with savings measured using the approach;

- Whether the M&V approach is subject to regulation by a public utilities commission or similar entity that evaluates measured energy savings for the purpose of establishing rates or otherwise compensating a regulated utility.

The examples above are provided for illustration only; states may consider other factors when evaluating to what extent to adjust EE savings measured and verified using a particular approach.

If a state plan does not provide an adjustment factor for uncertainty, or does not provide a reasoned basis for such a factor, EPA should consider applying a default adjustment factor based on the average degree of uncertainty observed in similar EE programs in other states.

Measurement and Verification Approaches

The following are three pathways states may adopt for the quantification of EE measure/program savings for the purpose of compliance demonstrations. In its plan, a state may determine that all compliance entities and third party EE providers within the state shall use one of the three approaches presented below; allow a compliance entity; to choose from among the pathways at the time it files its compliance plan; or choose an allowed approach for specific measures. Also, as noted above, states may propose alternative pathways for EE M&V at the time they file state plans.

As noted in the previous section, compliance entities are required prospectively to file, among other things, a complete M&V Plan consistent with the approach(es) selected and to file prospectively a complete M&V Report documenting measured savings. Consequently, the outlines of approaches presented herein are high-level concepts that would be used by states in setting the appropriate level of detail for review of compliance plans contained in their state plans.

1. Deemed Savings Pathway

In the Deemed Savings pathway, CEs and third party EE providers would be required to measure and verify the EE measure/program installations, but would rely on deemed savings values or calculation methods for quantifying program savings for compliance demonstrations. Consequently, for this M&V approach the measures and programs that may be funded by compliance entities and third party EE providers will be limited to those for which states have proposed, and EPA has approved, deemed savings values or calculation methods based on historical measurement and verification of energy efficiency programs. EPA should require that states demonstrate the reliability of proposed deemed savings values through presentation of evidence on the consistency and longevity of M&V results leading to deemed savings values. Other factors related to the Deemed Savings approach include the following:

- EPA should only establish deemed savings for programs or measures for which there is substantial and comprehensive historical data and information on the savings that result from such programs or measures.
- Approved deemed savings may rely on state and/or regional deemed savings databases that have been developed for long-standing EE programs, or otherwise on information available in EE literature.
- States that choose to rely on deemed savings shall not otherwise need to conduct separate measurement or verification of the savings associated with each measure.

- However, entities will need to fully document and quantify the installation of measures or programs, in terms of numbers of locations, numbers of measures installed, and related information.
- States should propose adjustments for energy savings associated with measures or programs relying on the Deemed Savings approach where uncertainty in energy savings is not already fully addressed (for example, if the deemed savings values are based on engineering estimates only, and not already adjusted for factors affecting the realization of savings post-installation).

2. PUC-Based Pathway

The PUC-Based Pathway recognizes that certain long-standing, PUC-overseen EE programs reflect unique combinations of M&V approaches. In the PUC-Based Savings approach, states would accept savings demonstrated through mandated M&V filings with the state's public utility commission for the purpose of approving rate recovery or otherwise compensating the regulated utility, with appropriate adjustments to address any residual uncertainty. Entities would be required to measure and verify EE measure/program installations, and would rely on PUC-approved savings values as the basis for estimating program savings for compliance demonstrations. Consequently, for this M&V approach, the entities that may apply for certification of avoided emissions would be limited to those for which the state's PUC has accepted responsibility for M&V evaluation. Other factors related to the PUC-Based Savings approach include the following:

- In order for a state to include the PUC-Based option in its state plan, it must file for EPA review a detailed description of the PUC M&V requirements and review process. Although the content of these filings will vary according to the needs of each state program, general attributes of a satisfactory state plan in this regard include:
    - Transparency and opportunity for public comment with respect to key M&V methods and assumptions;
    - M&V methods and assumptions correspond to generally-accepted approaches (i.e., rigorous deemed savings values or calculation methods; IPMVP, DOE Uniform Methods Project; or other documented practice)
    - Use of independent third parties to carry out key M&V and evaluation functions;
    - State approval or oversight of EE evaluations;
    - Transparent assessments of uncertainty surrounding evaluation results;
    - Description of QA/QC procedures;
    - Periodic use of field techniques (sampling, control trials, etc.) to validate evaluation results and improve M&V assumptions and methods on a prospective basis.
- The state plan must include provisions to ensure that the PUC-based measured savings are adjusted to address any residual uncertainty and incorporate only measures that are consistent with EPA's emission guidelines and other section 111(d) guidance.
- For certification through the PUC option, entities will need to file with the state implementing agency their M&V filing, and documentation of PUC review and approval. State implementation agencies must review such information and apply EPA-approved adjustments to account for uncertainty, and would be responsible to coordinate with the PUC to the extent necessary and appropriate.

- While state PUCs typically only review EE M&V efforts for regulated investor-owned utilities subject to PUC jurisdiction, states may choose to expand such review for the purposes of this program. The state plan would need to include an explanation of how entities not otherwise subject to PUC jurisdiction would be included for review of M&V programs by the PUC.
- The state agency implementing the Carbon Pollution Standards may consider entering into a memorandum of understanding (MOU) with the PUCs to ensure coordination on M&V data and information filings.

3. Tailored M&V Pathway

In the Tailored M&V approach, compliance entities or EE providers would be required to establish and implement a comprehensive M&V plan representative of national best-practices M&V approaches or other approaches appropriately adjusted to address residual uncertainty, that meet EPA-prescribed minimum standards, and is subject to the review and approval of the state agency implementing the Carbon Pollution Standards. Other factors related to the Tailored M&V approach include the following:

- EPA minimum standards for the Tailored approach shall rely on best-practice M&V standards required by PUCs in jurisdictions that have required comprehensive M&V of EE programs for rate recovery purposes for at least 10 years. Where applicable, EPA should require that states choosing the Tailored M&V Pathway apply the standards and protocols developed under the Department of Energy's Uniform Methods Project for measurement and valuation of EE savings.
- In its review of state plans adopting the Tailored M&V Pathway for one or more measures, EPA should consider factors such as the level of detail in the M&V approach, the level of state resources, expertise and administrative oversight of compliance plans, and how the M&V plan compares to best-practice M&V approaches in use at the time of the filing.
- There will be no limit on the types of programs or measures that may qualify under the Tailored M&V Pathway, provided M&V of such savings is consistent with EPA minimum standards.
- For certification through the Tailored M&V option, entities would need to file with the state implementing agency for review and approval their M&V Plan, supporting information and data, and M&V Reports presenting full M&V results. State implementing agencies must fully review and approve M&V results before certifying credit for emission reductions.
- Energy savings associated with measures or programs relying on the Tailored M&V approach must be adjusted by the state to address any residual uncertainty in the ES; however, where states adopting the Tailored M&V Pathway utilize established best practices, it is expected that there will be minimal further adjustment of savings;
- ***ALTERNATIVE TO THE UMP REQUIREMENT – Include a set of minimum contents/standards as follows*:** Where an applicable UMP protocol is not available, at a minimum, a state plan should include a description of at least the following measurement issues and approaches required to be included in entities' M&V plans:
    - Describe energy efficiency measure or program including target customer class (examples could include but are not limited to residential customers, commercial & industrial customers, low-income customers, all/cross sector programs,

retrofit-focused programs, new construction-focused programs and multifamily-focused programs) and a description of the target energy efficiency measures included in the program (examples could include but are not limited to HVAC, lighting, refrigeration, process, hot water, and behavior-based programs)

- Apply an appropriate baseline level of energy consumption that will be used to quantify energy savings
- Specify the specific measures installed, by proportion of program (examples could include but are not limited to CFLs, lighting systems, smart strips, refrigerators, freezers, appliance removal, programmable thermostats, energy management systems, central air conditioning, furnace fan motors, dehumidifiers, electric/oil weatherization, and variable frequency drives)
- Estimate and report both annual and lifetime gross and net measure impacts using accepted algorithms that consider the following adjustments
    - Gross measure impacts must specify what adjustments have been factored in, including but not limited to the following: summer and winter peak demand coincidence factors; Peak/off-peak daily demand coincidence factors; measure persistence; savings persistence; in-service rates; data errors; interactive effects; and any other applicable adjustment factored in
    - Net measure impacts must specify what adjustments to gross impacts have been factored in, including but not limited to the following: free ridership rate; participant spillover, non-participant spillover, and any other applicable adjustment factored in
- Conduct post-installation M&V audit. An independent evaluator must certify energy savings and impacts reported by the compliance entity or EE provider. The following minimum steps must be taken by the independent evaluator for each offered program:
    - Review a sample of completed projects, including conducting on-site M&V activities (which may include site visits, remote measurement, surveys, or other appropriate techniques).
    - Verify that each measure reported installed was installed correctly and is performing as expected.
    - Measure actual energy reductions due to each measure using data loggers and/or meter deployment as appropriate.
    - Calculate a realization rate (the ratio of evaluator-to-compliance entity reported energy savings) based on the results of data obtained.
    - Use the realization rate to adjust the compliance entity estimated savings for all completed projects in that program.
- Analysis of residual uncertainty – if any – in energy saving and commensurate level of discounting to address the uncertainty
- Use results of M&V to refine future estimates of program impacts. In situations where a compliance entity offers identical or substantially similar programs in multiple compliance periods, the results of the M&V audit described above should be used to refine forward looking projections of measure and program impacts.

APPENDIX A: EVOLUTION OF M&V PRACTICES

Support for the Evolution of M&V Practices and Standards Over Time

This guidance provides a number of options/pathways for the monitoring and verification of EE savings that reflect the diversity of M&V methods in place now, and allows states a degree of flexibility with respect to EE M&V requirements.

This approach is appropriate given the diversity among states in the level of investment in EE, and in the methods used to measure and verify EE savings. While EPA's approach to date reflects the deep experience with EE M&V that has developed over decades, it is also clear that measurement and verification techniques for EE savings will continue to be refined as experience is gained, and as the depth and scope of EE measures and programs grow over time. In the interest of facilitating states in their efforts to achieve compliance with CO_2 standards, EPA should support continued evolution of EE measurement and verification, and the transfer of M&V best practices across states. This process will allow compliance opportunities to expand, potentially leading to a number of environmental and economic benefits. Consequently, EPA's purpose in facilitating development and transfer of EE M&V approaches should be to

(1) increase the opportunities for states and compliance entities to rely on EE as a compliance approach, and increase the scope and depth of EE measures and programs that can be used for compliance;
(2) increase the certainty in EE savings measurement, allowing for most or all actual savings and associated emission reductions from implementation of EE in states to count towards compliance obligations; and
(3) provide a forum for the transfer of information on M&V approaches, to improve the implementation of EE M&V within states, and the consistency of M&V across states.

EPA's guidance on the form, process and data used in monitoring and verification of EE savings used for compliance should change over time to reflect the evolution of experience with M&V across states and time. EPA should support this evolution by coordinating with existing federal, regional and state efforts towards common M&V best practices, such as the ongoing efforts coordinated by the Department of Energy, the State and Local Energy Efficiency Action Network, and regional technical forums. In addition, EPA should periodically revise the M&V standards contained in this document to reflect this coordinated evolution of M&V practices over time.

Consequently, EPA should support as appropriate a national M&V coordination effort, including at least the following:

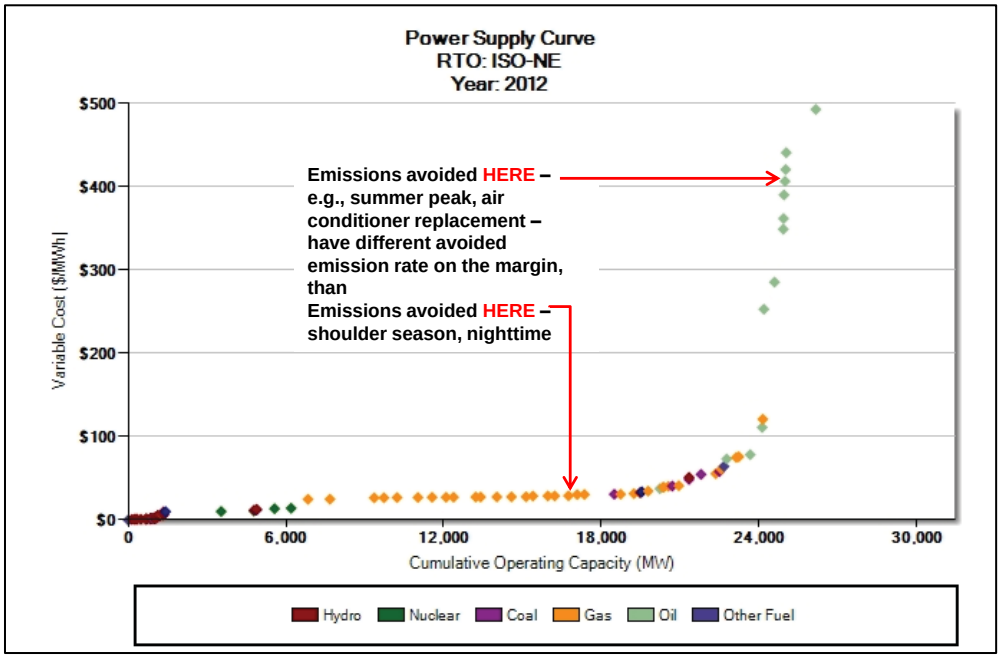
- Work with existing federal, regional and state efforts to improve EE M&V and work towards common, voluntary M&V practices. To the extent EPA convenes a workgroup (rather than assist existing national and regional efforts), states should be invited to participate fully in this effort.
- Facilitate meetings, studies and analysis to achieve a framework for consistent national EE M&V standards.
    - Periodically develop revisions to the guidance provided in this document, reflecting as much as possible the evolution of EE M&V for compliance, and the lessons learned through the coordination process. The revisions should capture

elements upon which there is significant progress and agreement, but need not represent a specific, prescriptive set of EE M&V standards.

APPENDIX B: PRIMER ON LOAD REDUCTION PROFILES

End-use energy efficiency reduces the total consumption of energy, and thus reduces the quantity of generation needed from power plants. That is straight-forward enough. However, it is far less obvious *which* power plants reduce generation due to EE, and this is the most important factor determining how many tons of CO_2 are avoided through EE savings. Two pieces of information are needed to figure this out: (1) estimates of *when* EE programs generate savings, and (2) identification of the power plants (and associated emission rates) operating when EE programs are generating savings. The first element has been, and continues to be, determined through measurement and verification of EE programs. The second can be determined through industry-standard power system dispatch modeling that has been used for decades for this and many other purposes, by regional transmission operators, utilities, and stakeholders.

To understand the challenge conceptually, take as an example the New England region. New England is a competitive wholesale market region, where power plants are dispatched (or turned on) in order of increasing marginal costs (short-term fuel and operations and maintenance expenses) to meet increasing consumer demand.[17] Thus, the quantity of emissions that results from an *increase* in demand depends on which power plant is turned on (or increased in output) to meet that incremental demand. Similarly, the quantity of emissions avoided when an EE program or measure *reduces* demand depends on which power plant's generation is *avoided* at the time of EE savings. The power "supply curve," represented in Figure 1, shows this conceptually.

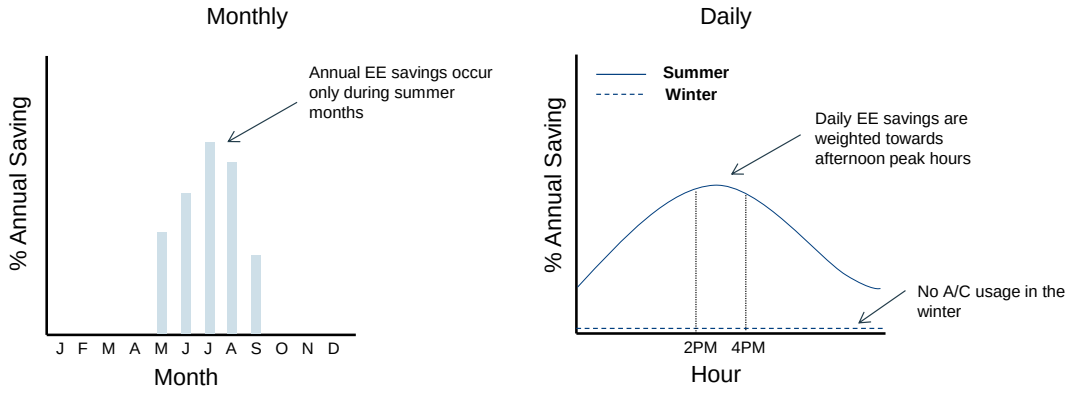


[17] New England is not unique in this respect. Even in regions that remain fully vertically integrated, or that are a mix of competitive and vertically-integrated companies, the manner in which power plants are dispatched to meet changing consumer demand generally follows the concept of dispatching units in order of increasing marginal costs.

New England's supply curve is characterized by a long stretch of competitively priced natural gas (primarily combined cycle (CC)) power plants, then a steep section of the curve heavily reliant on less efficient oil and gas steam power plants. If EE leads to avoided emissions at a load level between, say, 12,000 megawatts (MW) (about the lowest load level for the region) and 18,000 MW, the emissions avoided will generally be from relatively efficient CC natural gas-fired power plants. However, if EE leads to avoided emissions at a load level above 24,000 MW (characteristic of hot summer weekday conditions), the emissions avoided will be from far less efficient, oil-fired power plants. Thus, one megawatt hour of EE savings at this time of year will avoid more emissions of CO_2 – characteristic of inefficient, oil-fired power plants – than at the lower-load times of year – characteristic of efficient CC gas units.

This is important because different EE programs generate most of their savings at different times of the year and – thus – at different load levels. Two examples are presented below. The first is an air conditioner replacement program. An air conditioner replacement program will generate a significant portion of its savings during summer weekday, high-load conditions (in our example, above 24,000 MW and avoiding emissions from inefficient oil-fired peaking units), and a lesser portion during medium-load hours (e.g., summer night time conditions). The second example is a lighting replacement program. This program will generate nearly all of its savings at night, and more in the winter (when it is dark for a longer period of the day) than in the summer. Thus the emissions avoided from this program will be lower – on a per-MWh avoided basis – than the air conditioning program, because it will typically generate savings at a lower load level, when the "marginal" unit is more likely to be an efficient gas-fired combined cycle unit.

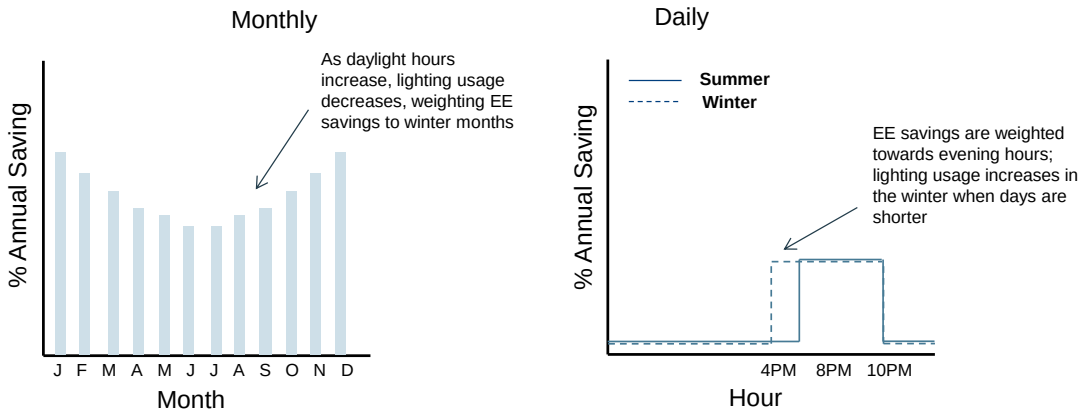
EXAMPLE 1: Air Conditioner Replacement Program in Northern States



The task of estimating avoided emissions consists of two steps. In the first step, total annual savings from EE programs need to be "spread out" across the year, based upon when the programs are reducing customer demand. Measurement and verification studies have split the *annual* savings from EE programs into different time "buckets" for many years. Consequently, depending on the measures installed, and the region of the country, it is possible to take annual savings from an EE program and spread those savings out

across all hours of the year to create an EE "*load reduction profile*" – or LRP – that is, an hourly profile of when the program is generating savings.

EXAMPLE 2: Light Bulb Replacement Program



The second step involves modeling how power plants are dispatched to meet customer demand on an hourly basis. This is less difficult than it may seem at first. Regional power system operators, owners of generation, utilities and power authorities, industry analysts, and energy and environmental policy makers and stakeholders have all used power system "dispatch models" to do this for decades (to, for example, estimate hourly prices, explore the value of a proposed new power plant, estimate annual and marginal emissions from power plant operations, and/or assess the need for and pricing impacts of new transmission investment). There are several different versions of power system dispatch models that are granular enough for this purpose, and that have been vetted through numerous applications over time (for example, GE's MAPS model, and Ventyx's ProMod).

In order to estimate the total emissions avoided from a particular EE program in a given region, one combines the EE LRP with the power system dispatch model. Running the model *with and without* an EE program's LRP establishes the total annual emissions avoided by the program. Doing this for discreet categories of programs in a region (e.g., lighting or air conditioning replacement programs) allows for a reasonable approximation of the total annual emissions avoided per MWh saved through the EE program. These results can be translated into simple emission reduction factors (in tons of CO_2 avoided per annual MWh saved) for categories of programs that can be used – in combination with total annual MWh savings figures established through measurement and verification programs – to translate EE annual savings into tons of CO_2 avoided for demonstrating compliance.