

The Economic Potential of Energy Efficiency

*A Resource Potentially Unlocked by the Clean
Power Plan*

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This Report presents the results of an independent analysis of energy efficiency potential studies in the context of EPA's Draft Clean Power Plan issued in accordance with section 111(d) of the Clean Air Act.

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1. Executive Summary

EPA's draft Clean Power Plan (CPP), issued in the summer of 2014, proposes state-specific standards for the amount of carbon dioxide (CO₂) allowed to be emitted per megawatt-hour of electricity produced at affected power generating facilities. In setting each state's standard, EPA considered in part the ability of states to reduce system-wide CO₂ emissions through investments in demand-side energy efficiency at the businesses and residences of the state. Based on an evaluation of historical experience with energy efficiency (EE) programs administered by utilities in leading states over the past couple decades, EPA concluded that states could grow EE savings at a rate of increase of at least 0.2 percent of sales per year, and over the initial term of the program (i.e. through 2030), could sustain annual average savings of 1.5 percent of state retail electricity sales.

Past experience with utility administration of energy efficiency programs as required (and generally limited) by states is a strongly conservative indicator of the potential for investment in EE going forward.¹ While there have been leading states pursuing significant levels of investment in EE, in most states the pace, level, and effectiveness of EE investment has been expressly constrained through the limitations of laws, regulations, and policy, and deterred by the inherent financial disincentive of EE lowering the sales (and revenues/profits) of electric utilities. In its current form, EPA's proposed regulation would vastly alter this dynamic by opening the door to states, new and existing market entities, owners of affected units, and utilities all investing in energy efficiency to profit from the use of EE as a compliance mechanism. EPA's proposed regulations would thus dramatically alter the delivery mechanisms, pace, magnitude, and market size of energy efficiency investments across the country over the next decade, compared to rate-driven utility programs.

Nevertheless, EPA drew on a wealth of information and data on historical EE implementation, and numerous studies of EE technical, economic, and achievable potential to develop reasonable (if conservative) estimates of EE ramp rates and sustain levels. In this Report we study the literature on energy efficiency potential and evaluate it in the context of EPA's proposed Clean Power Plan. Specifically, our analysis includes the following:

- A summary of EPA's Clean Power Plan, with a focus on EPA's evaluation of energy efficiency potential studies and building code and appliance standards, and how that evaluation factors into EPA's assumptions with respect to energy efficiency and emission goals;
- Literature review and evaluation of meta-analyses and individual studies on the potential for achieving energy efficiency savings across a wide range of geographies, industry structures, prevailing energy policies, and time periods;
- Analysis and summary of the structure of energy efficiency potential studies, how various categories of EE potential are defined, and how results are influenced by prevailing electricity price, technological, and economic factors;

¹ See Paul J. Hibbard and Andrea M. Okie, *Assessment of EPA's Clean Power Plan* (December 1 2014) for additional review of the degree to which historical utility-driven (and customer-funded) EE is a highly conservative measure of states' abilities to increase and sustain EE activity and savings.

- Review of literature on building energy efficiency codes and appliance efficiency standards; and
- Assessment of EPA’s assumptions regarding the potential for energy efficiency savings in setting goals and compliance options in the Clean Power Plan.

For this purpose, we evaluate recent studies of energy efficiency potential – including those considered by EPA and a number of others not included in EPA’s analysis. We analyze how the design and purpose of such studies influence the results, and inform how study outcomes should be interpreted in the current context. Virtually all of the studies we analyzed are studies of EE potential in states where public utility commissions have required regulated utilities to invest in EE, subject to typical constraints associated with rate caps, program designs, and cost impacts. Finally, while we conclude that enabling energy efficiency as a compliance option under the Clean Power Plan could expand the nature and extent of EE investment in states in significant ways, we do not try to quantify how this would affect economic or achievable EE potential within states as part of our analysis.

Summary of Key Findings

There is a wealth of experience across the U.S. with implementation of energy efficiency programs, and a large body of literature documenting the potential energy savings that may flow from EE investments. Some analyses are very specific to individual states, utilities, even rate classes. Other studies take a wider view, including some that estimate potential national energy savings available through energy efficiency investments. In this Report, we focus specifically on EPA’s analysis in the development of the Clean Power Plan, a recent meta-analysis of EE potential studies conducted by the American Council for an Energy Efficient Economy (ACEEE), a comprehensive review of a number of the most relevant EE potential studies reviewed in the ACEEE study, and two national estimates of U.S. EE potential.

Based on our review, we find that EPA’s assessment of EE potential is reasonable, but conservative – that is, we find that EPA’s conclusion likely significantly understates the potential for EE savings in states over the compliance period. We come to this conclusion based on a review of the experience with and literature on estimating EE potential in the past, analysis of the significant amount of “economic” energy efficiency potential cited in studies (well beyond EPA’s assumed savings potential), and recognition that EE as a CPP compliance mechanism would unlock vast amounts of EE potential that otherwise would not be captured by state consumer-funded EE programs, which are typically constrained by a number of factors. Specifically, we find the following:

- The results of the most recent and relevant energy efficiency potential studies and meta-analyses, completed in the context of ratepayer-funded utility energy efficiency programs, support the conclusions EPA drew based on its own analysis of a subset of the studies we reviewed;
- EPA’s observation of state achievable EE potential savings equal to (on average) 1.5 percent of state retail sales is squarely within the range of results (0.3 percent to 2.9 percent) analyzed by ACEEE in its recent full meta-analysis of EE potential;
- While supportive of EPA’s conclusions, it is important to understand the complexity of EE potential studies, and reasons why such studies tend to vary in results – namely, the purpose of

EE potential analyses are generally tied to specific assessments in the context of utility planning, EE program design, or performance evaluation, and are often constructed to conservatively estimate “achievable” potential considering a number of specific limiting circumstances and market barriers to EE investment that are addressed through state/utility programs. In fact, “achievable” EE potential is a *minimum* estimate, limited by study-specific policy choices and considerations, and is generally only a fraction of the overall “economic” EE resource found to generate savings in excess of costs. As such, the achievable potential discussed in the studies focused on in this report underestimates what the EE potential would be in a world where barriers to EE investment are lowered – possibly significantly – through Clean Power Plan compliance activities and funding;

- Longer-term studies systematically understate actual annual average EE potential by failing to adequately incorporate the impact of the evolution of energy-saving technologies and changes in customer acceptance of energy efficient technologies; the shorter-term studies (e.g., spanning a period of less than 15 years) point to higher EE potentials than the averages found using a wider cohort of studies (which were the bases for both EPA and ACEEE analyses). In our view, failing to incorporate the evolution of EE technologies – particularly in an environment that could include innovative market-driven investment in EE for CPP compliance – represents a downward bias in existing EE potential estimates, and suggests that the results of shorter-term studies are better indicators of energy efficiency potential in the current context;
- A study of national EE potential by McKinsey strongly supports EPA’s conclusions. The Electric Power Research Institute (EPRI) also developed a national EE potential estimate, one that came to a widely different estimate of national EE potential than the McKinsey study. However, when corrected for methodological shortcomings, the EPRI study better matches the McKinsey results with respect to national EE potential; and
- EPA did not incorporate the potential contributions of new state building codes and appliance efficiency standards, which offer a way for states to achieve significant energy savings outside of traditional ratepayer-funded EE programs. This is likely due to the fact that while studies have demonstrated robust potential energy savings from changes in such standards, there are tradeoffs between such savings and the savings possible in traditional EE programs; that is, aggressive codes and standard can reduce – to some extent – potential savings from EE programs. Thus, it is difficult to develop a precise estimate of combined potential without a clear indication of the relationship between savings from building envelope and appliance EE programs and that of building codes and appliance efficiency standards. Nevertheless, the literature indicates that codes and standards can, by themselves, achieve savings comparable to those EPA projects under building block 4, and reinforce our conclusion that EPA’s proposed savings targets are readily achievable.

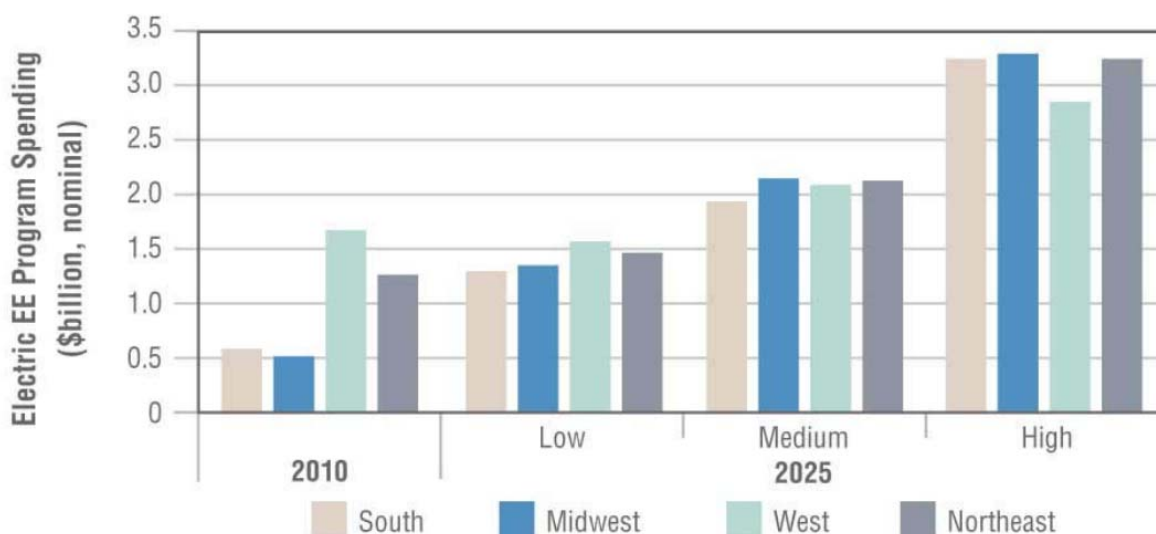
In short, we have comprehensively reviewed the studies that underlie EPA’s assessment of EE potential, the ACEEE meta-analysis and individual studies that underlie that review, national EE potential assessments, and studies estimating the potential impact of building codes and appliance efficiency standards. Based on our analysis we conclude that EPA’s estimate of annual average EE potential does not consider the impact of expanded market reach that would flow from the eligibility of EE for Clean

Power Plan compliance, understates the impact of building codes and appliance standards, and focuses solely on conservative measures of EE potential. Consequently, while we conclude that EPA’s estimate and conclusions regarding EE potential are strongly supported by our analysis of EPA’s approach and the EE literature, it likely underestimates the potential for EE savings actually achievable by states across the U.S., particularly if EE is available as a CPP compliance alternative.

2. Introduction

Energy efficiency (EE) has become a key focus of state energy policy in recent years, with U.S. customer-funded electric efficiency budgets totaling \$6.3 billion in 2013, a 37 percent increase over 2010 totals, and almost four times the national spending in 2006. Lawrence Berkeley National Laboratory (LBNL) predicts that, by 2025, energy efficiency budgets could exceed \$12.2 billion under its “high” scenario assuming that no new major policy developments (such as a national carbon policy) take place, noting that such new policy changes could “result in customer-funded energy efficiency program spending and savings that exceed the values in our High Case.”² See Figure 1. The U.S. Environmental Protection Agency’s (EPA) Clean Power Plan represents the type of national carbon policy that could have an amplifying impact on national EE spending.

Figure 1: Projected Electric Energy Efficiency Program Spending³



EPA’s Clean Power Plan will establish state-specific standards for the amount of CO₂ allowed to be emitted per megawatt-hour of electricity produced at affected facilities. In setting the standards

² Barbose, G. L., C.A. Goldman, I. M. Hoffman, M. A. Billingsley, “The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025,” January 2013, LBNL-5803E, available at <http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-projected-spend>.

³ Figure is from Barbose, G. L., C.A. Goldman, I. M. Hoffman, M. A. Billingsley, “The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025,” January 2013, LBNL-5803E, available at <http://emp.lbl.gov/publications/future-utility-customer-funded-energy-efficiency-programs-united-states-projected-spend>.

applicable to each state's power plants, EPA used a standardized methodology to analyze the emission reduction potential in each state based on assumptions about the amount of emissions reduction that could occur through investments and operational changes at affected power plants, through efficiency improvements at certain existing carbon-emitting generating sources, expanded use of existing and new low- and zero-carbon generating sources, and through energy efficiency. (EPA refers to these as its "building blocks.") EPA's fourth building block focuses on increased deployment of demand-side energy efficiency in order to reduce the amount of electric generation required and lower carbon emissions.

As part of this building block, EPA evaluated in part the technical, economic, and achievable energy efficiency potential, finding that a majority of EE savings could be achieved through the sort of EE program and measure strategies employed by electric industry participants in numerous states across the U.S. EPA finds that achievable potential from these types of EE programs is 1.5 percent of retail sales per year, based on a review of existing state programs and a meta-analysis of recent EE potential studies.

EPA's analysis of EE potential draws from the results of EE potential studies that have been carried out within the last decade that are relevant to the question of what the EE potential is across the states. In this Report we evaluate the reasonableness of EPA's assumptions by considering the context for energy efficiency investments under the Clean Power Plan versus the traditional model for EE investment, reviewing the EE potential analyses that EPA focused on in developing the Clean Power Plan, and researching in detail individual studies and meta-analyses of EE technical potential beyond those reviewed by EPA.

Our review includes the following components, in the order discussed in the following sections:

- Review of EPA's incorporation of EE in the Clean Power Plan goals and the analysis carried out by the Agency to determine appropriate assumptions for state EE savings potential, including its review of traditional utility programs and measures, as well as building codes and appliance efficiency standards;
- Literature review of energy efficiency potential studies, including a description of how EE potential is defined and how such studies are performed, challenges in comparing results across studies, specific review of the studies considered by EPA in developing the Clean Power Plan; and assessment of available information on building codes and appliance standards;
- Findings based on our review of available studies and analyses.

3. EPA's Clean Power Plan and Energy Efficiency

Overview

On June 2, 2014, the U.S. EPA proposed rules to reduce CO₂ emissions from existing electric generating units (EGUs) through Section 111(d) of the Clean Air Act (CAA).⁴ The proposed rules, called the “Clean Power Plan,” are expected to lower CO₂ emissions from the power sector by 30 percent relative to levels in 2005. EPA proposes a two-part timeline for control requirements: an “interim goal” that states must meet on average over the ten-year period from 2020-2029 and a “final goal” that states must meet at the end of that period in 2030 and thereafter. Under the CAA, EPA establishes the target level of emission reductions for each state, and the states develop (and submit to EPA for approval) State Plans to meet EPA’s requirements.

EPA’s proposal sets state-specific standards, in pounds of CO₂ emitted per megawatt-hour (MWh) of electricity produced at affected facilities. In setting the standards applicable to each state’s power plants, EPA used a standardized methodology based on assumptions about the amount of emissions reduction that could occur through investments and operational changes at affected power plants, through zero-carbon generating sources, and through energy efficiency. (EPA refers to these as the “building blocks.”) No state, however, is required to use all of these approaches.

States may choose from a wide variety of potential compliance mechanisms, actions and investments. Among the many options are: modifications at existing EGUs to increase their power-production efficiency; operating limits at EGUs; real or shadow prices on carbon emissions; emission-averaging across power plants; participation in single state or multi-state market-based emission-trading programs (mass- or rate-based); reliance on non-fossil alternatives, including ones that reduce demand through energy efficiency (and therefore reduce output at fossil plants), and others that retain/increase low/zero-CO₂ emitting resources (e.g., new renewable energy and existing or new nuclear capacity).

Each state will choose what elements to include in its State Plan for compliance. States may also be able to layer on various approaches as part of their State Plans. For example, rather than requiring a specific rate limitation at each affected plant, a state with vertically

EPA's Proposed Clean Power Plan:

- State-specific targets to reduce CO₂ in lb/MWh produced at existing fossil-fuel power plants.
- Two compliance periods: 2020-2029 (averaging compliance over the decades, to meet an interim target) and another by 2030.
- State Plans to be submitted to EPA to show how the state and the power plants within it will comply with the targets.
- States have the flexibility to propose a wide variety of options in their plans, including actions that directly affect emissions from fossil power plants (EGUs) and actions that indirectly affect those EGUs’ emissions (such as through energy efficiency, policies that encourage more investment in zero-carbon power generation technologies, or changes to electric transmission infrastructure).
- States may propose market-based mechanisms.
- States may join together for regional plans.
- States may use a “rate-based” approach (i.e., CO₂ lb/MWh) or a “mass-based” approach (i.e., a total amount of CO₂ allowed to be emitted in the state, sometimes also called a CO₂ budget or cap).

⁴ Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units; Proposed Rule, Environmental Protection Agency, 40 CFR Part 60, Federal Register, Vol. 79, No. 117, June 18, 2014 (hereafter the “Clean Power Plan”).

integrated utilities could decide to allow all of the plants owned by a particular company to average the emissions across its fleet.

Importantly, the Clean Power Plan allows a state to meet requirements through market-based approaches that leave the market to determine the cheapest compliance options, minimizing the state's overall compliance cost. As an extension of this, states may also decide to enter into agreements with other states that establish an overall blended-average emissions cap, and allow owners of plants in multiple states to trade their emissions reductions so that on average, all plants in the relevant states achieve the average emission-reduction target.

The Clean Power Plan's Four Building Blocks

In setting its state-specific standards, EPA considered four building blocks that can be used to reduce carbon emissions. EPA then analyzed historical data about emissions and the power sector to create a consistent national formula for reductions that reflects these four building blocks. The formula applies the building blocks to each state's specific circumstances, yielding a carbon intensity rate for each state in pounds of CO₂ per MWh. These building blocks and assumptions are as follows:

1. *Improved Heat Rates.* Fossil fuel power plants can undergo improvements in equipment and processes to use less fossil fuel to create the same amount of electricity, thus lowering carbon emissions per MWh. In setting its state emissions goals, EPA assumed that coal steam electric generating units in each state would undergo an average heat rate improvement of six percent.
2. *Increased Dispatch of Existing Low-Emitting Power Sources.* Less carbon pollution can be generated by using lower-emitting power plants more frequently to meet demand and using the most carbon-intensive power plants less frequently. EPA assumed that existing and under-construction natural gas combined cycle (NGCC) plants would be dispatched to achieve an average capacity factor of up to 70 percent.
3. *Expanded Use of Zero and Low-Emitting Power Sources.* Expanding renewable generating capacity, such as solar and wind, and using low-emitting nuclear facilities can lower carbon emissions. EPA assumed that new clean generation, including new nuclear generation under construction, moderate deployment of new renewable generation, and continued use of existing nuclear generation would occur in each state, based on the assumption that under-construction and existing nuclear capacity would achieve an average capacity factor of 90 percent, as well as state-specific assumptions about renewable generation growth.
4. *Increased Deployment of Demand-Side Energy Efficiency.* Reducing demand for electricity will reduce the amount of generation required, lower carbon emissions, and will reduce costs for those consumers and business who consume less power through efficiency investments. EPA assumed that states would achieve annual energy efficiency savings in the amount of 1.5% annually.

Spotlight on Energy Efficiency Potential and Building Codes and Appliance Standards

In support of its fourth building block, EPA’s draft Clean Power Plan presents relevant factors tied to states’ experience with energy efficiency programs to date, future state requirements for the capture of energy efficiency savings, and estimates of the amount of energy efficiency potential available across the states. Based on this analysis, EPA describes its methodology and assumptions regarding states’ abilities to scale their energy efficiency programs in the future and maintain a specific level of energy efficiency savings over time.

In setting standards, EPA identifies the relative opportunity provided by different energy efficiency strategies that could be adopted by states. One option – state efforts to mandate the availability of energy efficiency programs – is identified by EPA as an option offering “the substantial majority of potential savings” based on two national-level energy efficiency studies.⁵ EPA finds that achievable potential from these types of energy efficiency programs is 1.5 percent of retail sales per year, based on a meta-analysis of recent potential studies and the experience of several states that have achieved that level of savings. EPA also notes that improved state and local building codes can make an additional contribution, accounting for between 13 and 18 percent of energy efficiency opportunities, as summarized in Table 1 below.

Table 1: Relative Opportunities Provided by Key Energy Efficiency Programs and Building Codes

Study	Year	EE Programs	Building Codes	Other
ACEEE	2030	77%	13%	10%
Georgia Tech	2035	82%	18%	0%

Source: EPA’s Greenhouse Gas Abatement Measures Technical Support Document, p. 5-11.

In its State Plan Considerations Technical Support Document, EPA notes that it is not proposing to limit the types of renewable and demand-side energy efficiency programs and measures that may be included in a State Plan. EPA does however note that some types of measures, such as state energy-efficient appliance standards and building codes, have not typically been subject to evaluation of energy savings results. As a result, EPA finds that “these types of approaches may have substantial impacts, but may require additional documentation of EM&V [evaluation, measurement and verification] methods in accordance with EPA guidance, including development of appropriate quantification, monitoring, and verification protocols if they do not currently exist.”⁶ Further, EPA notes that compliance with building codes is typically the responsibility of state and local governments, and can be challenging to enforce and measure impacts from.⁷

⁵ EPA’s Greenhouse Gas Abatement Measures Technical Support Document, p. 5-11.

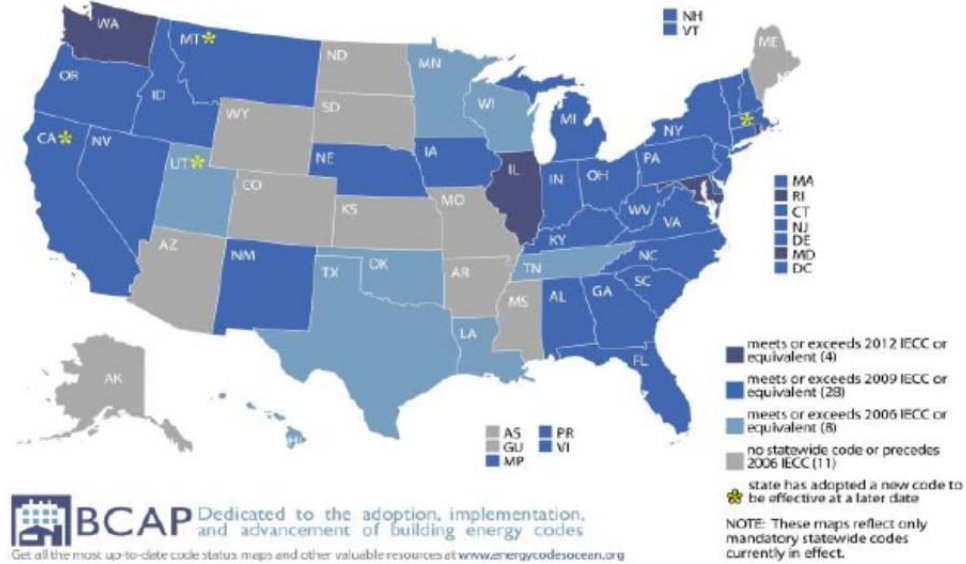
⁶ EPA’s State Plan Considerations Technical Support Document, p. 36 (hereafter “State Plan TSD”).

⁷ EPA notes that building codes “are often not fully or uniformly implemented for numerous reasons, including an emphasis on health and safety issues over the proper functioning of mechanical equipment, a lack of trained staff to review building plans and conduct onsite inspections, and limited funding to carry out key implementation activities. As a result, most jurisdictions do not have the capacity to analyze code compliance and to identify the measures and strategies that should be targeted for improved implementation.” See State Plan TSD, p. 120.

With respect to the implementation status of building codes, EPA notes that 28 states have adopted IECC 2009 while four states have gone further by adopting the IECC 2012. In the commercial sector, 33 states have adopted ASHRAE 90.1-2007 and five states have adopted ASHRAE 90.1-2010. EPA reports that as of February 2014, 11 states have outdated or no state-wide residential energy code, and 9 states have outdated or no state-wide energy codes for commercial construction. The status of state residential and commercial energy codes as presented by EPA is reproduced below in Figure 2 and Figure 3, respectively.

Figure 2: Residential State Energy Code Status

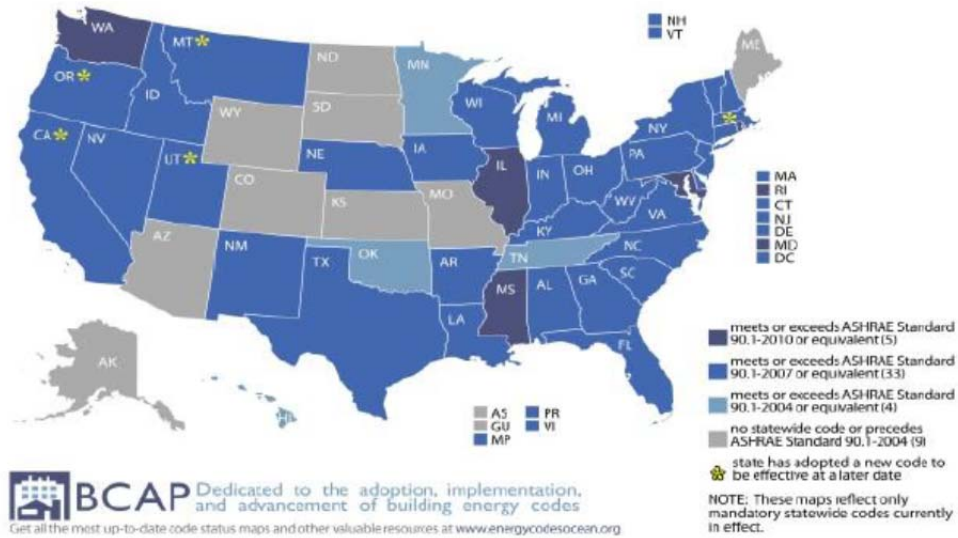
Residential State Energy Code Status AS OF FEBRUARY 1, 2014



Source: State Plan TSD, p. 121.

Figure 3: Commercial State Energy Code Status

Commercial State Energy Code Status AS OF FEBRUARY 1, 2014



Source: State Plan TSD, p. 121.

State appliance standards establish minimum energy-efficiency levels for those appliances and other energy-consuming products that are not already covered by the federal government. EPA notes that states typically find these to offer a cost-effective strategy for improving energy efficiency and lowering energy costs for businesses and consumers, though these standards are superseded when Federal standards are enacted for new product categories. EPA reports that 15 states and the District of Columbia have enacted appliance efficiency standards, though most of these standards have been superseded by federal standards. Still, nine states (AZ, CA, CT, MD, NV, NY, OR, RI, WA) and the District of Columbia have either enacted standards for equipment not covered federally or obtained waivers to enact tougher appliance standards where the federal regulations have become outdated. California currently leads all states in active state standards, covering 13 products, including consumer audio and video products, pool pumps and hot tubs, vending machines, televisions, battery chargers, and various lighting applications.⁸

Evidence Offered by EPA in Support of its Energy Potential Assumptions

Chapter five of EPA's Greenhouse Gas Abatement Measures Technical Support Document⁹ (GHG TSD) provides background on demand-side energy efficiency as an abatement measure to reduce carbon dioxide and further explains EPA's findings in support of its assumptions regarding states' abilities to achieve carbon reductions through these programs. As part of these assumptions, EPA calculated specific energy-efficiency targets across a broad range of categories, including energy-efficiency program/measure potential and building codes and appliance standards. To calculate energy-efficiency potential, EPA conducted a meta-analysis of recent potential studies and identified, based on this analysis, an average annual achievable potential of 1.5 percent. This number is used as an input to EPA's determination of state emission rate goals.¹⁰

EPA's meta-analysis relied on twelve studies conducted between 2010 and 2014 that report energy potential estimates at the utility, state or regional level. Average annual achievable potential is calculated by dividing the cumulative percentage savings by the duration, in years, of the study.¹¹ EPA notes that the studies selected for review are recent studies that supplement prior meta-analyses conducted by Eldridge (2008) and Sreedharan (2013).¹²

Of the twelve studies included in EPA's meta-analysis, eleven report economic potential, and ten report achievable potential. EPA conservatively relies on the minimum potential values (achievable) to

⁸ State Plan TSD, pp. 122-123.

⁹ Technical Support Document (TSD) for Carbon Pollution Guidelines for Existing Power Plants: Emission Guidelines for Greenhouse Gas Emissions from Existing Stationary Sources: Electric Utility Generating Units, GHG Abatement Measures, Docket ID No. EPA-HQ-OAR-2013-0602.

¹⁰ EPA GHG Abatement Measures, p. 5-1, EPA, "Goal Computation Technical Support Document," Technical Support Document for Carbon Polluting Guidelines for Existing Power Plants: Emission Guidelines for Greenhouse Gas Emissions from Existing Stationary Sources: Electric Utility Generating Units, Docket ID No. EPA-HQ-OAR-2013-0602, June 2014.

¹¹ EPA GHG Abatement Measures, p. 5-22.

¹² Sreedharan, P. 2013. Recent estimates of energy efficiency potential in the USA. Energy Efficiency. Eldridge et. al. 2008. State-Level Energy Efficiency Analysis: Goals, Methods, and Lessons Learned. 2008 ACEEE Summer Study on Energy Efficiency in Buildings.

calculate the 1.5 percent value it uses in CPP analyses. The studies are geographically diverse and represent eleven states and one geographic region, the Pacific Northwest.¹³ Additionally, the studies are conducted by a wide variety of consulting firms, state commissions, and other entities, and are varied in terms of study duration. Results on achievable potential from the individual studies are wide-ranging from a minimum of 0.8% in New Mexico to 2.9% reported in Pennsylvania.¹⁴ See Figure 4 for a summary of the EPA’s meta-analysis.

Figure 4: EPA’s Meta-Analysis Results

<u>State</u>	<u>Client</u>	<u>Author</u>	<u>Study Year</u>	<u>Study Period</u>	Average Annual Projected Potential as % of Baseline Sales	
					<u>Economic</u>	<u>Achievable</u>
Arizona	Salt River Project	Cadmus Group	2010	2012-2020	3.2%	2.2%
California	CEC	CEC	2013	2014-2024	n/a	0.9%
Colorado	Xcel Energy	Kema, Inc.	2010	2010-2020	1.8%	1.4%
Delaware	Delaware DNR/DEC	Optimal Energy, Inc.	2013	2014-2025	2.2%	n/a
Illinois	ComEd	ICF International	2013	2013-2018	5.3%	1.7%
Michigan	Michigan PSC	GDS Associates	2013	2013-2023	3.1%	1.4%
New Jersey	Rutgers University	EnerNOC Utility Solutions	2012	2010-2016	1.8%	0.8%
New Mexico	State of NM	Global Energy Partners	2011	2012-2025	1.1%	0.8%
New York	ConEd	Global Energy Partners	2010	2010-2018	2.9%	1.7%
Pacific Northwest (ID, MT, OR, WA)	US DOE	Lawrence Berkeley National Lab.	2014	2011-2021	1.9%	n/a
Pennsylvania	PA PUC	GDS Associates and Nexant	2012	2013-2018	4.5%	2.9%
Tennessee	TVA	Global Energy Partners	2011	2009-2030	1.1%	0.9%
				Range	1.1%-5.3%	0.8%-2.9%
				Average	2.6%	1.5%

Source: EPA, GHG Abatement Measures, pp. 5-65, 5-66.

EPA’s meta-analysis is geographically diverse and captures results across a variety of recent studies and methods. However, more extensive studies of energy efficiency potential have been conducted, and shed light on the reasonableness of EPA’s conclusions. For example, ACEEE reviewed 45 studies as part of their energy potential meta-analysis released earlier this year. A comparison of EPA’s results with those of the ACEEE Study is presented later in this Report.

¹³ The states represented are Arizona, California, Colorado, Delaware, Illinois, Michigan, New Jersey, New York, New Mexico, Pennsylvania, and Tennessee. See EPA GHG Abatement Measures, p. 5-66.

¹⁴ See EPA GHG Abatement Measures, p. 5-66.

4. Literature Review of Energy-Efficiency Potential Studies

EE potential studies have been conducted for decades to help identify opportunities for the installation of cost-effective energy-efficiency programs and measures. Results from EE potential studies are used to identify energy-savings opportunities, assist with energy-efficiency program design, and make the policy case for energy efficiency. Specifically, the data are used to determine energy-savings targets, funding levels, and assist with electric system planning.¹⁵ Studies are conducted by various stakeholders including utilities, regulators and other interested parties and are commonly used as inputs to state Integrated Resource Plans (IRP), the designing of energy efficiency programs, and for creating action plans for energy efficiency. This section provides background on EE potential analysis, starting with a review of the methods used and challenges associated with conducting EE potential studies, followed by a summary of EPA's approach to reviewing EE potential.

Depth and Conservatism in Energy Efficiency Potential Studies

In 2007, as part of the National Action Plan for Energy Efficiency (NAPEE), EPA released a guide that outlined the key concepts and steps for conducting an EE potential study.¹⁶ As part of this guide, EPA characterized EE potential studies by their application, and separated them by their level of detail and rigor of analysis based on this characterization. The three applications identified – from lowest level of detailed analysis to highest level of detailed analysis – are 1) building policy support and making the case for energy efficiency programs and funding; 2) studies that evaluate efficiency as an alternative to a supply-side project; and 3) studies to determine how much to spend on efficiency.¹⁷ The different applications affect the assumptions, detail of the analysis, and the accuracy and comparability of the results.

Although many potential studies have been published in the last few years, a review of the studies reveals the highly case-specific nature of rigorous and thorough EE potential analyses, which produce reasonable potential estimates in a manner that, while generally consistent in approach, reflect the diversity of EE program approaches, maturity, and regulatory/political context. As a result each individual study may use different definitions of EE potential and rely on different specific methods and underlying assumptions, reflecting, e.g., whether or not achievable potential should reflect a budget cap or constraint.¹⁸ For example, in identifying aspects of conducting EE potential studies, the Regulatory Assistance Project (RAP) lists different definitions of “achievable” savings as the number one element of EE potential studies that contributes to potentially wide variations in study results.¹⁹ This is an important element of the current context, because studies often distinguish *economic* and *achievable* by reducing *economic* potential to reflect market barriers to customer adoption of economic EE programs and measures that may be significantly reduced through CPP EE compliance opportunities.

¹⁵ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. 2-2.

¹⁶ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007.

¹⁷ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. ES-2.

¹⁸ Kramer, Chris and Glenn Reed, “Ten Pitfalls of Potential Studies,” RAP, November 2012, p. 5.

¹⁹ Kramer, Chris and Glenn Reed, “Ten Pitfalls of Potential Studies,” RAP, November 2012, p. 5.

Another challenge in constructing EE potential studies is how to incorporate the evolution and future cost of EE technologies, approaches, and measure installations, and in the policy and economic context for EE investments. Predicting the future is inherently difficult, and doing so across the myriad of necessary inputs needed for an EE potential study results in significant constraints on EE potential estimates. Such inputs necessarily include assumptions about future technology growth, capability, and cost; consumer behavior in response to changing technological conditions; and changes in economic conditions that often govern whether or not an EE program or measure is cost effective, or achievable. In light of these uncertainties, studies often omit future technologies and approaches to EE, which by definition lowers the ultimate measurement of achievable EE potential, particularly for longer lead-time studies.²⁰ As a result, energy efficiency potential studies tend to be conservative in their results. The National Academy of Sciences, in their 2010 study of energy efficiency noted “the plausible uncertainty around the median savings figures reported here is not symmetric. The risk of overestimating efficiency potential is minimal, owing to the methodologies that are used in the studies. Instead, the studies openly and intentionally make assumptions that lead to “conservatively” low estimates of the efficiency resource.”²¹

Definitions of Energy-Efficiency Potential

Energy-efficiency potential is primarily defined in three categories: technical, economic, and achievable.²² Technical potential is defined by the EPA as “the theoretical maximum amount of energy use that could be displaced by efficiency, disregarding all non-engineering constraints such as cost-effectiveness and the willingness of end-users to adopt the efficiency measures.”²³ Economic potential “refers to the subset of the technical potential that is economically cost-effective as compared to conventional supply-side energy resources.”²⁴ Achievable potential is a subset of economic potential and is defined by the EPA as “the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario... [and] takes into account real-world barriers to convincing end-users to adopt efficiency measures.”²⁵ Figure 5 below illustrates the three types of energy potential and demonstrates the levels of potential as subsets of one another.²⁶ Achievable potential is most widely used in practice because it has been the most conservative for planning purposes in terms of representing actual savings opportunities in the context of utility-driven EE programs supported generally by electric rates.

²⁰ Goldstein, David B., “Extreme Efficiency: How Far Can We Go If We Really Need To?” NRDC, 2008 ACEEE Summer Study on Energy Efficiency in Buildings, p. 10-50.

²¹ The National Academy of Sciences, “Real Prospects for Energy Efficiency in the United States,” 2010, p. 59

²² Note, some studies include a fourth level of potential sometimes called program potential.

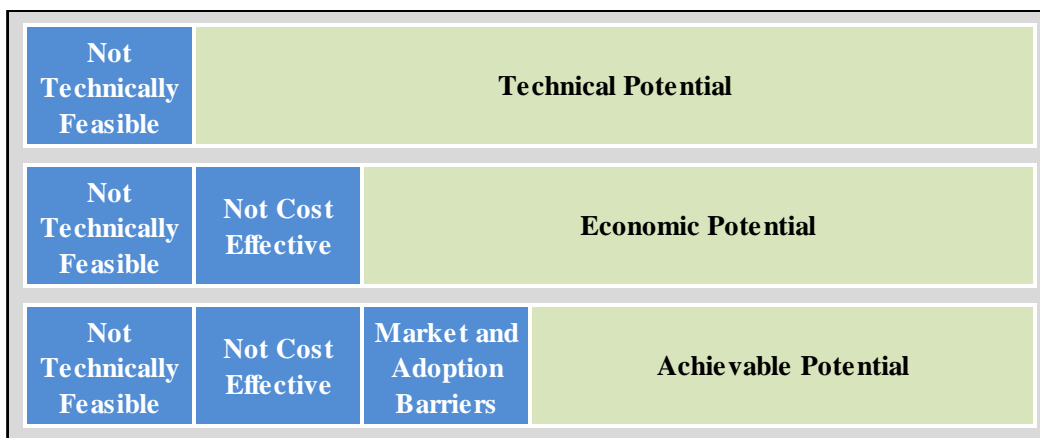
²³ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. 2-4.

²⁴ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. 2-4.

²⁵ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. 2-4.

²⁶ This figure was recreated from EPA’s Guide (and RAP) Kramer, Chris and Glenn Reed, “Ten Pitfalls of Potential Studies,” RAP, November 2012, p. 17.

Figure 5: Categories of Energy-Efficiency Potential



Definitions of technical and economic potential are generally widely accepted. However, despite agreed upon definitions, levels of technical potential will vary due to differences in how many cost-effective savings opportunities are included and the differences in thresholds for cost-effectiveness that are used in particular studies.²⁷ Defining achievable potential is more often where definitional differences arise. The EPA notes that the number of measures included in calculating achievable potential can range from 20 to over 1,000, in addition to the variations of the study’s timeframe, scope and comprehensiveness. The number of measures to include is determined by the state or group conducting the potential study and varies due to the scope and breadth of the analysis. An increase in the measures included increases the opportunity for potential and therefore studies with a small number of measures will understate energy efficiency potential. All of these factors result in differences in definitional and in the resulting achievable potential values.²⁸

To illustrate the point of varying definitions, Figure 6 below shows three definitions of achievable potential from studies done by the Cadmus Group between 2011 and 2013.²⁹ Despite the Cadmus Group calculating “achievable potential” in each study, the circumstances of the particular study result in different definitions. For example, in the PacifiCorp example, the definition of achievable potential does not consider cost effectiveness because it was not needed to inform the IRP process. Additionally, in the Vermont definition, Cadmus provides more specificity about the non-measure costs included in the definition. While these definitions don’t vary widely, it is important to note the subtle differences that will result in varying energy-efficiency potential levels.

²⁷ Nadel, Steven, et. al., “The Technical, Economic, and Achievable Potential for Energy Efficiency in the United States: A Meta-Analysis of Recent Studies,” ACEEE, 2004.

²⁸ EPA, “Guide for Conducting Energy Efficiency Potential Studies,” November 2007, p. 2-5.

²⁹ The Cadmus Group conducted one of the studies in the EPA’s meta-analysis, but these definitions are from other Cadmus studies.

Figure 6: Examples of Different Definitions of Achievable Potential

<u>Year</u>	<u>Author</u>	<u>Study Region</u>	<u>Achievable Potential Definition</u>
2011	GDS/Cadmus	Vermont	Achievable potential is the amount of energy use that efficiency can realistically be expected to displace assuming the most aggressive program scenario possible (e.g., providing end-users with payments for the entire incremental cost of more efficiency equipment). This is often referred to as maximum achievable potential. Achievable potential takes into account real-world barriers to convincing end-users to adopt efficiency measures, the non-measure costs of delivering programs (for administration, marketing, tracking systems, monitoring and evaluation, etc.), and the capability of programs and administrators to ramp up program activity over time.
2012	Cadmus	Iowa Util. Assoc.	Market potential represents a realistic upper bound to potential savings from cost effective efficiency programs that could be achieved offering incentives up to 100% of incremental cost, availability of financing to cover additional up-front costs, adoption of emerging technologies, and other best practices for efficiency programs.
2013	Cadmus	PacifiCorp	Achievable technical potential represents the portion of technical potential that might reasonably be achievable in the course of the 20-year planning period, given the possibility that market barriers could impede customer adoption. At this point, it does not consider cost-effectiveness, as identified levels of achievable technical potential principally serve as planning guidelines and to inform the IRP process.

It is also important to note that while the term “achievable potential” may imply that anything above that (technical and economic) is unachievable, this is not the case. Achievable potential is used in policy decisions, IRPs, and program designs because it is considered the most appropriate as the basis for financing and planning purposes in a given context typically characterized by limiting legislative authorities, state policies, regulations, and spending caps or guidelines. Achievable potential is therefore a highly conservative estimate of the amount of energy efficiency that is economic, or the amount that is technically possible to achieve. In the simplest example, a portion of economic potential may not be deemed achievable because there is a limit on the rate of EE spending under a specific program, or the current set of EE contractors is insufficient to implement a substantial portion of economic potential over the time frame of interest. Thus, many of the considerations relevant in translating economic potential into achievable potential are less – or not – relevant in the context of the Clean Power Plan, where the driving incentive is the availability of energy efficiency to serve as an emission reduction mechanism constrained only by whether it can lead to CPP compliance at a cost lower than alternatives (e.g., plant efficiency, fuel switching/substitution, etc. This will be discussed in greater detail later.

Energy-Efficiency Potential Study Methodologies

At a high level, there are a series of steps that need to be done to conduct an energy potential study and to specifically calculate technical, economic, achievable potential. Below, explanations of the basic steps needed to calculate each form of potential will be explained and several different methodology approaches will be discussed in more detail.

- *Technical Potential:* Assessing technical potential requires creating a baseline energy consumption forecast while taking into account what energy efficiency is already included in the

baseline such as codes and standards and planned efficiency programs. Then the baseline energy consumption needs to be broken down to the sector and end-use level to determine the amount of energy by each end use that could possibly be saved through energy efficiency. Primary sources of data to for these steps include using utility data and customer surveys.

- *Economic Potential:* Calculating the subset of technical potential that is economic potential requires evaluating which energy-efficiency measures are cost effective. Cost-effectiveness tests are used to evaluate the viability of demand-side programs and the most common of these tests used in practice is the total resource cost (TRC) test,³⁰ which measures the overall cost and benefit to society. The test measures the costs and benefits of a demand-side management program including the participant, stakeholder, and utility’s costs and can be presented as an NPV, a benefit-cost ratio or as a levelized cost.³¹ For example, the benefit-cost ratio formula is shown below:³²

$$\text{TRC} = \frac{\text{Benefits of Avoided Cost}}{\text{Technology Cost} + \text{Program Administrative Cost}}$$

The cost side of the equation includes the costs paid by the program sponsor (e.g., utility) and the recipient (e.g., customer contributions), including the cost to the utility of administering the program. The benefit side is associated with the cost of generating and delivering capacity, energy and ancillary services to the customer avoided through the EE program or measure. A ratio of greater than 1 indicates that a \$1 investment receives greater than \$1 in benefits whereas a ratio of less than 1 indicates the costs outweigh the benefits. Different studies will use different thresholds for passing the TRC test, but generally measures are included if the ratio is greater than 1. In addition to the TRC, other studies utilize less common costs tests.³³ While not considered further in our review, it is important to note that the TRC is narrow assessment of costs and does not include non-energy benefits of energy-efficiency such as public health improvements and avoided climate change risks that are benefits of reduced emissions. The Societal Cost Test (SCT) does include these non-energy benefits, but the SCT in practice is not used nearly as frequently as the TRC. While there is no best test to use, determining which test

³⁰ EPA, “Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers,” November 2008, p. ES-2.

³¹ CPUC, “California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,” October 2001, pp. 18-19.

³² For example, this definition of TRC was used in Navigant, “2013 California Energy Efficiency Potential Study Goals,” 2013, p. 50.

³³ In 2001, the CPUC created definitions of the various cost-effective tests to create a standardized means of evaluating analyses across studies. In addition to the TRC, other cost-effectiveness tests include the participant test, the ratepayer impact measure test, the societal cost test and the program administrator test. See CPUC, “California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects,” October 2001.

is appropriate for a given study is critical and making the underlying assumptions to these cost tests is also important to ensure accurate results.³⁴

- *Achievable Potential:* Calculating the subset of cost-effective potential that is achievable requires forecasting consumer adoption of energy-efficiency measures. Using technology adoption curves or direct estimation of adoption rates are two techniques that are used in such analyses; techniques that tend to require a significant level of limiting assumptions and subjective judgment. Many studies use customer surveys to obtain estimates of expected customer behavior. Additional steps include identifying the overall estimated market penetration or impact of the program in the relevant state or utility context and then calculating the total savings potential.

Different methodologies are used across the studies to perform the calculations described above, but the most common methodology is a bottom-up assessment to calculate the three types of potential. Of the studies reviewed for this report, the majority of methods used bottom-up assessments. Other methods include a bottom-up/top-down combination, meta-analyses, or combinations of all three. Below the bottom-up and top-down methods are discussed in more detail.

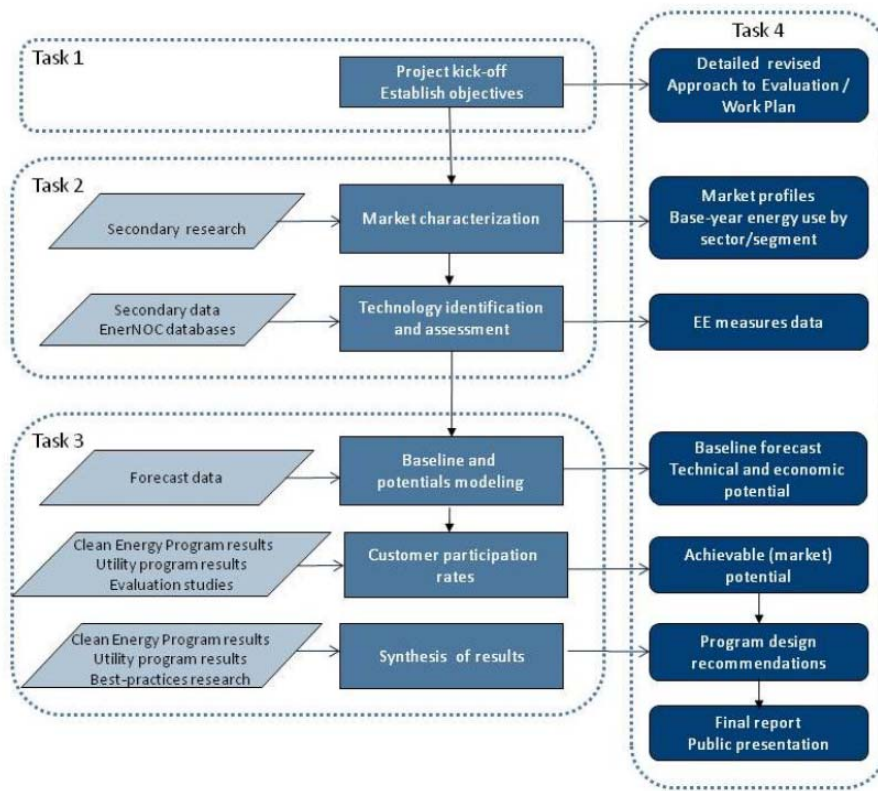
- *Bottom-up Assessment:* In a bottom-up analysis, calculations start at the individual appliance level where savings are determined by the energy saved when replacing individual pieces of equipment with the more efficient technology. This is done across all sectors and end uses where the data are available.³⁵ These measures are then applied against the baseline forecasts to calculate technical potential, cost-effectiveness is evaluated for each measure, and finally, customer participation is calculated to reach achievable potential. An example of a bottom-up assessment from the EPA's underlying meta-analysis studies is EnerNOC's assessment of New Jersey's energy efficiency potential to help inform funding levels for energy efficiency programs over the following four year period. Figure 7 is a sample diagram of a bottom-up assessment method, the processes of collecting data, conducting assessments, calculating potential, culminating in the ultimate program design decisions.³⁶

³⁴ EPA, "Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers," November, 2008, pp. ES-1, ES-2.

³⁵ EPA, "Guide for Conducting Energy Efficiency Potential Studies," November 2007, p. 3-7.

³⁶ EnerNOC, "New Jersey Energy Efficiency Market Potential Assessment," Report Number 1401, Volume 1, Prepared for Rutgers University, October 17, 2012, p. 2-4.

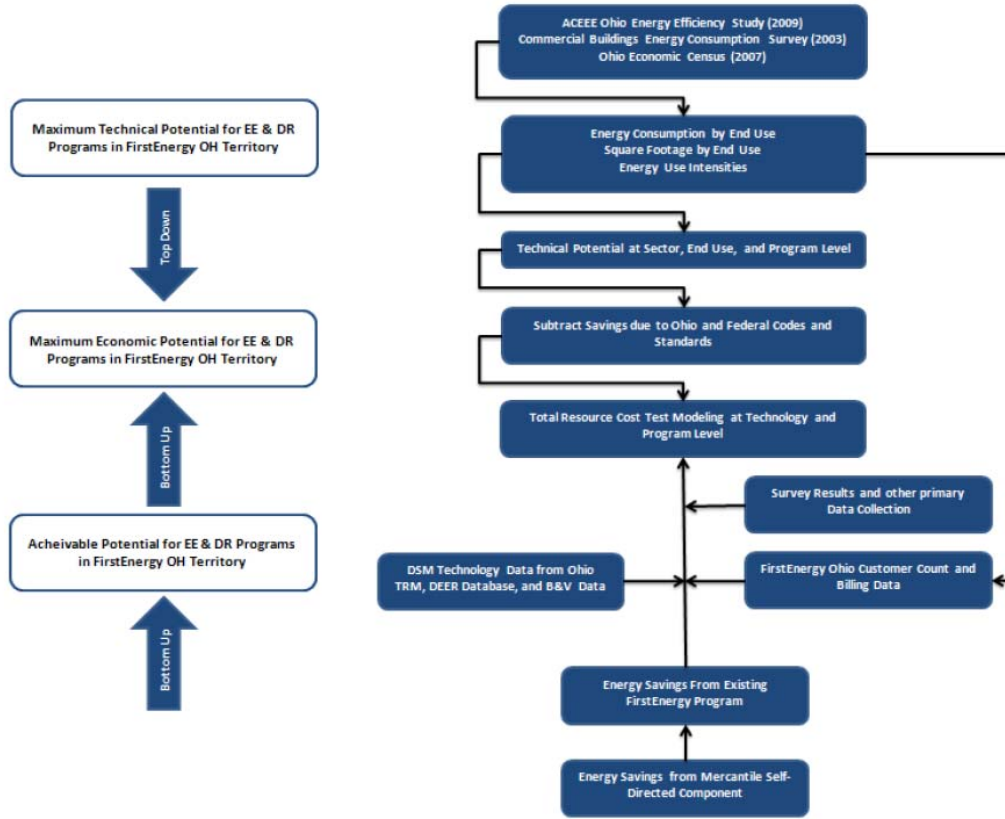
Figure 7: Sample Bottom-up Assessment Methodology



- Top-down assessments are another approach to calculating energy potential, although they tend to be less commonly used. In a top-down assessment, rather than starting at the equipment level the assessment starts at the energy sales level and savings percentages are applied to calculate energy potential. An issue that can arise with the top-down approach however, is that embedded energy-efficiency impacts may already be incorporated into the baseline and may be difficult to untangle. To address this, a combination of top-down and bottom-up assessments is sometimes used; an example of this approach can be seen in Figure 8 below from a potential study done by Black and Veatch in Ohio.³⁷

³⁷ Black and Veatch, “Market Potential Study: Energy Savings and Demand Reduction for Ohio Edison, Toledo Edison, and the Illuminating Company,” Prepared for FirstEnergy Corp., submitted in Ohio docket 12-2190-EL-POR, July 31, 2012, p. 33 of Appendix D. Note, this study was not included in EPA’s meta-analysis, but rather is a representative example of a top-down/bottom-up assessment.

Figure 8: Sample Bottom-up / Top-Down Assessment Methodology



Assessment of EPA’s Underlying Studies

EPA’s meta-analysis is consistent with other meta-analyses that have been conducted on energy efficiency potential. Our independent review of the studies reveals that they are thorough, geographically diverse, and representative of other studies conducted in the last five years. An examination of the methodologies of the studies reveals that the common bottom-up assessment, described above, is the dominant methodology. Of the ten EPA studies that report achievable energy potential, nine presented detail on study methodologies. Of these nine studies, seven use full bottom-up analyses, while two apply a bottom-up analysis of the residential sector and top-down analyses of the commercial and industrial sectors.³⁸ All regions of the country are represented across the twelve studies, and the studies are generally carried out by prominent consulting firms and other organizations that have conducted many energy potential studies in multiple contexts.

The existence of *state* EE potential studies covering a wide geographic span allows EPA to reasonably assess EE potential across states without needing to conduct original bottom-up assessments of EE potential for each of the fifty states. While evaluation based on existing analyses is complicated by differences in contexts and study methods, conducting a meta-analysis is a reasonable methodology for

³⁸ Bottom-up studies: California, Colorado, Illinois, New Jersey, New Mexico, New York, Tennessee; Combination of top-down / bottom-up: Michigan and Pennsylvania. See GHG Abatement Measures, p. 5-65 and 5-66.

reporting energy efficiency potential results and has been used in many other potential studies. EPA's analysis did not include an assessment of every EE potential estimate in the literature. For example, others, such as EPRI and McKinsey, have carried out independent *national* EE potential assessments that are instructive from a high-level viewpoint. In addition, other studies that are widely cited have used the methodology of a meta-analysis to evaluate energy potential and reach similar results. While each study must develop assumptions around a wide range of factors (costs (of technology, installation, avoided, etc.), participation rates, lifespan of technology, replacement technologies, etc.), the literature overall provides a robust basis for developing estimates of achievable potential. In the next section, we review the studies included in EPA's analysis alongside a number of other recent studies of EE potential, in order to evaluate the reasonableness of EPA's approach.

Review of EE Potential Studies Beyond the EPA's Clean Power Plan

Numerous recent studies assessing energy efficiency potential across a wide array of US states have been published, including the EE potential studies in EPA's meta-analysis. This section summarizes and assesses some of these notable studies and compares them to the conclusions drawn using EPA's subset of studies.

Assessment of ACEEE's 2014 Meta-Analysis

The 2014 Study by the American Council for an Energy-Efficient Economy (ACEEE) on energy efficiency potential – published just months after the release of the Clean Power Plan – is an extensive meta-analysis of studies conducted in the last five years, including those reviewed by EPA.³⁹ Specifically, ACEEE reviewed 45 publicly-available electric and natural gas energy potential studies published between 2009 and 2014 that cover a myriad of sources and geographic regions. The results include a quantitative summary of energy efficiency potential reported in the studies as well as a qualitative deep dive on ten of the studies to fully vet the underlying methods and assumptions.⁴⁰ ACEEE uses the same definitions of energy efficiency potential and calculates annual achievable savings in the same way as the EPA, by taking the cumulative percentage of savings and dividing it by the duration of the study.

In its findings, ACEEE reports annual technical, economic, and achievable potential for electricity and natural gas. ACEEE, for electricity, finds a mean value of economic EE potential of 2.2 percent, and a median of 1.9 percent. Focusing only on achievable EE potential, ACEEE identifies a range of 0.3 percent to 2.9 percent across all geographies studied.⁴¹ These results are then further analyzed to determine the possible effect of study duration and geographic region on the levels of achievable potential. ACEEE finds that the longer the study period, the lower the annual savings. Studies that forecast out over

³⁹ Neubauer, Max, "Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies," ACEEE, Report U1407, August 2014.

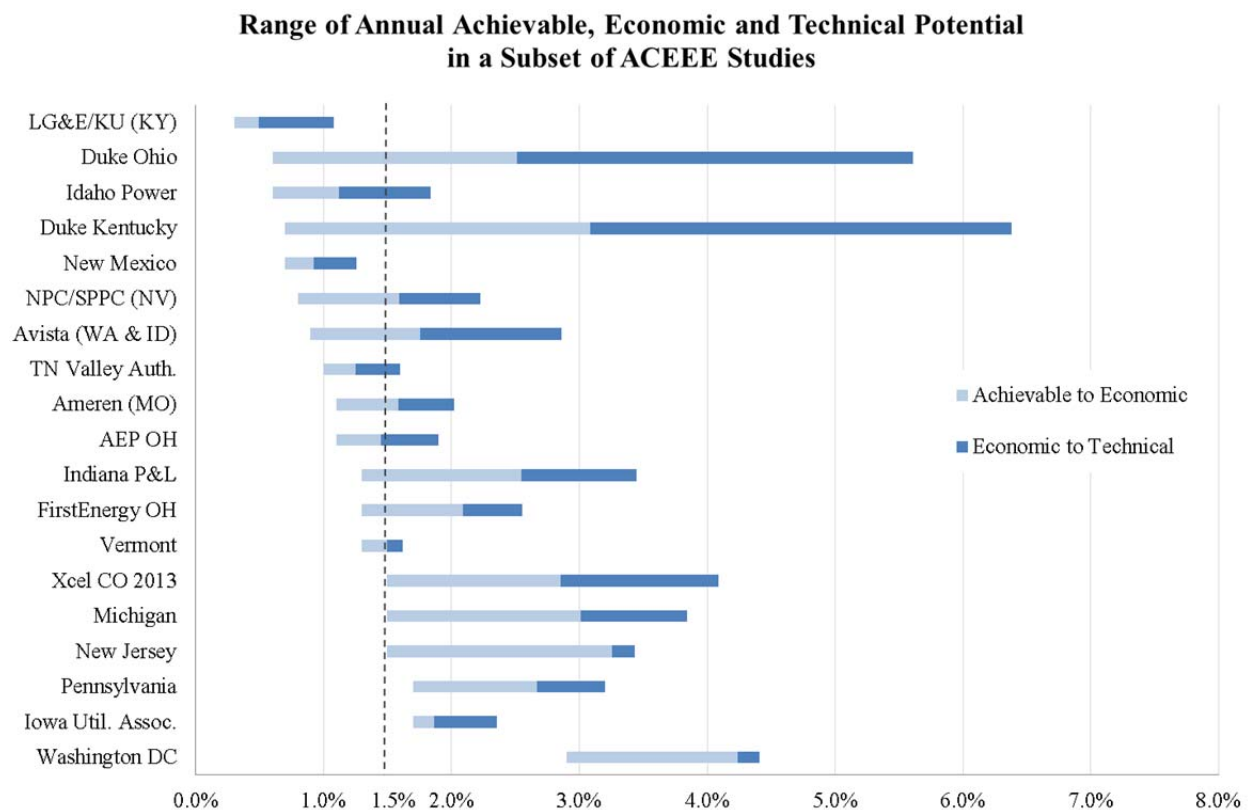
⁴⁰ Ibid, p. 5.

⁴¹ ACEEE also published a study in April 2014 that reported that all states can achieve and sustain cost-effective reductions in electricity consumption of 1.5% per year. See ACEEE, "Change Is in the Air: How States Can Harness Energy Efficiency to Strengthen the Economy and Reduce Pollution," April 2014, Report E1401.

fifteen years likely have lower results because new technologies that far out are not incorporated and assumptions like customer participation may not be accurately reflected so far in advance.⁴²

Figure 9 below shows the range of achievable to economic (and economic to technical) potential on an annual basis for the ACEEE studies that reported all three types of potential. As the figure demonstrates, EPA’s 1.5 percent finding is well within the range of achievable to economic potential estimates. The extent to which states would capture economic EE potential will depend on state CPP compliance directives, power system economics, and the actions of regulated entities. However, as demonstrated in Figure 9, states across the country will have a vast resource of EE compliance investment options that may not only be lower-cost than alternative compliance paths, but are cost effective on their own. That is, the “economic” EE potential (well in excess of EPA’s 1.5 percent finding) available for compliance activities generates savings in excess of costs even absent CPP compliance benefits.

Figure 9

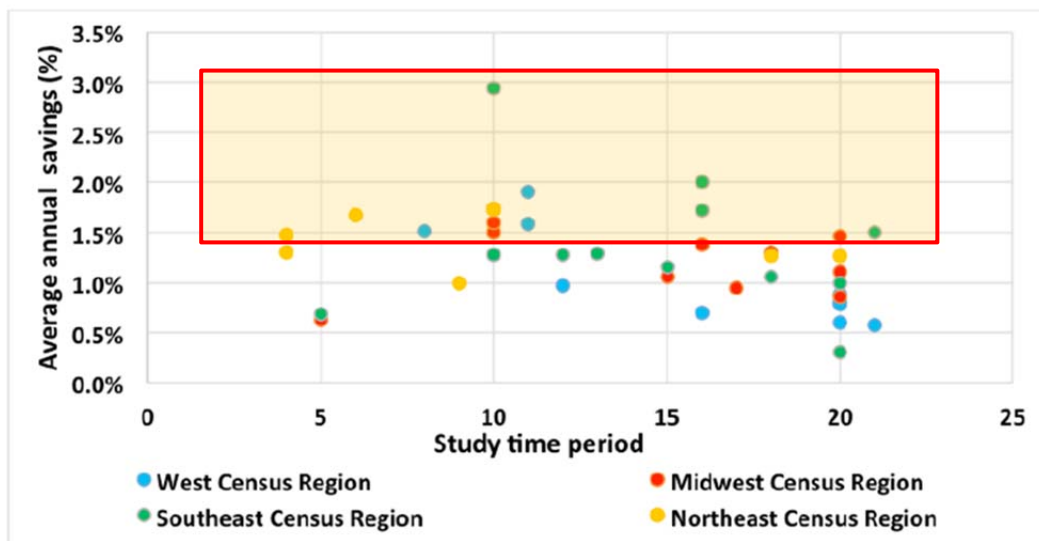


Note: Only studies that reported all three types of potential are included. The low value of each bar is achievable potential and the high value is technical.
 Source: Neubauer, Max, “Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies,” ACEEE, Report U1407, August 2014.

⁴² Neubauer, Max, “Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies,” ACEEE, Report U1407, August 2014, p. 28.

Finally, ACEEE found that geography appeared to have little to no effect on achievable potential, which is consistent with findings in other studies.⁴³ Figure 10 below demonstrates both the study duration and geographic effects on achievable potential based on the ACEEE review.⁴⁴ While this analysis reveals no geographic trend in achievable EE potential, it highlights the fundamental conclusion that all four regions of the country have economic and achievable EE potential in excess of EPA’s 1.5 percent assumption, with some regions hitting this value multiple times and across multiple study time periods. Notably, the average annual savings potential in these estimates represent an annual level of efficiency savings that can be sustained *at least over the time period studied*.

Figure 10: Geographic and Study Duration Effects of ACEEE Studies



Both EPA and ACEEE conducted meta-analyses in 2014 on energy potential, and drew similar conclusions on the potential of EE to generate economic savings. Generally, both EPA and ACEEE conduct robust studies of recent, relevant EE potential analyses. Their studies cover a wide range of geographies, program types, state electricity pricing and energy policy circumstances, and residential/commercial/industrial class program types. The studies included in their reviews are completed by organizations or individuals with deep expertise in EE savings assessments, and generally are deeply vetted by industry participants and peers, and are most often scrutinized as part of state regulatory adjudicatory or regulatory proceedings. EPA’s conclusions regarding a sustainable annual savings of 1.5 percent are reasonable and, if anything, conservative in light of the findings of the underlying EE potential studies reviewed both by EPA and ACEEE.

⁴³ Neubauer, Max, “Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies,” ACEEE, Report U1407, August 2014, p. 30.

⁴⁴ Neubauer, Max, “Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies,” ACEEE, Report U1407, August 2014, p. 30.

National Studies: Assessment of McKinsey and EPRI Studies

EPA and ACEEE meta-analyses focus on achievable potential within states and within company jurisdictions, primarily based on detailed, bottom-up engineering and economic analysis. Two entities – the Electric Power Research Institute (EPRI) and McKinsey – have conducted higher-level, national studies of EE potential, using similar metrics applied in the state- or regional-specific analyses. First, EPRI has published two national energy efficiency potential studies in the past five years, one in 2009 and one in 2014. EPRI’s 2014 efficiency potential study is an update to their 2009 assessment and relies on the same methodology – a bottom-up assessment of the United States as a whole – used in 2009.⁴⁵ EPRI, in their 2014 study, reports 0.4-0.52% annual achievable potential savings, which is an increase from the 0.2-0.4% annual savings from the 2009 study.⁴⁶ The results of EPRI’s two studies are noticeably lower estimates of achievable potential than almost all other EE potential studies we reviewed under any circumstance. For example, across ACEEE’s 45 studies in its meta-analysis, only one study reported a number lower than 0.6%.⁴⁷ Additionally, other experts in the field of EE potential have described EPRI’s 2009 findings as overly-conservative.⁴⁸ Despite these low reported numbers, EPRI states that the “reduction in growth and the creation of minimum efficiency standards that have the effect of reducing efficiency potential this report suggests that there continues to be an ample supply of cost effective energy efficiency for utilities to tap into.”⁴⁹

In 2009 McKinsey also published a national energy efficiency potential study and reported aggregate potential numbers that were far higher than EPRI’s. EPRI reports 473 TWh of economic potential in 2009 compared to McKinsey’s 1,080 TWh of NPV-positive potential for 2009.⁵⁰ A comparison of McKinsey’s and EPRI’s studies helps demonstrate why EPRI’s numbers are lower than other studies. Both McKinsey and EPRI rely on the AEO 2008 reference case as a baseline, but the primary differences arise from McKinsey using a wider range of energy-efficiency measures and market segments in addition to allowing evolution and replacement of certain technologies over time.⁵¹ EPRI is particularly conservative in their estimate because their methodology focuses on existing programs and does not consider as wide a breadth of end-uses of energy or the changes in technology over time that are seen not only in the McKinsey study, but in many of the other potential studies that we have reviewed.⁵² The chart shown below in Figure 11, constructed by McKinsey, illustrates these differences and breaks out

⁴⁵ EPRI, “U.S Energy Efficiency Potential Through 2035,” 2014 Technical Report, p. 2-1.

⁴⁶ EPRI, “Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010-2030),” January 2009, see Figure 2.

⁴⁷ A 2013 Kentucky study reports an annual achievable potential of 0.3%. See Cadmus and EHI, “Energy Efficiency Potential Study: Volume II,” prepared for Louisville Gas and Electric Company and Kentucky Utilities Company, December 2013.

⁴⁸ See, e.g., The Cadmus Group, “Assessment of Energy Efficiency and Load Management Potential (2011-2016),” Prepared for Commonwealth Edison, February 17, 2010, p. 35.

⁴⁹ EPRI, “U.S. Energy Efficiency Potential Through 2035,” 2014 Technical Report, p. vi.

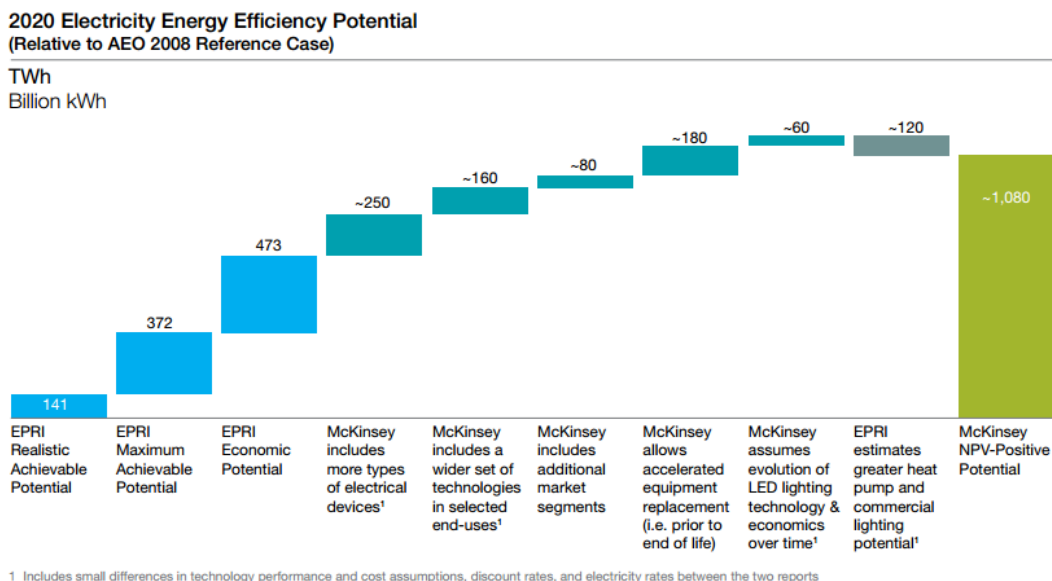
⁵⁰ McKinsey & Company, “EPRI and McKinsey Reports on Energy Efficiency: A Comparison,” 2009.

⁵¹ McKinsey & Company, “EPRI and McKinsey Reports on Energy Efficiency: A Comparison,” 2009.

⁵² EPRI, “U.S Energy Efficiency Potential Through 2035,” 2014 Technical Report, p. 2-1.

the specific assumptions that McKinsey makes that explain the difference between EPRI’s 473 TWh and McKinsey’s 1080 TWh.⁵³ EPRI’s results are incomplete relative to McKinsey’s analysis in part because they evaluate fewer technologies and market segments, and do not assume evolution of technology other than the technologies that existed at that time in the market.

Figure 11: Comparison of EPRI and McKinsey’s 2009 Energy Efficiency Potential



In the 2014 study, EPRI notes that they expanded the scope of some aspects of their methodology, but they also state that their analysis “does not assume the enactment of new energy codes and efficiency standards beyond what is already in law. More progressive codes and standards would yield even greater levels of electricity savings.”⁵⁴ Finally, EPRI’s study period extends out to 2035 without incorporating the cost and technological change likely to occur in the underlying EE programs and measures over this extended time period.

Literature Review - Energy Efficiency Potential from Improved Building Codes & Appliance Standards

Analysis Group reviewed the available literature to determine the extent to which strengthened building codes and appliance standards have and could provide energy efficiency savings and corresponding reductions in carbon emissions. We found evidence that there is ample opportunity for states to include CO₂ reductions through the expansion and enforcement of these types of policies in their State Plans, indicating that there are multiple energy efficiency strategies that could be adopted by states in complying with the Clean Power Plan.

⁵³ EPRI, “U.S Energy Efficiency Potential Through 2035,” 2014 Technical Report, p. 2-1.

⁵⁴ EPRI, “U.S. Energy Efficiency Potential Through 2035,” 2014 Technical Report, p. ix.

For example, ACEEE notes that buildings account for 74 percent of electricity and 41 percent of the total energy use in the U.S., and are responsible for 40 percent of the country's carbon emissions. They identify advanced building codes as a cost-effective strategy for helping consumers save energy and money, making new housing and commercial buildings more affordable, improving comfort, and reducing air pollution.⁵⁵ In July 2014, ACEEE estimated that advanced residential and commercial energy codes⁵⁶ could achieve cost-effective efficiency improvements of a 50 percent reduction in energy intensity by 2016/2018, when compared to a 2004/2006 baseline energy code. These building code provisions would save 1.35 quads of energy (including 94 billion kWh of electricity and 404 trillion Btu of natural gas), with CO2 emissions reductions of 72 million metric tons by 2030.⁵⁷

In a similar report also issued in July 2014, ACEEE notes that appliance, equipment, and lighting efficiency standards have been among the most successful U.S. policies for improving energy efficiency and reducing energy waste. ACEEE estimates that the typical U.S. household saves over \$500 per year in energy bills due to the federal standards that are already in place. For example, a typical new refrigerator uses 70 percent less energy than the typical refrigerator sold in the early 1970s, saving the average consumer about \$150 per year in energy costs.⁵⁸ In a 2012 report, ACEEE estimated that existing national standards will:

1. Save U.S. consumers and businesses more than \$1.1 trillion from products sold through 2035;
2. Save nearly 200 quadrillion Btu of energy cumulatively through 2035, equivalent to two years of current energy consumption in the U.S.;
3. Reduce peak demand for electricity by approximately 237 GW, or 18 percent, in 2035; and
4. Cut annual carbon dioxide emissions in 2035 by 470 million metric tons, an amount equal to the emissions of 118 coal-fired power plants.⁵⁹

In May 2011, the Edison Foundation's Institute for Electric Efficiency (IEE) estimated the savings that could be achieved through the adoption of new building codes and appliance and equipment efficiency standards beyond those embedded in the baseline electric forecast included in the EIA's Annual Energy Outlook for 2011.⁶⁰ Given the uncertainty inherent in the policy-making process, IEE developed two possible codes and standards scenarios – moderate and aggressive – intended to represent a range of possibilities in future legislative and regulatory actions surrounding codes and standards. The moderate scenario layers assumptions onto those embedded EIA's baseline forecast and expands the scope of

⁵⁵ "Advanced Building Energy Codes," ACEEE Policy Brief, July 24, 2014.

⁵⁶ These codes include improvements to residential building codes included in the 2012 and 2015 International Energy Conservation Code ("IECC"), as well as improvements to commercial building codes included in the 2010, 2013, and 2016 updates of the model commercial building code issued by the American Society of Heating Refrigerating and Air-Conditioning Engineers ("ASHRAE").

⁵⁷ "Advanced Building Energy Codes," ACEEE Policy Brief, July 24, 2014.

⁵⁸ "Advanced Appliance and Equipment Efficiency Standards," ACEEE Policy Brief, July 2014.

⁵⁹ 2012 study results as summarized in "Advanced Appliance and Equipment Efficiency Standards," ACEEE Policy Brief, July 2014.

⁶⁰ "Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2025)," Institute for Electric Efficiency, IEE Whitepaper, May 2011.

appliances and equipment that codes and standards address in order to define a plausible range of possible future outcomes that might be considered “likely,” while the aggressive added more aggressive efficiency assumptions onto those embedded in the moderate case.⁶¹ IEE’s results, reproduced below in Table 2, find that significant electric savings from codes and standards are possible: in 2025, savings from improved codes and standards range from 351 TWh under the moderate scenario to 556 TWh under the aggressive scenario, which is equivalent to 8.6 percent and 13.6 percent of the baseline electric forecast (included in the 2011 EIA AEO), respectively. EPA estimates that compliance with the Clean Power Plan will result in cumulative demand-side energy savings that lead to an 8 percent reduction in total generation relative to the base case in 2025, and an 11 percent reduction in 2030; therefore all of the demand-side energy savings needed for compliance could potentially come from aggressive improvements in building codes and equipment and appliance standards alone.⁶² Savings from improved appliance and equipment efficiency standards dominate the savings, providing two-thirds of the total energy savings in the moderate scenario and roughly three-quarters of the total energy savings in the aggressive scenario. IEE notes that the moderate scenario offsets all the growth in the baseline forecast between 2008 and 2025, and by 2025, the aggressive scenario results in a 5.2 percent decrease in electricity use compared to 2008.⁶³

Table 2: Codes and Standards Impacts in 2025 from Residential, Commercial, and Industrial Sectors as Estimated by IEE

	Baseline Forecast (TWh)	Moderate Scenario (TWh)	Aggressive Scenario (TWh)
Electricity Use	4,089	3,738	3,533
Savings from Building Codes		123	129
Savings from Equipment Standards		228	427
Total Savings		351	556
Savings (% of Baseline)		8.6%	13.6%

Source: “Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2025),” Institute for Electric Efficiency, IEE Whitepaper, May 2011.

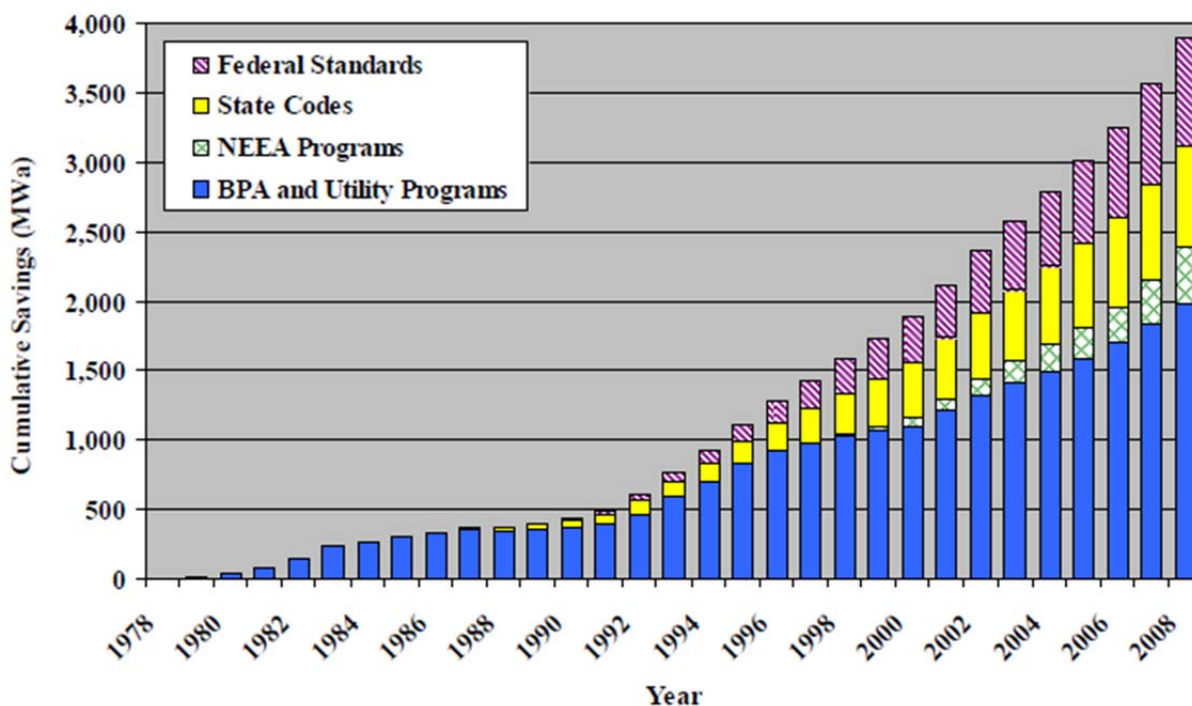
⁶¹ The moderate scenario includes standards for commercial IT equipment, home electronics, furnace fans, and commercial refrigeration equipment. The aggressive scenario assumes a variety of more aggressive assumptions by, for example, assuming that a new federal standard will raise the minimum SEER rating for a central air conditioner to 18, effective in 2022 (rather than to a SEER rating of 16 by 2022 under the moderate scenario); and that a standard for residential and commercial general service lamps and linear tube lighting systems equivalent to 65 and 97 lumens per watt, respectively, that can be met by LED lighting systems currently available in the market. For residential building codes in the moderate scenario, it is assumed that IECC 2012, with estimated energy savings of 25 percent compared to IECC 2006, goes into effect in 2016, and IECC 2015, with energy saving of 45 percent, goes into effect in 2019. The aggressive case uses the same assumptions as the moderate scenario until 2024, when it is assumed that a new code, with energy savings of 60 percent, goes into effect.

⁶² “Regulatory Impact Analysis for the Proposed Carbon Pollution Guidelines for Existing Power Plants and Emission Standards for Modified and Reconstructed Power Plants,” EPA -542/R-14-002, June 2014, p. 3-27.

⁶³ “Assessment of Electricity Savings in the U.S. Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes (2010-2025),” Institute for Electric Efficiency, IEE Whitepaper, May 2011.

The importance of improved building codes and appliance standards in achieving cost-effective energy efficiency savings can be illustrated using the experience of the Northwest Power & Conservation Council (NPCC) – a regional organization that develops and maintains a regional power plan that aggressively targets energy efficiency. NPCC updates its 20-year electric power plan every five years, dating back as far as 1983, and these plans include discussion of the past and future expected role of codes and standards in their conservation plans. For example, NPCC’s Sixth Power Plan (2010) estimates that over 40 percent of Northwest energy efficiency savings between 2010 and 2030 will come from increased building codes and appliance standards.⁶⁴ The same report notes that over the last 20 years, state building codes and federal and state appliance standards have accounted for over one-third of all energy efficiency savings accruing in the region.⁶⁵ Figure 12, replicated from NPCC’s Sixth Power Plan, shows the regions annual program conservation acquisitions since 1991, including those captured through codes and standards.

Figure 12: Cumulative NPCC Regional Conservation Achievement 1978 – 2008 (MWa)



Source: “Sixth Northwest Conservation and Electric Power Plan,” Northwest Power and Conservation Council, February 2010, p. 4-16.

The results of this literature review are illustrative in nature but provide a clear take-away message: strengthened building codes and appliance standards have and could provide ample energy efficiency savings and corresponding reductions in carbon emissions. There are multiple energy efficiency strategies that could be adopted by states in complying with the Clean Power Plan, including through the expansion and enforcement of building codes and appliance standards in their State Plans. Building

⁶⁴ Northwest Energy Efficiency Alliance, available at <http://neea.org/initiatives/codes-standards>, accessed October 31, 2014.

⁶⁵ “Sixth Northwest Conservation and Electric Power Plan,” Northwest Power and Conservation Council, February 2010, p. 4-16.

codes and appliance standards are in many ways additive to the EE potential identified in the prior sections, and should be viewed as supplementing EPA’s findings of EE potential in the Clean Power Plan. However, improving building codes can reduce otherwise available EE potential from some EE programs and measures in some years, by in effect changing baseline assumptions. Thus it is difficult to quantify what portion of such standards would be considered redundant with savings reported in EE potential studies.

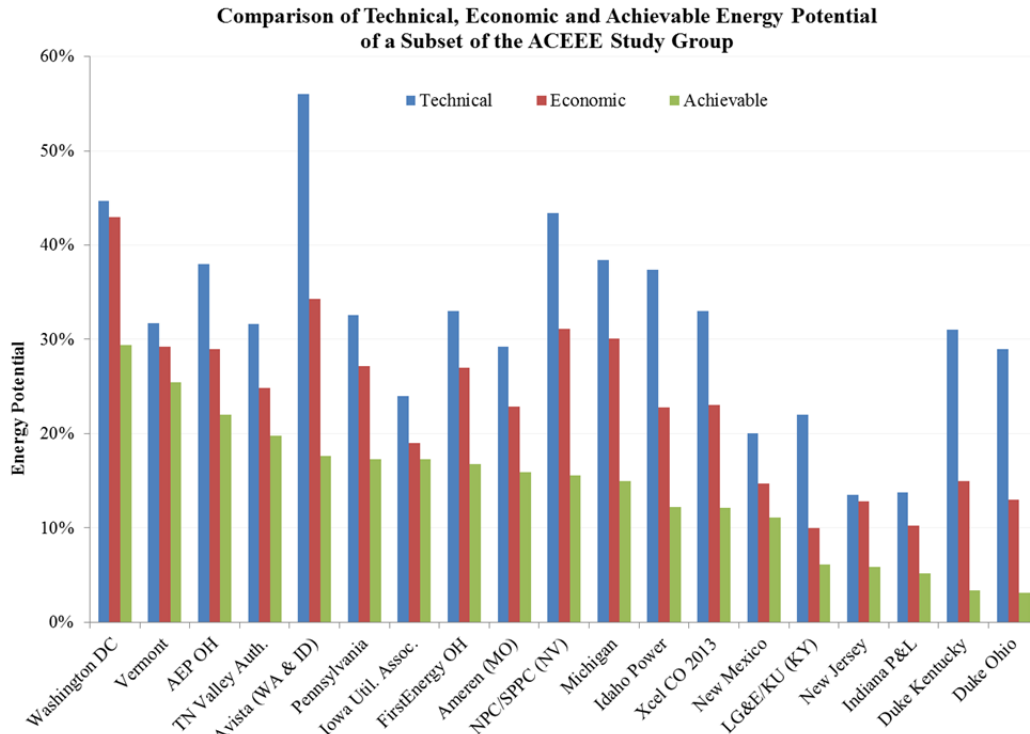
5. Considerations Related to EE Potential in the Context of EPA’s Clean Power Plan

Achievable Potential is a Conservative Estimate of Energy Potential

As discussed throughout this Report, achievable potential is the reported measurement of energy efficiency potential because it is deemed the most appropriate near-term objective applicable for specific planning purposes and program design in the context of existing, utility-driven EE programs. As a result, “achievable potential” is by definition the most conservative estimate of energy efficiency potential at a given time, given market structure, given regulatory conditions, given the policy choices and limitations reflected in the analysis, and in a given location. This is different than identifying the maximum EE *technical* potential, or the maximum energy that can be saved *economically* through energy efficiency programs or otherwise. Additionally, methodology variation and electricity price variation can result in significant variations in estimates of achievable potential for a given economic potential. These will each be discussed in turn below.

Achievable potential is affected by the method and rigor of the analysis in individual studies. For example, of the 45 ACEEE studies, only 19 report all three categories of potential: technical, economic and achievable. Figure 13 below illustrates the variations in the gap between technical and achievable potential in such studies. In some instances, achievable potential is only about 10 percent of technical potential as is the case with the Duke Kentucky study and in other instances achievable potential is over 80 percent of technical potential, as is the case with the Vermont study. Across the 19 studies, on average achievable potential is 60 percent of economic potential and 45 percent of technical potential. Additionally, economic potential is 73 percent of technical potential. The wide range in differences between technical and achievable potential demonstrates how different circumstances and different methods for conducting potential studies can have significant impacts on outcomes.

Figure 13



Note: Only studies that reported all three types of potential are included.

Source: Neubauer, Max, "Cracking the TEAPOT: Technical, Economic, and Achievable Energy Efficiency Potential Studies," ACEEE, Report U1407, August 2014.

For example, the jump from technical potential to economic potential is dependent on the electricity cost circumstances in the region and at the time of the study, and the cost curve for existing or new EE technologies. These factors would tend to increase the economic potential relative to technical potential over time, to the extent that the avoided costs (energy, capacity, delivery) tend to increase in a given state or region, and the costs of EE technologies decline. Further, the jump from economic potential to achievable potential often reflects practical constraints unique to a given time and a given state, and assumptions about market failures, policy design, implementation workforce, and other more subjective matters.

These considerations do not necessarily mean that the studies are flawed – estimates of achievable potential reflect real-world considerations that ratepayer-funded EE programs are, in part, designed to address. But it may mean that the focus on achievable potential and the results of past potential studies – developed under different conditions and assumptions and tied generally to constrained utility implementation of EE programs⁶⁶ – likely significantly understate the level of economic or achievable EE

⁶⁶ Utility-driven energy efficiency programs account for approximately 89 percent of all energy efficiency expenditures in the U.S. "Summary of Electric Utility Customer-Funded Energy Efficiency Savings, Expenditures, and Budgets," Institute for Electric Innovation, March 2014.

potential in a world that not only continues with utility-driven EE, but also involves the strong incentives and market opportunities that flow from Section 111(d) compliance-driven EE investments.⁶⁷

In short, by selecting a highly-conservative approach to develop an estimate of what the potential contribution of EE is to CO₂ emission reductions within each state through 2030, EPA is in effect ignoring potentially significant components of state EE potential. First, using *achievable* potential in the studies they review omits a vast quantity of EE potential that while not “achievable” under the circumstances and policy choices detailed in the studies at that time, is still *economic* – that is, investments that save more money than they cost (and that may cost far less than alternative approaches to CO₂ emission reductions). We expect that a far larger portion of economic EE potential could be captured through EE programs that reflect the deployment of EE as a pollution reduction strategy under an emission standard.

Second, EE potential studies often underestimate important elements of how EE evolves over time, including technological advancement (e.g., LED for lighting, higher-efficiency HVAC equipment, home energy use devices and applications (e.g., NEST), etc.) and EE program delivery innovation (e.g., financing mechanisms such as on-bill financing, improved customer outreach/education, new program designs, expanded or enhanced time-of-use pricing, etc.). Third, by focusing primarily on utility-driven EE programs most studies reviewed miss to at least some extent a wide array of EE opportunities available to the state, but outside the scope of the analysis, such as non-utility EE measures and savings (municipal programs, cooperatives, customer-driven); state-level building codes and appliance efficiency standards; and non-end-use efficiency measures (e.g., distribution or transmission upgrades, combined heat and power applications). All of these factors contribute to the conclusion that EPA’s analysis leads to a conservative (i.e., too low) estimate.

Potential is Maintained Over Time

EPA makes two fundamental assumptions in its analysis. First, it assumes that EE providers (whether utilities, municipals, cooperatives, or third-party providers) can ramp up EE programs that increase savings by at least 0.2 percent per year. Second, EPA assumes that once reaching an annual savings amount of 1.5 percent of retail load, can maintain that level of savings for at least the remaining years of their analysis. In this paper we review a wide range of studies and results that support EPA’s conclusions with respect to available EE potential, the ability to ramp up the level of EE savings, and the ability to sustain savings at 1.5 percent per year over the compliance period.

The ability to sustain a level of EE savings over time depends, in part, on how sustainable EE is as a resource. Considering this, we reviewed the available literature to determine the extent to which, based on past state experience, states can sustain moderate levels of energy efficiency programs before

⁶⁷ Ultimately, states will decide whether to allow EE investments as a Clean Power Plan compliance mechanism, who may carry out EE investments in this context, and how such EE programs would be certified. See Paul J. Hibbard and Andrea M. Okie, *Assessment of EPA’s Clean Power Plan*, December 1, 2014. However, given cost and economic benefit advantages of EE over alternative compliance mechanisms, we expect that many states will avail themselves of this opportunity, leading to potentially widespread expansion of EE providers and investment in EE programs and measures.

available cost-effective energy efficiency potential is depleted. Part of the answer is found in our analysis of EE potential studies, summarized above, and in our analysis of state and utility EE programs, presented in a companion paper.⁶⁸ Most importantly, Analysis Group’s review of these factors demonstrates that leading states – including states that have implemented EE for over a decade – continue to be able to achieve high levels of annual energy efficiency savings as programs grow. For example, electric utilities in the Southwest have implemented a set of strategies to continue to meet energy savings goals that include encouraging behavior change, integrating demand response and energy efficiency efforts, adding financing to energy efficiency programs and supporting building energy code adoption and implementation, among other things.⁶⁹ Similarly, because studies are done at points in time and only consider the known technology at that moment, updated studies in subsequent years continue to uncover more energy efficiency potential.⁷⁰ It is clear that achieving savings at the rate assumed by EPA can be sustained throughout the EPA proposed compliance period. This suggests, in part, that as technological innovation advances and the cost of new technologies falls, more cost-effective energy efficiency potential becomes available in some sense continuously building the resource of EE potential.⁷¹

Conclusion

EPA’s draft Clean Power Plan, issued in the summer of 2014, proposes state-specific standards for the amount of carbon dioxide allowed to be emitted per megawatt-hour of electricity produced at affected power generating facilities. In setting each state’s standard, EPA considered in part the ability of states to reduce system-wide CO₂ emissions through investments in demand-side energy efficiency at the businesses and residences of the state. Based on an evaluation of historical experience with energy efficiency programs administered by utilities in leading states over the past couple decades, EPA concluded that states could grow EE savings at a rate of increase of at least 0.2 percent of sales per year, and over the initial term of the program (i.e. through 2030), could sustain annual average savings of 1.5 percent of state retail electricity sales.

In this Report we study the literature on energy efficiency potential and evaluate it in the context of EPA’s proposed Clean Power Plan. Based on our review, we find that EPA’s assessment of EE potential is reasonable, but conservative – that is, we find that EPA’s conclusion likely significantly understates the potential for EE savings in states over the compliance period. We come to this conclusion based on a review of the experience with and literature on estimating EE potential in the past, analysis of the significant amount of “economic” energy efficiency potential cited in studies (well beyond EPA’s assumed savings potential), and recognition that EE as a CPP compliance mechanism would unlock vast

⁶⁸ Paul J. Hibbard and Andrea M. Okie, *Assessment of EPA’s Clean Power Plan*, December 1, 2014.

⁶⁹ Geller, Howard, et. al., “Maintaining High Levels of Energy Savings from Utility Energy Efficiency Programs: Strategies from the Southwest,” SWEET, ACEEE, 2014.

⁷⁰ See, for example, New York studies in 1989 and 2003 found similar levels of available energy efficiency potential. The National Academy of Sciences, “Real Prospects for Energy Efficiency in the United States,” 2010, p. 58.

⁷¹ See the discussion in (other study), at pages [a-b].

amounts of EE potential that otherwise would not be captured by state consumer-funded EE programs, which are typically constrained by a number of factors. Specifically, we find the following:

- The results of the most recent and relevant energy efficiency potential studies and meta-analyses, completed in the context of ratepayer-funded utility energy efficiency programs, support the conclusions EPA drew based on its own analysis of a subset of the studies we reviewed;
- EPA’s observation of state achievable EE potential savings equal to (on average) 1.5 percent of state retail sales is squarely within the range of results (0.3 percent to 2.9 percent) analyzed by ACEEE in its recent full meta-analysis of EE potential;
- While supportive of EPA’s conclusions, it is important to understand the complexity of EE potential studies, and reasons why such studies tend to vary in results – namely, the purpose of EE potential analyses are generally tied to specific assessments in the context of utility planning, EE program design, or performance evaluation, and are often constructed to conservatively estimate “achievable” potential considering a number of specific limiting circumstances and market barriers to EE investment that are addressed through state/utility programs. In fact, “achievable” EE potential is a *minimum* estimate, limited by study-specific policy choices and considerations, and is generally only a fraction of the overall “economic” EE resource found to generate savings in excess of costs. As such, the achievable potential discussed in the studies focused on in this report underestimates what the EE potential would be in a world where barriers to EE investment are lowered – possibly significantly – through Clean Power Plan compliance activities and funding;
- Longer-term studies systematically understate actual annual average EE potential by failing to adequately incorporate the impact of the evolution of energy-saving technologies and changes in customer acceptance of energy efficient technologies; the shorter-term studies (e.g., spanning a period of less than 15 years) point to higher EE potentials than the averages found using a wider cohort of studies (which were the bases for both EPA and ACEEE analyses). In our view, failing to incorporate the evolution of EE technologies – particularly in an environment that could include innovative market-driven investment in EE for CPP compliance – represents a downward bias in existing EE potential estimates, and suggests that the results of shorter-term studies are better indicators of energy efficiency potential in the current context;
- A study of national EE potential by McKinsey strongly supports EPA’s conclusions. The Electric Power Research Institute (EPRI) also developed a national EE potential estimate, one that came to a widely different estimate of national EE potential than the McKinsey study. However, when corrected for methodological shortcomings, the EPRI study better matches the McKinsey results with respect to national EE potential; and
- Literature review indicates that building codes and appliance efficiency standards can, by themselves, achieve savings comparable to those EPA projects under building block 4, and reinforce our conclusion that EPA’s proposed savings targets are readily achievable.

In short, we have comprehensively reviewed the studies that underlie EPA’s assessment of EE potential, the ACEEE meta-analysis and individual studies that underlie that review, national EE potential assessments, and studies estimating the potential impact of building codes and appliance efficiency standards. Based on our analysis we conclude that EPA’s estimate of annual average EE potential does not consider the impact of expanded market reach that would flow from the eligibility of EE for Clean Power Plan compliance, understates the impact of building codes and appliance standards, and focuses solely on conservative measures of EE potential. Consequently, while we conclude that EPA’s estimate and conclusions regarding EE potential are strongly supported by our analysis of EPA’s approach and the EE literature, it likely underestimates the potential for EE savings actually achievable by states across the U.S., particularly if EE is available as a CPP compliance alternative.