Reducing Greenhouse Gases and Improving Air Quality Through Energy Efficiency Power Plants: Cutting Through the Fog to Help Air Regulators "Build" EPPs

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ABSTRACT

Half of Americans live in areas violating national health-based air quality standards. Coal- and gas-fired power plants are important contributors to the problem. The Clean Air Act has historically addressed power plants through regulation of smokestack emissions, employing "stovepiped," pollutant-by-pollutant control strategies. Air quality has improved, but through duplicative or conflicting requirements and at ever-increasing cost. Worse, such controls often increase CO_2 emissions, consume additional water, and create thermal discharge and ash disposal concerns. This paper summarizes recent efforts to help air regulators consider energy efficiency programs as a viable alternative to smokestack controls. It outlines the regulatory challenges that must be addressed and legal constructs that can be used, and it highlights specific steps that the energy efficiency community can and should take. The paper also presents a planning tool to demonstrate to regulators how the effects of many different efficiency measures installed by many different customers can be aggregated in a sufficiently rigorous and detailed way to meet regulatory needs. Our hope is that the emissions reductions from an "Efficiency Power Plant" could be accepted by EPA and state air regulators in ways that are analogous to those from mobile sources (e.g., vehicles) . The tool enables users to input as few as ~20 assumptions about the number of different "proxy" efficiency measures that will be installed, and generates seasonal and hourly emissions reduction profiles. Preliminary discussions with air regulators suggest the tool offers great promise for illustrating the impact of multiple pollutants, not only for CO_2 but for criteria pollutant emissions as well.

Introduction

Energy efficiency (EE) programs are air quality control measures. The accumulated benefits of programs such as appliance standards, updated building codes, and more efficient manufacturing have been responsible for significant air quality improvements achieved by the United States since the 1970s (Laitner 2009).[1]

EE can play even a greater future role. Integrating EE into air quality planning will permit states to more cost-effectively meet air quality objectives in the same timeframe or sooner

1 "Looking only at productivity gains in electricity consumption, we estimate that deployment of semiconductor technologies—whether in consumer goods, industrial operations, or the production of alternative energy resources—has generated a net savings of about 775 billion kilowatt-hours (kWh) of electricity in the year 2006 alone. This is on the order of a 20 percent savings for the entire U.S. economy. A large 600 megawatt coal-fired power plant might generate just over 4 billion kWh in a year's time. So stated differently, our national economy might have required the construction and operation of 184 large electric generating power plants "but for" the widespread use of semiconductor technologies."

than end of pipe emissions controls. However, without engagement by the EE community in the development and implementation of air quality rules,[2] states likely will not integrate energy and air quality planning, higher costs will be passed along to consumers and businesses, and utilities will be exposed to unnecessary financial risk.

The Regulatory Assistance Project (RAP) and Energy Futures Group (EFG) developed a demonstration tool which helps to demonstrate the benefits of energy efficiency as an air quality management tool. Our goal is to support the EE community as state air regulators consider and accept EE as a legitimate compliance mechanism.

Energy Efficiency Has Helped to Improve Air Quality for Decades

Energy efficiency as an air quality measure is the most cost-effective means to meet EPA and state air quality regulations. EE jointly reduces all pollutants: criteria pollutants, toxic pollutants, and greenhouse gases. In the European Union, EE has helped to achieve one-third to one-half the progress to reduce criteria pollutant emissions, and similar contributions have occurred for California's air quality plans (Amann 2013; Bollen et al. 2009; Rosenfeld 2008). EE has also provided significant criteria air quality benefits in China. Although not quantified, those same EE measures have also reduced greenhouse gas emissions. Recent data from these regions reflect that EE has helped to sustain long-term air quality improvement, maintain electricity reliability, and protect consumers and businesses from higher energy bills, as demonstrated by the following examples:

- Minnesota: Xcel Energy's EE programs have avoided construction of 2500 MW of new power plants since 1992 (Xcel Energy 2013), avoided emissions of over 11,000 tons of oxides of nitrogen (NO_X),[3] and avoided an economic burden of nearly $2 billion (NRC 2010).
- California: EE programs in 2010-11 saved 5,900 GWh of energy and avoided the construction of two power plants (Smart Energy Universe 2014), saving an estimated $590 million in capital costs.[4] The state has avoided the construction of about 40 power plants and their associated emissions since the late 1970s (ASE 2013).
- China: Efficient refrigerators and air conditioners have saved energy equal to the output of Three Gorges Dam,[5] avoiding more than 374 million tons of coal from being burned.[6]
- European Union: EE is responsible for one-third of SO_2 reductions achieved since the mid-1970s (Amann 2013).

[2] While all air quality rules offer opportunities to better integrate energy efficiency, special opportunities exist in those rules that address the power sector and those that require states to develop or revise plans (called state implementation plans [SIPs]) to meet national ambient air quality standards.

[3] 2500 MW at capacity factor of 70%, and emissions rate of 1.5 pounds NO_X per MWh (representative of a well-controlled existing power plant).

[4] Assumes that natural gas combined cycle plants would have been constructed at a levelized cost of $100/MWh (Lazard 2008).

[5] With a generating output of 10,000 MW, Three Gorges Dam is currently the largest power plant in the world (Rosenfeld and Poskanzer 2009).

[6] Energy savings are 100 TWh, and average coal consumption is 340 grams per kWh.

- Maryland: Its existing EE and renewable energy programs provide about 0.60 parts per billion (ppb) reduction to ozone concentrations—an analysis based on programs which are not mature. Maryland continues to expand its EE programs under the Empower Maryland Act, with further air quality benefits expected to accrue (Aburn 2013).

EE consistently ranks near the top, if not at the top, for measures to meet the reduction goals of state greenhouse gas mitigation plans.[7] Today, EE's role can be equally or more significant as EPA crafts greenhouse gas emissions standards to be applied to existing power plants.

The benefits described here could be much larger, and synchronized better with current and future air quality requirements if the EE community became more directly engaged with air regulators at the state and federal level.

Clean Air Act Overview

The Clean Air Act comprises two major programs that are important for the EE community to understand:

- National Ambient Air Quality Standards (NAAQS): Established for six pollutants (also called the criteria pollutants), including ozone, fine particles ($PM_{2.5}$), sulfur dioxide, oxides of nitrogen, carbon monoxide, and lead. State and local air quality plans (SIPs) must show how pollutants will be reduced to attain and maintain compliance with each NAAQS.
- New Source Performance Standards (NSPS): Nationally applicable emissions standards for new and modified stationary pollution sources. NSPS establish the floor (or least stringent) requirements for best available control technology (BACT) in state and local air permits. NSPS limits are set by source category.[8]

In general, EPA is responsible for developing air quality regulations, issuing guidance to help states develop their plans to meet regulatory requirements, and overseeing and, if necessary, enforcing the state plans. The state's role is to develop the air quality plans, adopt regulations to improve air quality, and enforce conditions upon affected sources.[9] NAAQS is primarily an obligation upon the states to develop plans and regulations that will improve air quality enough to comply with air quality standards. NSPS is directed primarily at sources of pollution (e.g. power plants, industrial facilities, etc.); states must adopt regulations and plans that show how the state will implement and enforce them. NAAQS are analogous to having a federal requirement to reduce electricity consumption by a sufficient percentage to meet a national goal.

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[7] Referring to the approximately 30 state level climate change action plans developed in the 2005-2008 period.
[8] Two other major EPA programs address toxic air pollutants (National Emissions Standards for Hazardous Air Pollutants [NESHAPS]) and construction and operating permits for new and modified pollution sources (New Source Review and Title V [NSR]). NESHAPS are technology-based standards; NSR is a case-by-case review. The programs referenced in this paper offer the greatest opportunities for integration of EE. We do not address NESHAPS or NSR, though they could be a subject for a later paper.
[9] In the early years (1970s and 1980s), EPA provided the majority of funding to states. Today, EPA funding primarily covers costs associated with operating the ambient air quality monitoring network.

By contrast, the NSPS is analogous to a program where each new air conditioner, clothes washer, etc., must meet a specific efficiency rating.

The details of each of these programs are beyond the scope of this paper. The interested reader is referred to this source to learn more details about Clean Air Act programs:EPA 2012. EPA is statutorily required to periodically revise each of these programs. Each revision presents an opportunity to inculcate the rulemaking processes with policies, processes, and mechanisms that can either improve energy intensity at the facility itself or permit an affected source or state to explicitly use energy efficiency as a means to comply with the requirements.

Why Should the EE Community Get Involved in Air Regulations?

A leading question is why should the EE community interact with air regulators? The Clean Air Act is arcane, complicated, and highly process driven. Chief among the reasons that compel interaction by the EE community are:

- Cost effectiveness: Energy efficiency continues to be one of the most cost-effective means to improve air quality and maintain energy reliability.
- Symbiosis: Explicit inclusion of EE into air quality programs benefits EE programs by increasing their value and cost-effectiveness. This symbiosis helps the EE community make a more persuasive case to state public utility commissions for funding and deepening efforts to procure more energy savings.
- Public health: One-half of Americans live in counties that exceed one or more existing National Ambient Air Quality Standards (NAAQS). Avoiding pollution from power plants provides direct public health benefits, the economic value of which exceeds the retail price of electricity in many states (National Research Council 2010).[10]
- Many areas exceed a NAAQS by only 5-10%: Increasing the energy savings from state EE programs alone could be sufficient to reduce ambient pollution concentrations, and avoid a non-attainment designation along with its accompanying inflexible requirements.[11] For example, the current ozone standard is 75 parts per billion (8-hour average). Based on existing science and medical data, EPA's Clean Air Science Advisory Committee is expected to recommend that EPA adopt a more protective standard in the range of 60-69 parts per billion. In Figure 1 below, those areas shown in turquoise, yellow and orange would be at most risk from being designated in violation of any revised standard, and offer the best opportunities to ramp up the quantities of energy saved from EE, so they can avoid such designation and the associated loss of flexibility.

[10] This report calculated that the mean economic burden of each kWh from a coal plant was 3.2 cents. The equivalent burden from a natural gas plant was 0.16 cents per kWh. The 95th percentile burden was 13 cents per kWh for coal and 0.55 cents per kWh for natural gas.

[11] Based on 2011 and 2012 ozone and fine particle (PM2.5) data from EPA. In particular, many counties in the southeast and south central states have measured ozone concentrations of 76-78 parts per billion, compared to the current 75 part per billion standard.

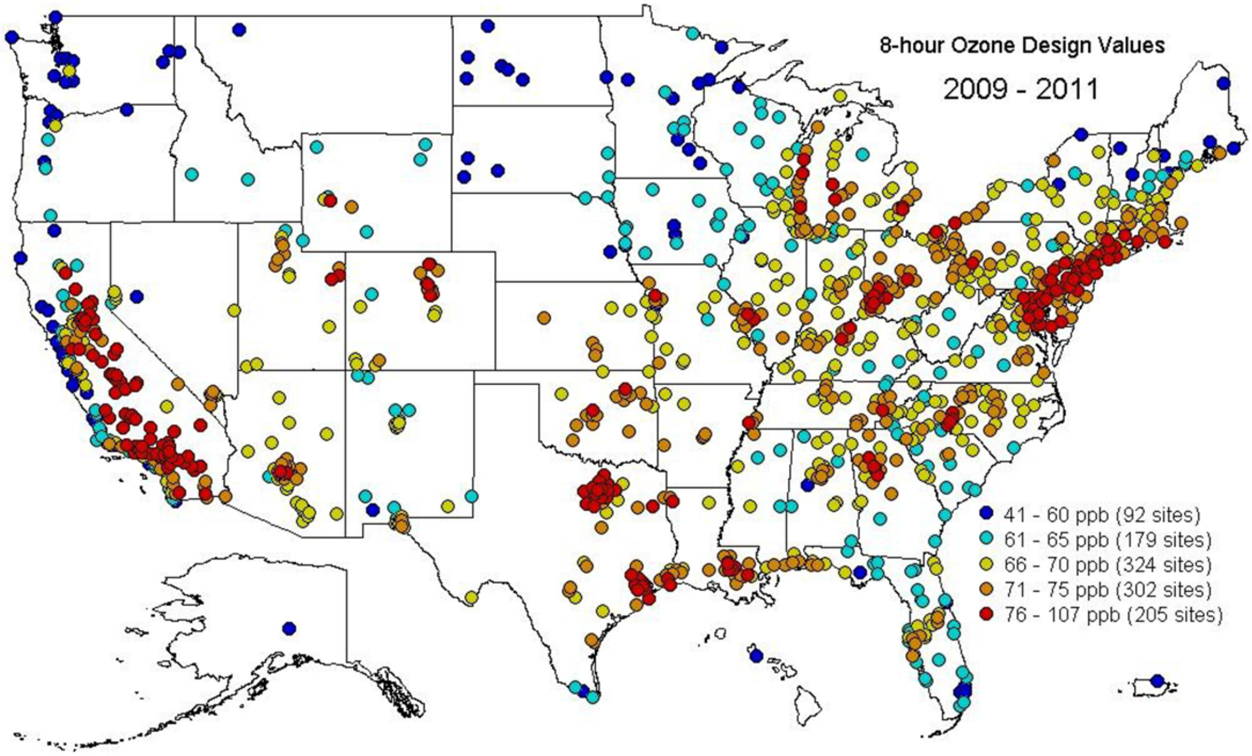

Figure 1. Ozone design values 2009-11. *Source*: EPA 2014b

Opportunities to Include Energy Efficiency in Clean Air Act Requirements

The EE community can help spur the inclusion of EE in new and revised air quality rules, and promote EE's role in helping states and air pollution sources comply with such rules, in two principal areas. First, the EE community should assure that EPA rules explicitly include EE as a compliance option. Because many states are expressly prohibited by their state constitutions from adopting rules more stringent than federal requirements, EPA guidance and rules must explicitly include language that promotes EE. Otherwise, it will not be adopted by the states. Second, when a new standard or federal regulation is published and implemented by the states, the EE community should engage with air regulators during the state planning processes. Like integrated resource plans (IRP) in the energy utility world, many state air agencies convene air quality planning processes. Not every state does this, but the EE community can certainly encourage this activity by suggesting it.

For each of the major air quality program areas identified above, the state program must synchronize with the federal counterpart. This does not mean an exact match is required, but state programmatic elements must be equivalent to the federal program in terms of degree of stringency and the timing to achieve the required air pollution reductions. Equivalency is an active topic now, because it is a major part of the discussion about how states will comply with section 111(d) of the Clean Air Act (which requires EPA to adopt emissions standards for existing power plants under the NSPS program).[12]

The forthcoming greenhouse gas standards to be proposed by EPA in June 2014 for existing power plants present an ideal opportunity for the EE community to take action. The 111(d) standards will be finalized in June 2015, and states will have one year to develop the plans that, when fully implemented, will be equivalent to the federal standards. States have the most flexibility and control of their destiny if they develop their 111(d) plan prior to June 2016, the expected final date for state plan submission. States that do not submit plans, or submit inadequate plans, will have inflexible federal plans imposed upon them until a satisfactory state plan is developed and submitted to EPA.

While the 111(d) standards have not been proposed as of the time of this writing, we believe that EPA has expressly indicated that it wants EE to be part of the compliance mechanism used by states to demonstrate adequacy. We also expect the initial 111(d) standard will likely require a 5-10 percent reduction in greenhouse gas emissions over a several year period. EPA can set standards based on either emissions per unit or on fuel mix, but we expect that states will be able to substitute EE if they can show equivalency.

This framing is perfect for EE to be included as the prime means for states to comply with the 111(d) requirements. As the best EE programs today yield energy savings of 2-2.5 percent per year, EE, writ large, can play an important and highly cost-effective role to assure that equivalency is achieved by the state plans. The rather modest levels of the expected 111(d) standard also mean that states whose current EE programs are not mature or who are ramping up their energy savings may also be able to demonstrate equivalence with the 111(d) standards using EE as a prime compliance mechanism. Even a state with small energy savings of 0.3 percent per year can ramp up to 1 percent per year over three years, and after five to seven years (the expected period for the initial EPA standards), those state 111(d) plans can clearly show how EE can satisfy the bulk, if not all, of the required emissions reductions.

How the EE Community Can Influence Air Quality Planning

Earlier, two opportunities for the EE community to get engaged with air regulators were described- at the time that EPA rules are written and in state air quality planning processes. To facilitate those conversations, below are steps that should be completed to assure that EE is a resource equal to others normally included in air quality plans:

- Identify and leverage best practices in EM&V for EE, and improve EM&V in many jurisdictions;
- Work with the U.S. Department of Energy (DOE) and EPA to develop “deemed emission reductions” for a given season and/or time period. Strive to create acceptance within EPA and among state air regulators that the character and performance of EE-based emission reductions are statistically analogous to mobile sources; and

[12] The Clean Air Act is full of acronyms and seeming contradictory terms. One of these is the provision that EPA can regulate existing sources under a “new source” section of the Act. This provision is directed at controlling pollutants for which a NAAQS has not been set.

- Strive to create acceptance within EPA and among state air regulators that the character and performance of EE-based emission reductions are statistically analogous to mobile sources

Leverage and Improve EM&V for EE

Before the saved or avoided emissions can be determined, the quantities of energy saved must be evaluated, measured, and verified. Air regulators must be assured that the underlying energy savings are real, quantifiable, and persist for the expected life of the measures, projects, and programs.[13] There are large differences between states in how they conduct EM&V, from net vs. gross savings to very different assumptions about per unit savings for the same type of measures. Good EM&V programs develop manuals that deem the energy savings of literally hundreds or even thousands of different devices and applications. The best examples, such as those from the Pacific Northwest Regional Technical Forum and the Northeast Energy Efficiency Partnership's EM&V Forum, utilize a continuous audit, and are consistently updated and revised to accommodate new measures and changes to energy savings based on field audits.

If each of the energy savings from these thousands of discrete measures in a suite of efficiency programs are summed, the result is a portfolio of energy efficiency measures and projects, analogous to that of a virtual power plant, which can be relied upon for capacity and energy benefits. For NO_X and SO_2 emissions reduced from EE programs, the timing and location of energy saved is a critical factor; for CO_2 emissions reductions, these are less critical.

In the mobile source program, the emissions saved are derived based on the manufacturer, vintage, and urban or rural application. Similarly, for EE programs, EM&V manuals exhaustively provide data by the manufacturer, appliance or device use, the protocols used to measure the energy saved, and data sources. The manuals also often include information on the times of year and day when savings occur, the incremental cost of the efficiency measures, and ancillary data such as water usage where applicable (e.g., for washing machines).

In order to assess the efficacy of EE programs to reduce tons of emissions, we must know the aggregate energy savings from all installed measures, projects, and programs. In other words, from an emissions savings perspective, it is not important to know that a single building in a city has installed more efficient lighting, since while the discrete energy (and money) saved by that building matters to the building owner, the quantity of emissions saved by this one building is small (measured in fractions of a pound per day). However, EE programs involve installing more efficient devices at thousands or even millions of discrete locations in a city or state, and the sum of *all* these discrete installations can produce emissions savings of hundreds (or more) of tons per year for sulfur oxides and oxides of nitrogen, and hundreds of thousands (or more) tons per year for carbon dioxide.

Develop Deemed Emissions Reductions

The second area where the EE community can influence air quality planning is to work with DOE and EPA to develop "deemed emission reductions" for a given season and/or time

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[13] For a detailed analysis of EM&V, see: Shenot, J. 2013. *Quantifying the Air Quality Impacts of Energy Efficiency Policies and Programs*. Montpelier, VT: Regulatory Assistance Project. http://www.raponline.org/document/download/id/6680.

period. Deemed energy savings from EE measures are familiar to the EE community, and regularly used for planning purposes. To improve air quality and reduce greenhouse gases, air regulators would similarly benefit from having deemed emissions reductions that they can use in air quality plans. The deemed emissions reductions can be multiplied by deemed energy savings for individual EE measures (and/or by the time-differentiated, seasonal/hourly load shapes the EE community uses for EE) and applied to state air quality plans.

The DOE Uniform Measurement Protocol (UMP) is an on-going project which has objectives that include development of deemed emissions savings efforts. For a suite of energy saving measures and devices, the UMP can help establish EE inputs for subsequent avoided emissions calculations. Many others have already quantified the emissions avoided from energy efficiency programs. ISO-NE's Marginal Emissions Analysis is the best example. Others include Synapse Energy Economics' work for the California Energy Commission and EPA, efforts at Texas A&M University, and the EPA Avoided Emissions and Generation Tool (AVERT). Regional emissions factors, such as those from eGrid, can also be used if more granular data are not available.

Armed with the technical framework outlined above, the EE community can positively influence the role of EE in meeting air quality standards. RAP and EFG have developed a simple-to-use tool to advance this conversation.

Work Toward Acceptance of the Mobile Source Analogy Among Regulators

The third area builds upon the earlier recommendations to improve EM&V and to develop deemed emissions reductions by suggesting that air regulators consider an analogy that energy efficiency performance is closer to that of mobile sources rather than individual emissions points.

When traditional control measures, such as selective catalytic reduction (SCR) for NO_X and flue gas desulfurization (FGD) for SO_2, are evaluated, calculating the tons of pollution removed by these technologies is a straightforward subtraction exercise based upon the effectiveness of the particular emissions controls. Air regulators can bank upon the quantities of emissions reductions captured by these emission control devices. The equipment itself is warranted to perform, and the emissions not captured are measured through continuous emissions monitoring systems (CEMS). And, the precision and accuracy of CEMS data are assured through quarterly and annual relative accuracy tests and relative accuracy test audits. Likewise, for control measures applied to mobile sources, such as emissions and fuel standards for cars, trucks, boats and rail, the emissions credit for these measures has traditionally been first calculated by EPA (or California) based on manufacturers' data and testing of vehicles in laboratories (EPA 2009). EPA (or California) then deems certain quantities of emissions saved for various mobile source control measures, and these quantities are used by states in their air quality plans. This process is analogous to the way many efficiency measure savings (at least for measures promoted/sold in mass quantities) are estimated – by using manufacturers' data or field measured data on connected load or kW draw, then multiplying by what is often called full load hours (or the average number of total hours in a year a product is used). The only difference between the emissions credit for mobile sources and that from EE programs is that estimating savings from efficiency requires one more step: multiplying the energy saved by an emission rate.

Determining the emissions benefits from energy efficiency programs has proven more challenging for air regulators than it needs to be. Early attempts tried to associate the benefits of an EE program to a particular power plant. Then, regulators tried to analogize the same methods used to measure the efficiency of a SCR or FGD, a continuous emissions monitoring system on a stack, to assess the performance of a particular EE measure. These analogies have concurrently created false expectations for how EE programs perform and minimized the possible benefits that EE programs could make if considered as an equal policy to end-of-pipe emissions controls. The approaches air regulators have taken to evaluate the air quality benefits of EE also underscore the need to improve understanding of how the electricity grid functions, how EE programs are designed, and the protocols that are used to evaluate, measure, and verify the quantities of energy that are being saved. It is therefore crucial to understand what EE measures are needed, and their quantities, to remove tons of pollutants from the air.

When the performance of EE programs is considered, its characteristics bear greater resemblance to the mobile source program, with similar features:

- Hundreds of thousands, even millions, of discrete installations in a city or state;
- Installations may be concentrated (e.g., corporate vehicle fleet or whole office building retrofit) or dispersed (CFL sales to many thousands of home-owners);
- Quantification of performance-using algorithms developed based on statistical sampling (for either energy saved, or tailpipe emissions); and
- Key variables to assess performance focus on manufacturing parameters and vintage.

The most important points for air regulators to understand about energy savings data are:

- On average, each device or appliance can be shown to save a defined quantity of energy and, by extension, a defined quantity of pollutant emission reductions, based on its characteristics and use;
- The quantity of energy saved by each device or measure is typically based on assessments of the performance of these devices in the field;
- Several thousand efficient devices may be required to be installed in order to remove one ton of criteria pollutants (the effect of any specific device on any one single power plant is small); and
- Additional direct and indirect energy, economic, and environmental benefits occur and accumulate.[14]

Based upon how energy efficiency programs are deployed, the diversity represented in the types of devices or measures installed, the numerous and decentralized locations of the installations, and the additional electric benefits beyond the direct improvement in energy consumption, air regulators should deem the emissions saved by the aggregate of EE devices in a manner similar to how EPA determines mobile source emissions credits.

[14] Avoided line losses are a direct energy benefit. Each MWh saved through energy efficiency programs means that at least 1.06 or 1.07 MWh of generation is avoided. During periods of peak electricity demand, line losses can be as high as 20 percent; Therefore, each MWh of energy saved during peak demand periods may mean that as much as 1.12 (1.2/1.07) MWh of generation is avoided.

Energy Efficiency Power Plant Tool

RAP and EFG have developed a simplified, Excel workbook-based planning tool[15] to help demonstrate to both EPA and state regulators how efficiency program portfolios can be seen as analogous to mobile source emission standards. Specifically, the tool demonstrates how the effects of thousands or even millions of efficiency measures installed at nearly as many different sites through a dozen or more different efficiency programs could be aggregated into a single "Efficiency Power Plant (EPP)" with substantial impacts on emissions that can be characterized with a great deal of sophistication.

As Figure 2 illustrates, the tool is set up so that the user need only input the number of each of 17 different efficiency measures that an efficiency program portfolio would cause to have installed annually. The measures are proxies for each of seven different residential end uses (including one catch-all "other" end use) and 10 different commercial & industrial (C&I) end uses (including one catch-all "other" end use). The tool provides default per measure savings values, but the users could substitute their own. For illustrative purposes, the model is populated with measure inputs that are consistent with Efficiency Vermont's savings in calendar year 2012.

The tool uses a library of default end use efficiency load shapes (12 months by 24 hours per day) to allocate the annual savings estimates of the different measures to each of the 8,760 hours of the year. The current default load shapes are primarily derived from California sources, mostly because they were readily accessible. A next iteration of the tool would need to, among other things, enable adjustments to some of the load shapes based on climate and other factors. The users have the option of customizing the tool by substituting more appropriate, locally-derived load shape assumptions.

The current version of the tool provides three sets of outputs, each of which is graphically depicted:

- MWh savings by month, by end use;
- Average MW savings by month, by end use; and
- Hourly MW savings for an average July day.

The first of these – monthly MWh savings associated with the inputs shown in Figure 2 – is shown in Figure 3 below. The corresponding hourly MW savings for an average July day are shown in Figure 4. This provides some indication of the impacts on system peak loads for electric systems that are summer peaking (most systems in the U.S.).[16]

Preliminary conversations with air regulators suggest that the tool is very effective in helping them both to appreciate the sophistication of the efficiency industry's ability to characterize the impacts of a wide range of measures and programs and to understand the way in which the impacts of literally tens of thousands, hundreds of thousands, or even millions of measures can be aggregated without exorbitant effort or expense. Thinking in terms of a

[15] The tool is available for download at http://www.raponline.org/featured-work/cutting-through-the-fog-to-build-energy-efficiency.

[16] Though average summer day savings during late afternoon hours are good indicators of peak savings for most measures, they likely understate actual impacts on system peaks for cooling or cooling-related measures (note that lighting, ventilation, and some other measures often provide some cooling savings), since cooling saving will be higher on the hottest summer days, when peaks tend to occur, than on average summer days.

portfolio for EE is a shift for many air regulators, as their tendency and training has been to focus on discrete points of emission.

The next step for air regulators would be to translate the aggregated electricity savings into estimates of reduced carbon and/or other pollutant emissions through the use of regional or other appropriate emission factors. For example, for greenhouse gases, one option might be to use eGrid's non-baseload emission factors which the EPA publishes for 26 different sub-regions of the country.[17] RAP is considering the possibility of adding an emissions module to this tool.

It should be emphasized that the purpose of the tool is to demonstrate to air regulators the potential for using efficiency programs as part of a compliance strategy for meeting federal air emission regulatory requirements. In other words, it is only intended to be illustrative. The tool is not currently intended to be used as part of a state implementation plan. However, we fully envision that vendors in the private sector will develop more sophisticated tools, built on the same principles as our demonstration tool, that could potentially be used by states as part of their future plans. Indeed, many existing tools used by efficiency program administrators would require only modest modifications (and perhaps no modifications in some cases) to provide such functionality.

Enter the quantity for each row in the bright yellow cell in Column E

Only change the savings per unit in the light yellow cells in Column F if you have savings estimates that are specific to the service territory you are analyzing

"End Use" (what the electricity is being used for)	Representative installed equipment (also called "Measure")	Unit of installed equipment (what are you counting?)	Quantity of installed equipment (how many will be installed?)	Savings per Unit (kWh/yr)	Total Savings (MWh/yr)
RESIDENTIAL					
Residential Cooling	ENERGY STAR Central A/C	Air Conditioner	756	150	113
Cooking & Laundry	CEE Tier 3 Washer	Washing Machine	6,830	237	1,619
Lighting	CFL	Light Bulb	981,130	35	34,340
Refrigeration	Recycled Refrigerator	Refrigerator	2,127	720	1,531
Space Heating	Weatherization	One Home	542	1,500	813
Water Heating	Low Flow Showerhead	Showerhead	3,530	260	918
Other	Custom Projects	One Home	3,257	1,000	3,257
			Total Residential		**42,591**
COMMERCIAL & INDUSTRIAL					
A/C	Project	One C&I Project	623	5,505	3,429
Hot Water	Project	One C&I Project	139	1,000	139
Industrial Process	Project	One C&I Project	73	140,000	10,220
Interior Lighting	Project	One C&I Project	2,621	16,000	41,936
Motors	VFD<= 10 HP	One C&I Project	1,509	5,400	8,149
Refrigeration	Project	One C&I Project	147	17,500	2,573
Space Heating	Project	One C&I Project	112	4,250	476
Ventilation	Project	One C&I Project	73	13,400	978
Compressed Air	Project	One C&I Project	62	29,187	1,810
Other	Project	One C&I Project	540	2,000	1,080
			Total Commercial & Industrial		**70,789**

Figure 2. Efficiency power plant planning tool inputs.

[17] EPA recently made public the 2010 eGrid emission factors (both annual emission rates per MWh and non-baseload emission rates) for both criteria pollutants (e.g. sulfur dioxide and nitrogen oxides) as well as greenhouse gases (EPA 2014a). Non-baseload emission rates are a proxy for marginal emission rates, and are therefore a better indicator of the emission reductions that efficiency programs will have.

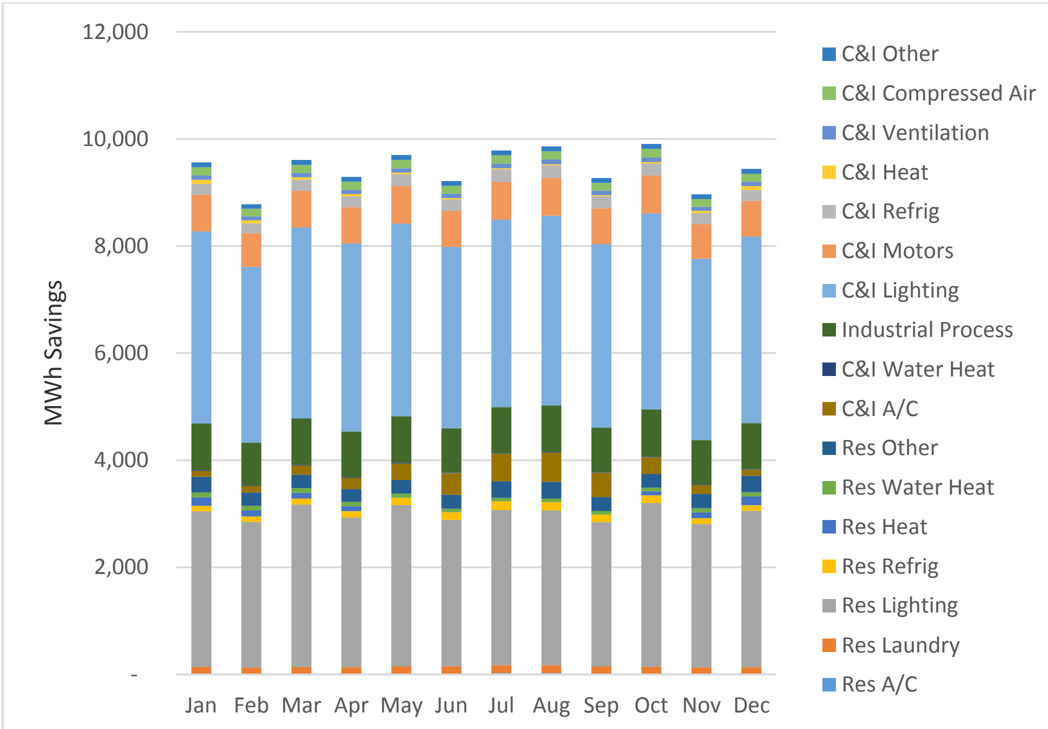

Figure 3. Monthly MWh savings profile for efficiency program portfolio.

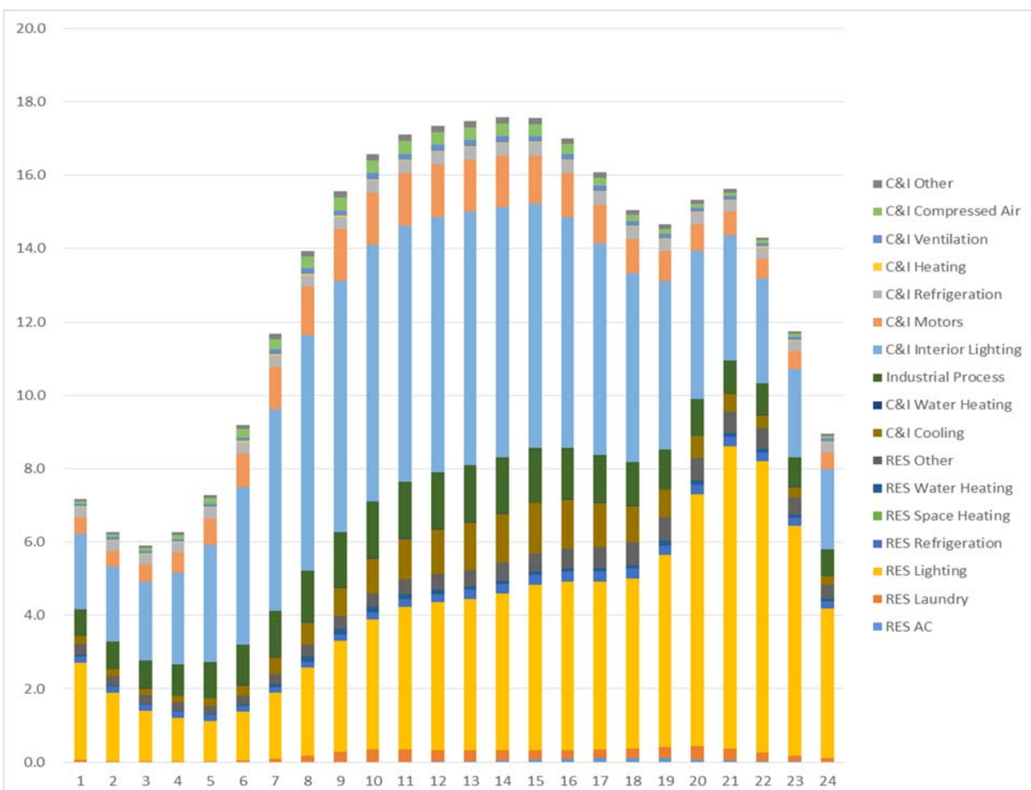

Figure 4. Hourly MW savings for an average July day.

Next Steps

In advance of EPA's proposed 111(d) rule to regulate greenhouse gas emissions from existing power plants, the EE community can be very engaged in the following areas. This engagement will also amplify EE's role to help states improve air quality (reduce ozone precursors, fine particles, and toxic pollutants).

- Highlight the best EM&V programs and replicate best practices in regions where EM&V needs improvement.
- Use the EPP tool described here. Expand the number of measures included, evaluate load shapes from other regions, and develop additional scenarios to further build the case for energy efficiency power plants. Adapt other existing tools for the same purposes.
- Work with EPA headquarters and regional offices to enable EE at scale by treating its performance as analogous to that of mobile sources.
- Use a mobile source analogy to determine the emissions credit for EE in state air quality plans.
- Assure that new and revised air quality rules treat EE as an equal and effective means by which to achieve compliance.

The paper's authors will present further thoughts on these recommendations at the 2014 Summer Study, as the rule covering greenhouse gas emissions from existing power plants will be proposed in June 2014.

References

Aburn, T. 2013. "Building Energy Efficiency and Renewable Energy into the Clean Air Act Planning Process." Presentation at the ACEEE Market Transformation Conference, Washington, DC, March 24-26, 2013.

ASE (Alliance to Save Energy). 2013. *California's Energy Efficiency Initiatives*. Washington, DC: Alliance to Save Energy.

Amann, M. 2013. "International Institute for Applied Systems Analysis." Presentation at the Clearing Blue Skies Forum, Beijing, China.

Bollen, J., J. Brink, H. Eerens, and A. Manders. 2009. *Co-Benefits of Climate Policy.* Netherlands Environmental Assessment Agency.

EPA (Environmental Protection Agency). 2014a. *eGrid 9th Edition Version 1.0. Year 2010 Summary Tables*. Washington, DC: U.S. Environmental Protection Agency.

———. 2014b. *Policy Assessment for the Review of the Ozone National Ambient Air Quality Standards*. Research Triangle Park, NC: U.S. Environmental Protection Agency.

———. 2012. *Plain English Guide to the Clean Air Act*. Washington, DC: U.S. Environmental Protection Agency. http://www.epa.gov/air/caa/peg/.

———. 2009. *EPA Releases MOVES2010 Mobile Source Emissions Model: Questions and Answers.* Washington, DC: U.S. Environmental Protection Agency.

Laitner, J. 2009. *Semiconductor Technology: The Potential to Revolutionize U.S. Energy Productivity*. Washington, DC: American Council for an Energy Efficient Economy.

Lazard. 2008. "Levelized Cost of Energy Analysis-Version 2.0." Presentation at the National Association of Regulatory Utility Commissioners Summer Committee Meetings, Portland, OR, July 20-23, 2008.

NRC (National Research Council). 2010. *Hidden Costs of Energy: Unpriced Consequences of Energy Production and Use*. Washington, DC: The National Academies Press.

Rosenfeld, A. 2008. "The First and Most Profitable Way to Delay Climate Change." Presentation at Pacific Energy Center, San Francisco, CA, May 19, 2008.

Rosenfeld, A. and D. Poskanzer. 2009. "A Graph is Worth a Thousand Gigawatt Hours: How California Came to Lead the United States in Energy Efficiency." *Innovations*. Fall 2009.

Smart Energy Universe. 2014. California PUC Outlines Energy Efficiency Success: Avoid New Power Plants. Vol. 3, No. 9.

Xcel Energy. 2013. *Partnering for a Better Energy Future*. Minneapolis, MN: Excel Energy.