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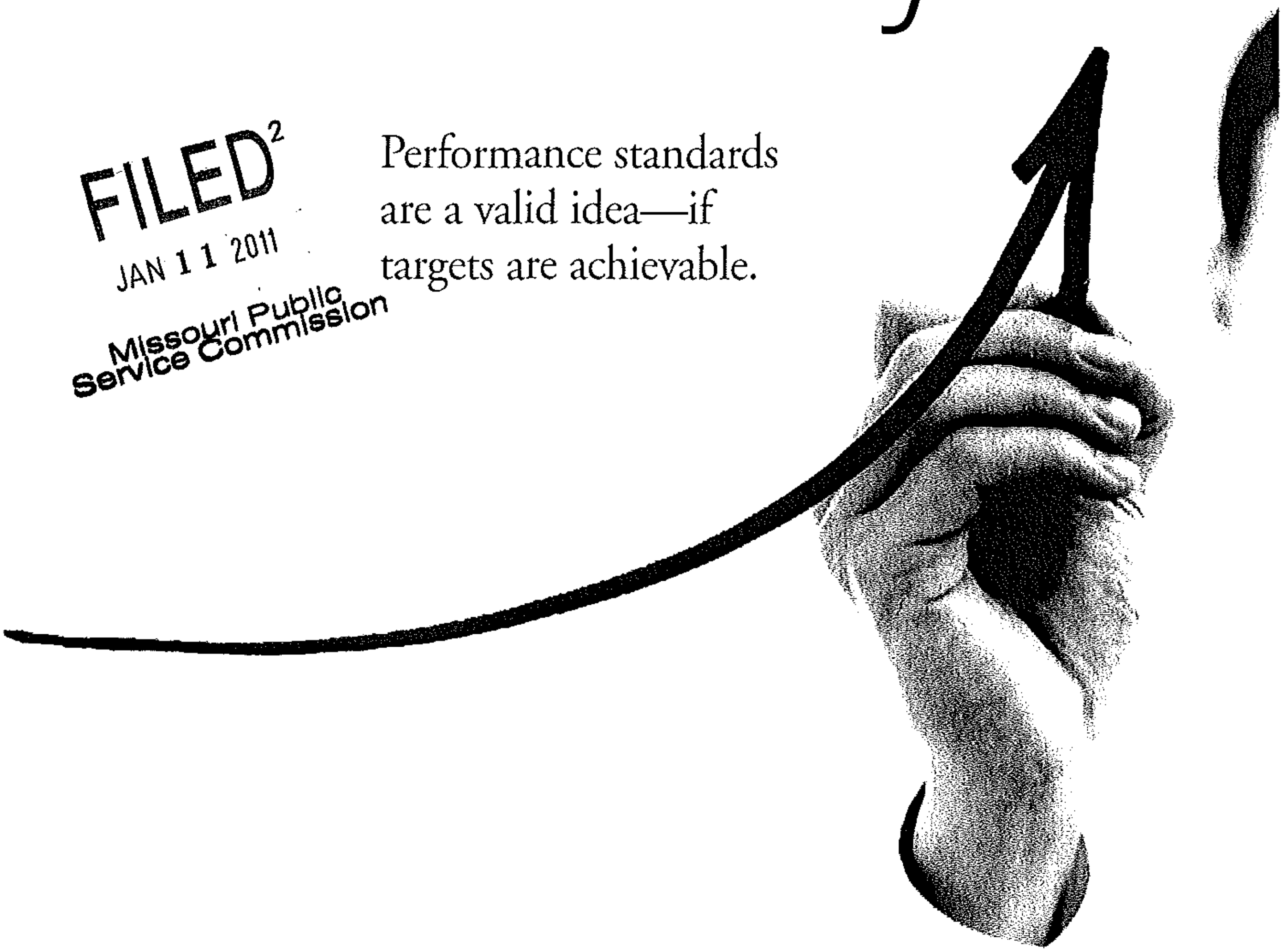
Public Utilities Fortnightly

Extreme Efficiency

1. Targets are not sustainable
2. Most states allow flexibility
   - code & standards
   - CHP
   - infrastructure



Performance standards are a valid idea—if targets are achievable.

BY HOSSEIN HAERI AND ELI MORRIS

The Northwest Power and Conservation Planning Council (NPCPC) was formed under the authority granted by the 1980 *Federal Power Act* (FPA). The primary role of the NPCPC is to assure an adequate and reliable supply of electricity in the Pacific Northwest. Every five years, the council forecasts the region's long-term demand for electricity and examines different ways to meet it. The result is a 20-year resource plan that recommends a mix of power supply and cost-effective conservation options, always treating conservation as the highest priority.

The NPCPC produced the first regional power plan in 1983, projecting on average as much as 4,790 MW (*e.g.*, 42 million MWh) of cost-effective conservation likely would be achievable by 2002. Under the FPA, the Bonneville Power Administration, which is the regional federal power marketing agency, is required to make resource acquisition decisions consistent with the power plan, including the acquisition of all identified cost-effective conservation. Publication of the 1983 power plan, therefore, marked what is possibly the first formal energy-efficiency performance standard (EEPS) in the United States.[1]

In 1999, Texas became the first state to institute an EEPS through legislative action, requiring the state's utilities to reduce their load growth by 10 percent through end-use efficiency improvements.[2] Two recent reports by the American Council for an Energy-Efficient Economy (ACEEE) and the Pew Center for Climate Change show EEPS have been enacted in 23 states at an accelerating pace. Approximately one-third of all of the standards in place today have been adopted since 2007.[3]

Efficiency goals and standards are necessary for improving the industry's efficiency and performance on conservation efforts. But such initiatives will be most successful if they're realistic and reasonably achievable. The effectiveness of conservation efforts so far has been driven largely by the rationality of programs. A uniform, market-based approach would give retailers flexibility and spur innovation—and have a greater chance of achieving efficiency policies.

Paths to a Common Goal

An energy-efficiency resource standard (EERS), or energy-efficiency performance (or portfolio) standard, is a regulatory mechanism for encouraging greater efficiency in energy use. An EEPS is similar to a renewable portfolio standard (RPS) in that it requires energy utilities to reduce energy use by a specified—and often increasing—amount each year for a specified period. Most states have a separate EEPS and RPS, while others such as Connecticut, Nevada and North Carolina combine the two mechanisms by allowing energy efficiency to meet part or all of an RPS.

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It isn't clear how long some efficiency mandates can be sustained, since they don't appear to be based on realistic potential.

In the majority of states with an EEPS, targets are set by legislative mandates, but in several cases, they have been mandated by state regulators. In Arizona, the state with the most aggressive EEPS, targets were ordered by the Arizona Commerce Commission. In California, which has one of the longest histories of active conservation, energy-efficiency requirements were established by the California Public Utilities Commission. In Iowa and Indiana, state regulators set the saving targets now in effect. In Florida, a decision on EEPS is pending before the Florida Public Utility Commission. Washington is the only state where EEPS legislation originated with a direct voter initiative (WA I-937) in 2006.

There also are instances in which performance standards were set by public utility boards and municipal governments. For example, aggressive saving targets were approved by the boards of municipal utilities for Sacramento Municipal Utility District in California and Austin Energy in Texas. Performance standards in the form of energy reporting requirements and disclosure ordinances are in effect in San Francisco and Seattle, among others, and now are being considered by several other cities such as Portland, Ore., and New York.

Performance standards can apply to electricity, natural gas, or, in a handful of cases, to both. Electric performance standards may include goals for energy savings, capacity savings, or both. In some states, eligible savings are restricted to energy-efficiency measures and practices approved in statewide technical reference manuals.

Several states allow flexibility in how saving targets are satisfied. For example, in Connecticut, energy-efficiency targets may be met partially through distributed generation resources such as combined heat and power. In California, Minnesota and Washington, efficiency savings resulting from new appliance standards and building energy codes may be counted toward the target. In other states, utility system improvements qualify. The California PUC recently allowed quantifiable savings from behavior-based energy-efficiency initiatives to be counted toward saving targets.

The allowed period of performance also varies from state to state and ranges from as few as four years in Pennsylvania to 15 years in Ohio, with 10 years appearing to be the norm. In most cases, targets also include phase-in provisions. Cost-effectiveness is a universal condition, and many states mandate ceilings on expenditures. In several states, performance regulations include penalties for failure to meet the mandated targets and awards, typically in the form of shareholder incentives, for outperforming them.

How Performance Is Measured

EEPS are basically annual energy savings targets; however, even a cursory survey of performance standards in effect today reveals how diversely they are defined and structured. Performance standards in effect today generally are defined in one of four ways.

- Fraction of annual sales is the most common approach. The fraction generally is calculated against sales in a particular historical baseline year (*e.g.*, Pennsylvania), or the previous year (*e.g.*, Arizona and Michigan), or an average of several past years (*e.g.*, three years in Indiana, Minnesota, and Ohio).
- In several states, such as California, Hawaii, Massachusetts, and Vermont, targets are set as absolute amounts of energy and capacity savings.
- In other states, including Massachusetts, Rhode Island, and Washington, utilities are required to acquire all cost-effective conservation. In Washington state, utilities must acquire all cost-effective and reasonably achievable levels of the projected energy-efficiency potential.
- Texas is the only state where savings are measured against load growth.

Variations in existing EEPS might be characterized in terms of at least four general features: target levels, complexity, governing rules, and constraints. These features are significant in that not only do they demonstrate extreme diversity, but they are also important indicators as to whether the targets ultimately are achievable.

Target Levels

The defining feature of an EEPS—and the primary measure of performance in most cases—is the expected level of energy savings, whether measured as an absolute amount, a fraction of sales, or a portion of expected load growth. The mandated saving targets and allowed performance periods vary widely among states. The impact of these variations becomes apparent when examining the annual and cumulative electricity saving targets mandated in Arizona, Illinois, Indiana, Ohio, Minnesota, and Indiana (*see Figure 1*). Performance standards in all of these states were adopted in a rather short time span, from 2007 to 2010, and all include a phase-in provision of at least 10 years.

Arizona has the most aggressive target among the six states, and, for that matter, any state. According to the 2009 ruling of the Arizona Corporation Commission, utilities providing retail electricity in the state are required to produce electricity savings equivalent to at least 22 percent of their previous year's sales by 2020. The 10-year standard begins at 1.25 percent of the previous year's retail electricity sales in 2011, grows to 2 percent in 2013 and 2.5 percent in 2016, where it remains through the end of the performance period in 2019. Demand response and energy savings achieved in earlier years do count toward meeting the targets.[4]

The Illinois Legislature passed Public Act 96-0033 in June 2009, which sets annual energy saving targets for electric and natural gas utilities. Beginning in 2010, electric utilities are required to generate annual savings that begin with the equivalent of 0.2 percent of their previous year's sales in 2008. The savings increase gradually to 2 percent in 2016 and continue at that rate through 2018, establishing the second-highest cumulative saving target among the six states. The legislation also sets relatively modest peak-load saving targets of 0.1 percent annually over the course of the 10-year plan.

Even assuming a 12-percent achievable potential, Arizona would exhaust its potential by about 2016, Illinois by 2018, and all other states by 2020.

In Indiana, which has the third-highest performance standard among the six states, saving targets begin at 0.3 percent of the average annual sales for the previous three years. This number increases to 1.1 percent in 2014 and 2 percent in 2019.

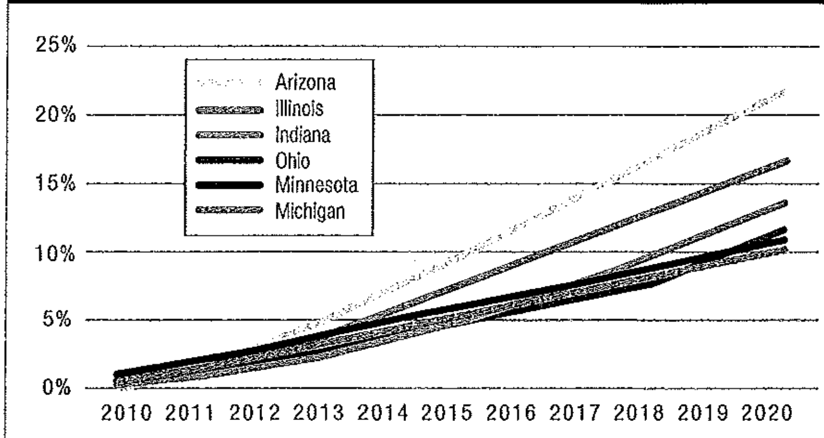
In Ohio, Senate Bill 221 sets annual saving rates beginning in 2009 at 0.3 percent of the average sales for the previous three years, ramping up to 1 percent by 2012, followed by 1 percent annual savings through 2018 and 2 percent every year thereafter until 2025, requiring utilities to accumulate savings of at least 22 percent by 2025.

Savings targets in Minnesota and Michigan are similar to those set in Ohio, but have lower cumulative targets. In Michigan, where cumulative performance standards are the lowest, annual targets start at 0.5 percent of the previous year's sales in 2010, increase to 1 percent in 2012 and remain at that level through 2020.

How Targets Were Selected

Statutes prescribe; they don't explain. So it's difficult to know the rationale behind states' specific performance targets—both levels and performance periods—without extensive research

FIG. 1 RECENTLY MANDATED 10-YEAR CUMULATIVE ENERGY-EFFICIENCY TARGETS



Source: ACEEE and Pew Center for Climate Change

it helps mitigate rate shocks resulting from the effects of direct utility expenditures and revenue losses. However, in most cases, the mandated ramp-up rates are overly aggressive and don't allow utilities enough time to develop effective programs, prepare marketing plans, and put in place the necessary infrastructure to implement large portfolios. This is especially true in states with little or no recent experience with demand-side management.

In many cases, the established targets seem arbitrary when compared to the accomplishments in recent years of utilities with successful programs in other states. Moreover, it isn't clear how long the mandated annual savings can be sustained, since they don't appear to be based on a systematic assessment of realistically achievable energy-efficiency opportunities.

Energy savings produce significant benefits to end users. More important, they help avoid or defer the need for new energy sources to meet future requirements. From this point of view, setting saving targets relative to projected loads—particularly load growth, as it's done in Texas—conceptually is appealing; however, it also creates a considerable uncertainty for utilities obligated to meet the targets. Performance targets defined as absolute amounts or relative to a fixed historical baseline largely eliminate this uncertainty, but they lack a clear relationship with planning imperatives. The model used in Massachusetts, Washington, and Rhode Island is a more sensible approach from a resource-planning point of view, which also eliminates at least some of the uncertainty facing utilities.

into the legislative record. The U.S. Energy Information Administration (EIA) has data on what has been accomplished by utilities in the United States, and the data available from 2006 through 2008 via FERC Form 861 provide a useful benchmark. Of the 191[5] records of utilities reporting energy-efficiency activity,[6] some 55 investor-owned utilities consistently reported energy-efficiency expenditures and savings from 2006 to 2008. These utilities reported savings averaging 0.42 percent of sales in 2006, increasing to 0.49 percent of sales in 2008—a rise, on average, of about 16 percent in two years. Between 2006 and 2009, 28 utilities nearly doubled their savings on average. In spite of the obvious improvements in annual savings among the 55 utilities, there were only 24 cases with reported savings of 1 percent (*i.e.*, relative to annual sales) or greater in any one year. And, crucially, utilities reported annual savings of 2 percent or more in any one year in only five cases.

The difference between mere expectation and a target is that targets are intended to be a stretch from the normal. But if the purpose of setting a target is to improve performance, then that target should be realistic and achievable. Compared to historical performance of utilities elsewhere, the standards set in the six states appear aggressive and, in some cases, possibly unachievable. What's more, in the majority of these states, the targets are expected to be met through utility programs, with no provisions for contributions from other measures, such as applying new building energy codes or relying on supplemental generation from, for example, combined heat and power. In the case of Ohio, ACEEE estimated that including these measures would satisfy 10 percent of the EERS target, leaving a more realistic and achievable savings target of 12 percent through utility programs.[7]

Managing Targets

The phased approach adopted by these standards is, of course, useful. It's also sensible from a regulatory point of view in that

There have been approximately 60 studies of energy-efficiency potentials since 2000, including more than a dozen by the authors of this article. These studies generally estimate cost-effective, energy-efficiency potentials of about 15 to 20 percent of annual loads at the end of the forecast horizon, usually 10 to 20 years away. A 2009 study sponsored by EPRI shows the national average cost-effective potential to be lower, at about 12 percent. The study estimates a maximum achievable potential at 8 percent of projected loads with 5 percent being "realistically achievable." These estimates are, however, overly conservative, being lower than what many utilities already have realized.[8] Nevertheless, even assuming a 12-percent achievable potential, Arizona would exhaust all of its potential by about 2016, Illinois by 2018, and all other states by 2020 or shortly thereafter.

Of course, the actual energy-efficiency potentials vary by state, depending on a number of factors such as customer mix, end-use saturations, existing energy codes and standards, and efficiency gains already realized through past conservation programs.

There's also the knowledge that the amount of energy-efficiency potential isn't fixed. New and more efficient technologies appear regularly, and emerging end-uses, such as home electronics, generate new opportunities for efficiency improvements. However, these developments are gradual and will continue beyond the performance deadlines in such states as Illinois and Ohio.

Expenditure Caps

Cost-effectiveness is an explicit condition for performance standards in all cases. The criterion is almost universally based on the total resource cost (TRC) or the societal perspective, except in Utah and Michigan where energy-efficiency programs are judged—inexplicably from a resource planning point of view—according to the utility cost criterion. A less-common practice is to set expenditure limits, usually at 2 percent of the utility's annual retail sales. Expenditure caps are appealing from a regulatory point of view; they serve as measures of cost control and, like ramping, they help mitigate near-term rate shocks. But caps also limit a utility's ability to construct optimal portfolios that increase the depth of savings. Caps encourage the utility to pursue only the least-cost savings options, leaving significant amounts of cost-effective energy-efficiency potential untapped, a practice known as cream skimming. In this way, caps constrain investments in efficiency to levels that are significantly below a utility's avoided costs.

More important, expenditure caps, coupled with aggressive annual saving targets, might prove impractical. In Illinois, for example, spending limits start at 1.5 percent of revenues in 2010. They increase to 2 percent in 2011 and remain at that level through the end of the performance period in 2016. The resulting relationship between annual performance targets and allowed annual expenditures appears counterintuitive and is inconsistent with historical data available from EIA. The data clearly show a strong, positive relationship between savings and expenditures (*see Figure 2*). They also show that the few utilities saving 2 percent or more of their annual sales spent at least 2.5 percent of their annual revenues to achieve that savings level. There are no cases where expenditures of 2 percent of annual revenues produced savings larger than 1.5 percent.

California allowed quantifiable savings from behavior-based efficiency initiatives to be counted toward saving targets.

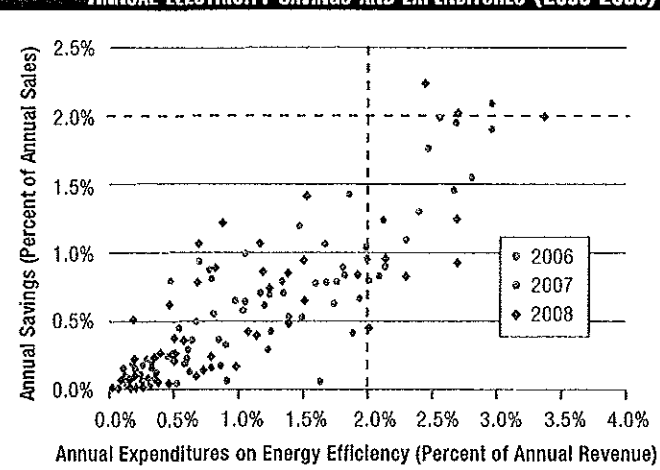
There are, of course, possible learning effects and likely economies of scale. As utilities gain more experience in implementing energy-efficiency programs, they'll learn to do so more effectively and more cheaply. The growing investment in energy efficiency also attracts firms to enter the market, stimulating competition and lowering costs. There's also an argument for the existence of scale economies, but the evidence of such is weak and inconclusive. The available data from EIA show that savings increased from 0.42 percent of sales in 2006 to 0.49 percent of sales in 2008, with a three-year average of 0.45 percent. During that same period, spending increased from 0.9 to 1.2 percent of revenue—an increase of 30 percent. Regression analysis of per-unit cost of first-year savings as a function of savings, measured as a percent of annual sales, shows an elasticity of approximately 0.3 percent.[9]

As studies of energy-efficiency potential have shown, conservation supply curves invariably re positively sloped. Marginal costs of energy savings are more likely to increase as savings potentials from low-cost measures are exhausted and the early-adopter markets are saturated first during an energy-efficiency program's life cycle. Over time, and as higher savings need to be achieved, utilities need to implement more expensive measures, consider paying higher incentives, intensifying marketing efforts to attract more participants, or both.

Also, utilities might be impeded in realizing aggressive saving targets after 2014, once the 2007 residential lighting standards of the *Energy Independence and Security Act* (EISA) fully take effect, thus eliminating significant savings from compact fluorescent light bulbs, a major source of electricity savings in nearly all utility energy-efficiency programs.

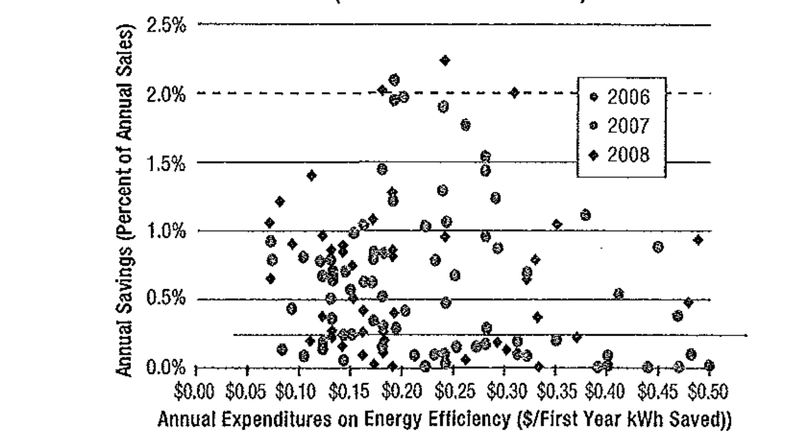
Analysis of the per-unit cost of energy savings is another way to examine the effects of expenditure caps. For exam-

FIG. 2 ANNUAL ELECTRICITY SAVINGS AND EXPENDITURES (2006-2008)



Source: Energy Information Administration ple, in Illinois the allowed expenditure limits in conjunction with the increasing annual saving targets results in an average, per-unit budget that begins at approximately 18 cents per first-year kWh saved in 2010, but decreases to 8 cents in 2016 for the typical utility (*i.e.*, a weighted average of 10 cents over the performance period). The EIA data, on the other hand, show that utilities approaching 2 percent savings tend to spend between 20 and 30 cents per kWh, more than the Illinois limits, particularly by 2016 (*see Figure 3*).

FIG. 3 PER-UNIT COST OF CONSERVED ENERGY RELATIVE TO ACTUAL SAVINGS
(% OF ANNUAL RETAIL SALES)



Source: Energy Information Administration

Too Many Objectives

In 2008, Pennsylvania enacted Act 129 (the Act), establishing a four-year EERS. The law requires each electric distribution company with at least 100,000 customers[10] to reduce energy consumption by at least 1 percent by May 31, 2011, relative to 2009-2010 retail electricity sales, phasing to 3 percent by May 31, 2013. Peak demand also must be reduced by 4.5 percent, on average, during the highest 100 hours of the utility's load by May 31, 2013. Also, the law directs the Pennsylvania Public Utilities Commission to set targets beyond 2013.

During each of the four years from 2010 to 2013, utilities may spend up to 2 percent of their 2006 annual revenues to achieve these targets. Failure to reach either energy or peak demand-reduction targets subjects the utility to a penalty of not less than $1 million and, potentially, up to $20 million.

Moreover, utilities are required to offer programs equitably—interpreted as proportional to their share of the utility's load—to various customer classes, including the low-income segment. The law also directs utilities to ensure that at least 10 percent of all energy savings come from institutional and non-profit entities.

The electricity saving targets, which average about 0.75 percent of sales per year, aren't formidably high compared to what recently has been adopted in other states—or compared to what actually has been achieved by many utilities. It's by no means unreasonable to expect that benefits to each customer class from energy-efficiency programs should be commensurate with their share of the costs of these programs. The required peak-load reduction, although aggressive compared to achievements in demand-response programs elsewhere in the United States, possibly might be attainable.

What makes the Pennsylvania performance standards unique and especially challenging is their multiplicity of—often competing—objectives. This is particularly true with the peak-load reduction targets, especially given the unusual way the statute defines the peak period. The gravity of this challenge is clearly evident in the plans filed by the seven utilities in 2009, showing that utilities grappled with the challenge of balancing these objectives when preparing their portfolios within the strict confines of the law.

Looking Ahead

The problem with prediction is that the future eventually arrives. According to a recent estimate from the NPCPC, by the end of 2002, the Northwest had achieved on average about 2,300 MW of savings, equivalent to 12.5 percent of the actual electricity use in 2002.[11] Although markedly below the forecasted amount, the achievement was substantial, especially for a first comprehensive attempt at systematic conservation. Additionally, the savings likely would have been higher without the severe cutbacks in conservation expenditures resulting from the attempts at restructuring of the electric power industry in the 1990s.

In April 2010, the NPCPC published its *6th Regional Power Plan*, projecting nearly 5,860 MW of technically achievable conservation potential on average—about 22 percent of the average demand forecast scenario by the end of the forecast period in 2030. Most of this potential is projected to be available at a levelized life-cycle cost of less than $200 per MWh in 2006 dollars.

Setting targets is essential to effective planning, so challenging goals are necessary for improving performance—but only as long as the goals are realistic and reasonably achievable. Several years ago, ACEEE proposed developing a nationwide energy-

(Cont. on p. 65)

A market-based approach to achieving efficiency targets would give retailers flexibility and spur innovation.

Extreme Efficiency

(Cont. from p.53)

efficiency performance standard, which would set a national goal for energy efficiency to be implemented and enforced at the state level. Utilities that provide retail electric service would be required to implement measures each year so as to save the equivalent of 1 percent of the electricity used by their customers. The U.S. Department of Energy would set uniform national energy savings measurement protocols to verify and report the energy savings, and state regulators or other governing boards would be responsible for enforcing them. Under the ACEEE proposal, electricity retailers also could meet the savings goal by purchasing energy savings credits from other retailers achieving greater savings than required. This market-based approach would give retailers flexibility and spur efficiency innovation. At the time the proposal was made, the idea seemed far-fetched. Judging by how states have gone about setting standards, the idea is beginning to seem quite reasonable.

Endnotes:

1. Energy-efficiency performance standards were adopted in several European countries in the late 1990s, including the United Kingdom, France, and Italy. For example, the United Kingdom instituted energy-efficiency performance standards targeting the residential sector as early as 1998. The standard included a trading scheme, known as the Energy-Efficiency Commitment (EEC), which currently runs in three-year cycles. The structure and terms of the standard are described in the *Energy Efficiency Standards of Performance for Electricity Suppliers* 1998-2000, United Kingdom Office of Electricity Regulation, or the Director General of Electricity Supply, April 1998.
2. On June 15, 2007, the Texas HB 3693, an omnibus energy efficiency bill, was signed into law, increasing this standard to 15 percent of load growth by Dec. 31, 2008 and 20 percent of load growth by Dec. 31, 2009. HB 3693 also required that a study determine the potential to increase savings targets to 30 percent by 2010 and 50 percent by 2015.
3. "State Energy Efficiency Resource Standards," is a chronological list of standards adopted by states, updated annually. The latest update was published by ACEEE in January 2010. A similar list is also published by the PEW Center for Climate Change.
4. *Proposed Rulemaking on Energy Efficiency*, Decision No. 71436, RE-00000C-09-0427, The Arizona Corporation Commission.
5. The data for Pacific Gas and Electric in 2008 indicated savings of 3.5 percent of the utility's annual load. This record appeared to be an outlier and was removed.
6. Electric utility reports on sales, revenues, and energy efficiency activities are available through the Energy Information Administration (EIA), the Federal Energy Regulatory Commission (FERC) form 861.
7. ACEEE, "Shaping Ohio's Energy Efficiency Future: Energy Efficiency Works," ACEEE Report Number E-092, March 2009.
8. *Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010–2030)*, Electric Power Research Institute 1018363, January 2009.
9. This elasticity measures the percent of change in the first-year cost of conserved energy, measured as $/first-year kWh saved, as a result of a one percent change in savings, measured as percent of annual sales for the 2006-2008 EIA data. The elasticity was estimated using several specifications of a general equation with the following general formulation: log ($/kWh) = f (log (percent Sales Saved)). The results generally showed consistency with various models with statistically significant elasticity estimates, ranging from 0.28 to 0.35 percent.
10. There are seven electric distribution companies (EDCs) in Pennsylvania that meet the threshold: PECO Energy, Allegheny Power, Duquesne Light, Metropolitan Edison, Pennsylvania Electric, Pennsylvania Power, and PP&L Electric Utilities.
11. Achievable Savings: A Retrospective Look at the Northwest Power and Conservation Council's Conservation Planning Assumptions, August 2007 Council, Document 2007-13.