Conservation Potential Assessment Meets Savings Target

Tina Jayaweera, Travis Walker and Hossein Haeri, Cadmus

ABSTRACT

Many states that are establishing an energy efficiency resource standard (EERS) arbitrarily set high standards, often with catchy names such as "20 by 20."Given prevailing market conditions and pending state or federal codes and standards, these goal-setting practices mean some jurisdictions may not meet such unrealistic targets.

To establish a more realistic EERS, some states have set savings targets using results from a conservation potential assessment (CPA). A CPA provides a long-term (10- or 20-year) outlook on technical, economical, and achievable energy-savings potential. Yet turning CPA results into a program plan to achieve established targets often requires forcing square pegs into round holes. Specifically, CPAs incorporate broad-brush applications of cost-effectiveness and their adoption may not be appropriate for program plans.

In this paper, the authors present three case studies in which utilities across the United States have developed plans using CPAs. They demonstrate various approaches along with some limitations and implementation challenges. The three utilities varied in these ways:

1. One utility's CPA follows conventional rules but allows flexibility in program design.
2. One utility applies stringent cost-effectiveness criteria obtained from the CPA.
3. One utility, striving to achieve significant savings, revises the classic definitions for economic potential to avoid measure-level, cost-effectiveness limitations.

Through these examples, we discuss how utilities adapt CPA results according to the circumstances in their jurisdictions.

Background

In 1980, the U.S. Congress passed the Pacific Northwest Power Planning and Conservation Act (the Act), authorizing creation of the Northwest Power and Conservation Council (Council), which sought to ensure adequate and reliable electricity supplies in the Pacific Northwest. Three years later, the Council adopted its first Power Plan; this plan identified a mix of generation and cost-effective conservation to meet the region's long-term electricity needs.

The Act required the Bonneville Power Administration (Bonneville), the region's federal power marketing agency, to use the Council's Power Plan as the basis for all resource acquisition. In effect, the Council's Power Plan laid the groundwork for the first formal energy efficiency resource standards (EERS) in the United States, and Bonneville served as the first major power supplier tasked with translating broad savings targets into detailed energy efficiency plans (Haeri 2011).

Starting with Texas in 1999, more states have adopted an EERS, with 25 states currently using long-term savings targets or an EERS. Roughly one-third of these have been adopted in the last five years and many include aggressive savings. Varying by state, savings targets range from 0.1% to 2.6% of annual forecasted energy sales (ACEEE 2013). More utilities now face the same challenge Bonneville faced in 1983: how to translate estimates of long-term conservation potential into energy efficiency program plans.

Conservation potential assessments (CPAs) are often the first step in the program planning process. CPAs provide a long-term (often 10- or 20-years) outlook on technical, economical, and achievable savings energy efficiency potential. They establish an upper bound for achievable savings and identify cost-effective measures for which a utility could offer incentives. Energy efficiency potential studies allow utilities to gauge whether EERS targets can be attained. In some jurisdictions, they serve as a basis for targets.

In Washington, for instance, under the state's EERS (defined by initiative 937 [I-937], later enacted into law as the Energy Independence Act), utilities can set targets based on their share of regional conservation potential identified by the Council's regional power plan or on their own CPAs. Many Washington utilities have elected to conduct their own CPAs, because utility-specific CPAs can account for nuances within their service territories, such as service-territory-specific equipment saturations, adoption curves, and measure applicability.

When a utility uses a CPA to set targets and design programs, it must reconcile disconnects between CPA modeling and program implementation. Any planning study faces a challenge: how to take results from a CPA—an abstract, long-term forecasting exercise—and turn these into implementable programs. Although most utilities employ a common methodology for estimating conservation potential, they diverge in how they use those estimates to develop program plans. This paper presents three case studies, in which the authors assisted in producing the CPAs, illustrating different approaches and their consequences.

What Is a CPA?

The National Action Plan for Energy Efficiency (NAPEE) guide on potential studies defines a CPA as: "a quantitative analysis of the amount of energy savings that either exists, is cost-effective, or could be realized through the implementation of energy efficiency programs and policies" (NAPEE 2007). These studies generally characterize four types of potential:

- **Technical potential:** The quantity of savings that can be realized if energy efficiency measures passing a qualitative screening are applied in all feasible instances, regardless of cost. Where measures compete, the most efficient option will be chosen, up to technical feasibility constraints.
- **Economic potential:** A subset of technical potential represents measures that are cost-effective, generally based on a total resource cost (TRC) perspective. In this case, the most efficient and cost-effective measure will be selected, again up to any technical feasibility constraints.
- **Achievable potential:** A subset of economic potential, it identifies the amount of energy savings that feasibly can be achieved through program and policy interventions. It accounts for consumers' willingness to adopt an energy efficiency measure, often estimated through customer surveys. Sometimes referred to as a "maximum" achievable potential, if the consumer's financial barriers are removed.
- **Program potential:** A subset of achievable potential, this represents a realistic potential level achieved through utility programs, considering budgets and other resource constraints, and it accounts for resource acquisition rates.

Figure 1 illustrates the relationships among these types of potential.

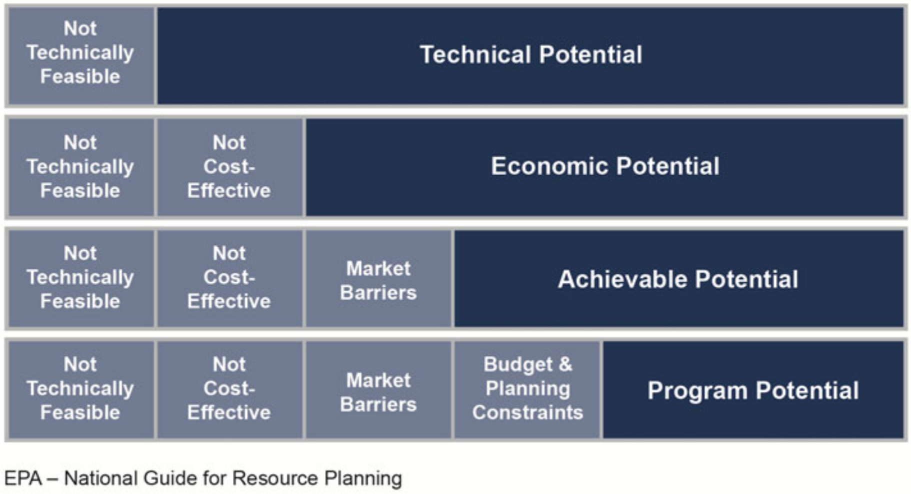

Figure 1. Potential types. *Source:* Guide for Energy Efficiency Potential Studies (NAPEE 2007).

Completing a CPA requires three main elements of data: utility customer (market) data, measure data, and economic data. A CPA often relies on primary data collected to characterize the market. For example, residential appliance saturation surveys can estimate the saturation of electric water heaters. Developing a comprehensive list of measures is another primary activity of a CPA, for which further details are provided below. Finally, the economic potential, as stated above, is based on the comparison of the measure costs with the measure benefits, as determined through the utility avoided cost and discount rates.

Using a CPA to Inform Program Design

One of the key benefits of a potential study is that it can help identify and quantify potential gains from energy conservation (Haeri 2011). Through the CPA, the utility establishes a comprehensive list of measures with estimates of cost, savings, and effective useful life for its customers. A CPA highlights areas in which savings are most likely to be realized and demonstrates where the market is becoming saturated. It also provides an estimate of the cost to acquire these resources so that energy efficiency can be compared against supply-side options through an integrated resource planning (IRP) process. CPAs can also quantify the impact of pending codes and standards.

Weakness of a CPA in Program Design

Although the CPA does establish a comprehensive list of measures, these measures represent savings based on an “average” or “typical” customer. They do not account for the diverse characteristics by which that average customer is defined (e.g., building aspect ratio, number of stories, household size) or how human behavior can influence savings (e.g., temperature setpoints, length of showers) (Moezzi 2009).

In addition, as described above, in the Pacific Northwest the Council prepares a regional power plan that forms the basis for setting savings targets. However, these values, as the Council states, are agnostic to the means by which the savings are acquired (Bonneville 2010). In other words, utility programs—in addition to codes and standards, market transformation activities, and other non-programmatic activities—can contribute to savings. As such, part of a utility's difficulty in interpreting a CPA will be in determining *how* to best achieve the savings the CPA demonstrates are available.

Given these weaknesses, stakeholders need to be cognizant of the challenges and assumptions made in a CPA and how the CPA relates to program planning. Establishing this context allows stakeholders to more fully understand the limitations of using a CPA to set targets.

Case 1: Traditional CPA and Utility Has Flexible Program Planning

In this first case, the utility conducted a CPA and obtained estimates of the first three types of potential: technical, economic, and achievable potentials (shown above in Figure 1). The utility used the CPA results to develop a multiyear energy efficiency plan. Though this utility did not contend with a mandated EERS, many stakeholders actively participated in the planning process, with the CPA serving as a basis for the savings the utility should capture through its programs.

This study defined achievable potential as the maximum potential that could be achieved upon reducing or eliminating cost barriers. That is, achievable potential development assumed that energy efficiency funding would be available and that utility incentives would cover 100% of incremental costs to install measures.[1] Despite such high incentives, market barriers remain and achievable potential falls below economic potential.

The overall approach is shown in Figure 2. For this utility, the program potential is not a direct subset of the maximum achievable potential. Rather, because of the commission rules around the program plan, this utility is able to offer individual non-cost-effective measures, as long as the entire *program* (including multiple measures) passes the cost-effectiveness screen. This is a difference from the standard NAPEE approach illustrated in Figure 1.

[1] Incremental cost represents either the difference in cost between a standard and high-efficiency measure, for cases where equipment must be replaced, or the full cost of installing a measure where burnout does not occur (e.g., installing insulation in an uninsulated attic).

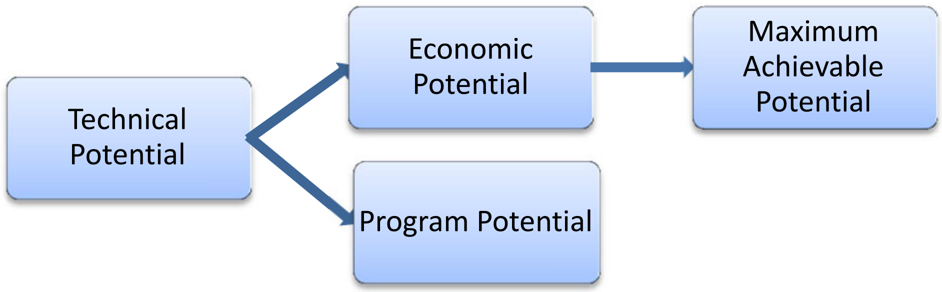

Figure 2. Case 1 approach to potential.

After estimating the maximum achievable potential, the utility used the results of the CPA to develop its energy efficiency plan. For this utility, the process worked well, and it is an example of how a CPA can effectively inform program design. The regulatory rules provided the utility with flexibility to include measures that may not be cost-effective, but for which there is customer and trade ally interest, and to pilot new measures for which cost or savings may be evolving. However, there were still a few areas of difficulty, discussed below.

The utility's first step in program design was to compare the comprehensive measure list prepared for the CPA with measures in programs that offered rebates. Although generally intended to encompass the "universe" of measures, the CPA list is often limited to measures that are commercially available and would not result in increased peak demand.[2] In addition, an expansive measure list must consider budget and time requirements for the study's completion – the more measures included, the more time required to complete all the details.

For example, a consumer purchasing a new furnace today would encounter a market that offers a minimum efficiency of 80% AFUE.[3] High-efficiency furnaces, or "condensing units," have an efficiency of at least 90% AFUE. One can purchase nearly every efficiency increment over 90% (e.g., 92%, 93%, 94%, 95%, and 96%). Given the number of choices, which efficiency levels should be included when developing a CPA measure list? If the most comprehensive measure list includes every efficiency level available, obtaining accurate costs for every option could be difficult; most CPAs limit efficiency options to a few. One study may include 90% and 95%; another 90%, 93%, and 96%; and yet another 92%, 94%, and 96%. The chosen efficiency levels often align with how the programs currently differentiate among equipment options, though any technological innovation must also be considered.

Continuing with the furnace example, prior to the CPA, the utility may have offered one incentive level for units of 90% to 93% AFUE and another for units of 94% AFUE or greater. From a technological viewpoint, a furnace of 95% AFUE represents a shift in the design required

[2] For example, potential studies often exclude electric tankless water heaters. Although they operate at a higher efficiency than a standard storage unit and result in lower average annual consumption, they require significant power draws during usage, which can increase peak loads.

[3] AFUE is the Annual Fuel Utilization Efficiency, a measure of a furnace's efficiency. A rating of 100% would mean that all of the fuel going into the furnace is transformed into heat.

to achieve that efficiency, and generally it costs more. A preferred program design would offer an incentive for units with a 90% to 94% AFUE and another for a unit with a 95% or higher AFUE. Consequently, the CPA measure list should align with the program's list, but it should also reflect at least these two ranges of efficiency to most readily inform forward-looking planning. This CPA included 92%, 94%, and 96% AFUE to align with the utility's program offerings. In retrospect, the authors believe it may have been useful to add a 95% AFUE to the 94% and 96%, to provide the widest range of options for the utility to explore during planning.

Once the measure list is established, the economic and achievable potentials assume all technically feasible installations are at the most efficient and cost-effective option. For this utility, the CPA listed 92%, 94%, and 96% AFUE, and both the 94% and 96% proved cost-effective (based on the TRC) with similar technical feasibility constraints, so the economic and achievable potentials then assume all customers would install the 96% AFUE unit. Based on market demand, the utility decided to offer incentives for both the 94% and 96% AFUE levels. This decision means the program potential for furnaces will always be lower than the achievable potential.

The CPA also identified high-impact, cost-effective measures that were not offered through existing programs. For example, a recently commercialized technology, not previously considered in the programs but proven cost-effective through the CPA, was included in the program design. Conversely, the CPA determined that some measures historically offered through the programs were no longer cost-effective. As described above, this utility has the option to include non-cost-effective measures within its programs, as long as the program as a whole is cost-effective. For example, residential floor insulation was not cost-effective, but in order to provide a whole-house approach for insulation, and because historically there were few participants for this measure, the utility opted to maintain a rebate for the measure by grouping the floor insulation measure in a program with cost-effective measures, such as ceiling and wall insulation.

As indicated above, CPAs can provide insight into the impact of codes and standards. This utility historically offered rebates on high-efficiency electric storage water heaters. As the CPA illustrated, however, the 2015 federal water heater standard will limit savings from high-efficiency storage units, so the utility chose to disallow the rebate for these units. Other water heating saving measures (such as aerators, showerheads, and pipe wrap), though still cost-effective, will not save as much as previously assumed given the new baseline, and will therefore affect targets.

Overall, the CPA offered a useful tool in developing this utility's program plan, primarily through producing estimated costs and savings for a comprehensive list of measures and highlighting areas on which the utility should focus its resources. In addition, the maximum achievable potential estimated through the CPA did provide an upper limit of savings against which targets could be evaluated by stakeholders. The difficulty arose primarily in the development of the measure list, where it was aligned with historic program offerings but was missing a key efficiency level. In the authors' opinion, this is a relatively minor issue, and Case 1 is a successful application of a CPA for a program plan.

Case 2: Strict Rules on Cost-Effectiveness

In the second case, the utility had to update its CPA every two years, and the achievable potential directly determined the savings target. However, the utility's program planners did not have the flexibility to introduce non-cost-effective measures. This utility had excess long-term energy supply and so there was less need to pursue conservation than may be the situation at more constrained utilities. This inflexibility made planning difficult for program managers, who frequently had to adjust program offerings but still try to achieve specific savings levels. In conducting the CPA, incorporating as much utility-specific information as possible proved critical to most accurately represent each measure's cost and savings.

This utility generally followed the traditional approach to a CPA, as shown in Figure 3.The program potential follows maximum achievable potential, which follows economic potential, which follows technical potential. The maximum achievable potential determines the target, while the program potential illustrates what portion of these savings the utility will acquire through programmatic activity (as opposed to non-programmatic sources such as codes and standards or market-induced adoption).

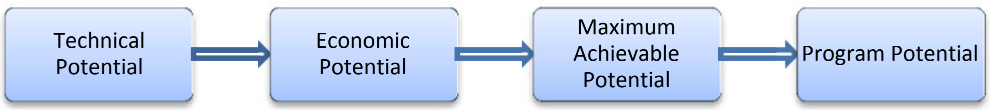

Figure 3. Case 2 approach to potential.

As discussed, a CPA generally includes a large number of measures. The measure's potential is determined across prototypical building types. For example, savings for infiltration control measures depend on a building's square footage, occupancy schedule, insulation levels, and building configuration (e.g., aspect ratio, number of stories). Given infinite permutations, a potential study selects the building types that best represent the utility's service territory in order to estimate, on average, the measure's cost and savings and thus its cost-effectiveness. The quality of this estimate greatly depends on the quality of data about particular building types.

Due to their expense, comprehensive market baseline studies—particularly for the commercial sector—are not completed often. Although assessments in the residential sector often use surveys, detail may be insufficient to accurately estimate savings. As such, a potential study may rely on old or secondary data. Cost data can be informed by programmatic tracking systems, if available, but may also incorporate regional or statewide estimates that do not necessarily represent the utility's service territory (e.g., rural versus urban or availability of trade allies). Also, for nearly all measures considered, the costs are not a single-point estimate. Product features, beyond efficiency levels, can vary widely in costs, and individual contractors can charge different rates to install the same measure in the same house.

Thus, a measure in a CPA contains uncertainty in its cost-effectiveness estimates, and a prototypical building, meant to represent an average customer, may not apply to a specific building. As such, if the assumptions based on a prototype resulted in a non-cost-effective measure, this utility could not offer it in its programs, even if the measure would be cost-effective for a percentage of customers.

CPAs generally apply a broad assumption of administrative expenditures in the TRC estimate. Often, a 20% adder is used across the board: the CPA increases the cost for all measures by 20% to approximate the cost to deliver the program. However, because this utility was so sensitive to measure cost-effectiveness, the CPA applied measure-specific administrative adders based on the utility's experience. This provided more accuracy on the measure's cost-effectiveness, where measures not found to be cost-effective under the blanket 20% assumption now passed the screen.

As this utility relied on the CPA to determine its targets and program offerings, it was highly sensitive to measure assumptions. Although other jurisdictions can afford greater tolerance for the uncertainty inherent in prototypical buildings, administrative expenditures, and measure cost, this utility had to ensure *all* assumptions were as close to actual conditions as possible. This made every detail of the CPA critically important, where expectations could not always be met given limited budget and resources.

Case 3: Revised Definition of Achievable Potential

In the final case, the utility had high targets and used the CPA to inform the most appropriate approach for its achievement. Though this study estimated technical potential and economic potential using the traditional, utility-standard approach, the assessment deviated from the standard by examining the maximum achievable potential and program potential. Rather than considering maximum achievable potential as a subset of economic potential, this utility estimated achievable potential directly from technical potential. In other words, the achievable potential included non-cost-effective measures, as illustrated in Figure 4.

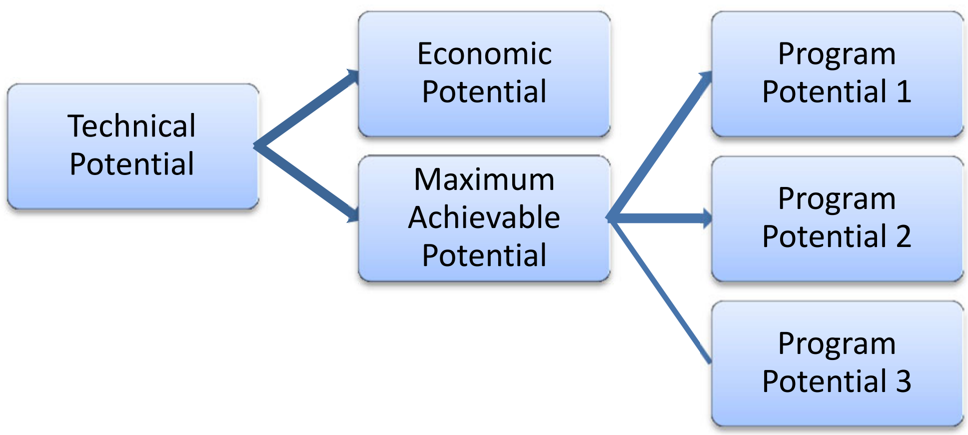

Figure 4. Case 3 approach to potential.

This resembles Case 1, in which the utility had some flexibility in including non-cost-effective measures in its program plan, but the utility in Case 3 differs in that the maximum achievable potential also included non-cost-effective measures. The estimates of potential included all measures across all permutations, not just those included in the plan. This approach allowed the utility to reach aggressive targets because including non-cost-effective measures, which are otherwise eliminated by applying a cost-effectiveness screen (such as high-efficiency appliances, heat pump water heaters, and LED lighting), can produce significant savings.

This utility estimated the maximum achievable potential by assigning “applicability factors” to non-cost-effective measures to ensure that the sector was cost-effective, even if individual measures were not. These applicability factors accounted for fewer cost-effective measures being less likely to be adopted, so this factor was applied to the maximum achievable potential for all measures within the specific cost effective bundle. Table 1 presents the factors chosen for one sector. For example, measures with a benefit-to-cost ratio between 0.3 and 0.5 will have at most a 5% adoption rate. For a different sector, where the measures as a whole proved most cost-effective, the only adjustment required was to eliminate measures with a benefit-to-cost ratio less than 0.3 from the maximum achievable potential.

Table 1. Applicability factors based on benefit-to-cost ratios

Benefit-to-cost ratio	Applicability factor
Up to 0.3	0%
0.3 to 0.5	5%
0.5 to 0.8	15%
0.8 to 1.0	30%
1.0 and above	100%

Applicability of measures can be further modified based on a utility's expectations for program activity. For example, this utility offered incentives for residential central air conditioners, spanning multiple efficiency levels (e.g., SEER 15 and SEER 16 and greater).[4] The measure list included SEER 15, SEER 18, and SEER 22 to represent the span of options. While technical potential would assume only the most efficient units (e.g., SEER 22) will be installed and economic potential would assume the most efficient cost-effective unit would be installed (e.g., SEER 18), the maximum achievable potential can account for the utility's program offering incentives for a mixture of SEER 15, SEER 18, and SEER 22 units. As long as sector cost-effectiveness can be preserved, additional applicability factors can be imposed based on expected program activity for competing equipment. This ensures that all measures offered by the utility become part of the achievable potential.

Table 2 provides the technical, economic, and maximum achievable potential as a percentage of baseline utility sales. Contrary to the traditional classification of the potential types, the maximum achievable potential for this utility proved *larger* than the economic potential.

Table 2. Potential as a percentage of sales

Technical potential	Economic potential	Maximum achievable potential
31%	21%	25%

The final step in the assessment required estimating the program potential. Unlike the utility in Case 1, where program potential was determined when developing the energy efficiency plan, this utility estimated program potential as a subset of the maximum achievable potential. The utility’s budget played the defining role in determining the program potential. In general, the greater the utility’s spending on incentives and marketing, the greater the expected market penetration. Thus, this utility estimated three scenarios of program potential, assuming

[4] SEER is the seasonal energy efficiency ratio. A higher value means a more efficient unit.

different incentive levels and marketing and administration expenditures. However, in order to do this in a CPA, the utility made broad assumptions of incentives. For example, all measures received incentives at 50% of incremental cost, with another 20% applied for administrative and other expenditures. At the time of this paper, this utility is at the beginning stages of developing programs that will accomplish these goals.

Conclusion

CPAs are often used to determine targets for utilities. Typically, achievable potential accounts solely for a fixed percentage of the economic potential. Intrinsic to this approach is that all measure adoption is assumed to go to the most cost-effective, technically feasible measure. However, less-efficient measures can still be cost-effective and included in programs. Thus, the CPA can represent a maximum potential that may not be realizable through the programs. Conversely, some utilities are permitted to include measures in their programs that are not cost-effective, as long as the program or portfolio is cost-effective. In this scenario, the estimated achievable potential could understate the actual program potential.

Program design is expected to be informed by the CPA, and, conversely, the measures included in the CPA are informed by the programs. However, tying the two together can be a challenge. Although a typical CPA includes a large number of measures, it is not feasible to include every possible measure that could be delivered through the utility's programs, particularly when considering all possible efficiency levels for the measure. Moreover, each measure's costs and savings must be generalized for a prototypical building type. Although appropriate for estimating aggregate levels of potential across all customers, this approach does not capture individual customers' unique characteristics or the cost differences between contractors or implementation firms.

Case 1 represents a utility that applied the CPA relatively effortlessly as a resource in program planning. The utility had flexibility to include measures that were not cost-effective. The biggest challenge was in determining the specificity of measures that were included in the CPA and the program plan. In Case 2, the main challenge was that the cost-effectiveness of the measures, as calculated in the CPA, determined if the measures were allowed to be included in the programs, but did not account for the uncertainty inherent in each measure's cost and savings. This approach can result in significant attention to of all the details of the CPA development. Finally, Case 3 represents a utility with aggressive targets, which meant the utility estimated achievable and program potential outside the standard paradigm. The CPA applies broad-brush assumptions that may not translate into actual program accomplishments. Although a CPA shows the technical feasibility for the utility to achieve these savings, the challenge for program designers is to determine how best to get customers to adopt the measures.

In each jurisdiction, stakeholders must be cognizant of the unique challenges and assumptions made in a CPA, and of how the CPA relates to program planning. Establishing this context allows the stakeholders to more fully understand the limitations of using a CPA to set targets.

References

ACEEE. 2013. "Policy Brief: State Energy Efficiency Resource Standards (EERS)." July. http://www.aceee.org/files/pdf/policy-brief/eers-07-2013.pdf

Bonneville Power Administration. 2010. Action Plan for Energy Efficiency 2010-2014. https://www.bpa.gov/energy/n/pdf/BPA_EE_Action_Plan_External_Final_032410.pdf

Haeri, Hossein. 2011. "Frontiers of Efficiency: What conservation potential assessments tell us about 'achievable efficiency.'" *Public Utilities Fortnightly*.

NAPEE (National Action Plan for Energy Efficiency). 2007. *Guide for Conducting Energy Efficiency Potential Studies*. Prepared by Philip Mosenthal and Jeffery Loiter, Optimal Energy, Inc. http://www.epa.gov/cleanenergy/documents/suca/potential_guide.pdf

Moezzi, Mithra, Iyer, Maithili, Lutzenhiser, Loren, and Woods, James. 2009. *Behavioral Assumptions in Energy Efficiency Potential Studies*. Prepared for California Institute for Energy and Environment (CIEE) and the California Public Utilities Commission. http://library.cee1.org/content/behavioral-assumptions-energy-efficiency-potential-studies/