Recognizing the Value of Energy Efficiency's Multiple Benefits

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Executive Summary

Multiple benefits refer to the impacts of energy efficiency improvements beyond energy savings. These benefits accrue to program participants, electric utility systems, and society as a whole. Examples include comfort, health, and safety enhancements for building occupants; productivity enhancements for businesses; and reduced system costs for electric utilities. Prior research demonstrates a range of quantified multiple benefit values, some of which can exceed utility bill savings. This evidence should resonate not only with household and business decision makers, but also with policy and program professionals tasked with the design, outreach, and evaluation of energy efficiency programs. Awareness of multiple benefits may sway decision makers who may otherwise be ambivalent about energy efficiency investments. Efficiency program administrators can segment and serve the market by leveraging these benefits.

Residential Sector

A number of studies have evaluated and quantified multiple benefits resulting from single-family residential energy efficiency improvements. The value of multiple benefits that accrue to the participant is particularly important to consider when evaluating the costs and benefits of whole-home energy retrofits, for which homeowners generally make a greater contribution to project costs than in other residential energy efficiency programs (e.g., consumer product rebate and behavior programs). Retrofits can improve occupants' health, safety, and comfort, in addition to lowering maintenance costs and increasing property value. For single-family homes, the value of these benefits has been estimated at anywhere from 50% to 300% of energy cost savings. Residential energy efficiency is also shown to reduce utility bill arrearages, bad debt write-offs, and reliance on low-income household energy assistance.

Multifamily building energy efficiency improvements provide financial benefits to owners and investors through improved operations and reduced maintenance needs. Improvements that positively affect tenants, like reduced tenant utility bills and more-comfortable living spaces, can also improve building occupancy. Recent evaluations have measured a number of benefits to building owners from energy efficiency improvements. Improved operations have been valued at 3% to 150% of the value of energy savings; improved property value, at 10%; and, in one study, vacancy and turnover improvements, at 100%.

Multiple benefits have generally been evaluated by surveying program participants using various survey types including contingent valuation (willingness to pay), conjoint analysis, and relative valuation. As experience with these approaches grows, program evaluators are determining values more rapidly and with fewer resources. Multiple benefit values are just as important to energy resource managers for outreach and marketing as they are for program cost–benefit screening. Sharing results across jurisdictions is key to recognizing and using these values.

BUSINESS SECTOR

The business sector encompasses commercial, institutional, and industrial facilities. Energy efficiency and its multiple benefits manifest differently across these subsectors. The industrial sector is crucial to energy resource planning, as these facilities usually provide the most cost-effective energy savings. Multiple benefits include some combination of operations and maintenance savings, enhanced productivity, higher product quality, improved work environment, improved capital value, risk abatement, and more.

One study described the value of multiple benefits as 44% of industrial energy savings, while another indicated 122%. A study of a variety of business types found that 92% of 63 businesses reported reduced maintenance materials costs and 63% avoided procurement costs. As with the residential sector, business-sector multiple benefit findings are preliminary. The data are still insufficient to reliably predict the benefit value associated with each unit of energy saved. Nevertheless, the variety of multiple benefits ensures that some will be more practical to define and measure than others.

Energy resource planners can anticipate this by segmenting multiple benefits accordingly. Perhaps the most practical segment of benefits to promote and evaluate is reductions in concurrent facility expenses such as electricity demand, water consumption, maintenance, labor, and regulatory compliance costs. These stand out because these, like energy, tend to fall within the purview of facilities management staff. Various forms of tax relief are potentially valuable benefits, but they are grossly underutilized even when businesses make energy improvements. Internal communication is the culprit.

Multiple benefit values are often pivotal in convincing industry managers to adopt energy-saving improvements. Program administrators may direct consumers to multiple benefits as a way to achieve intended energy savings. When they do this, market segmentation will help to optimize their incentive and outreach budgets. Just as multiple benefits vary in their ease of accounting, they also vary in their relevance to prevailing consumer needs and aspirations. Market segmentation can be achieved accordingly: by motives for customer investment such as financial gain, regulatory compliance, risk abatement, and more. Segmentation may also reflect the pace and timing of customers' response to program outreach. Their response may depend on considerations such as capital budgeting cycles, management turnover, economic conditions, product market evolution, and coordination with other industry or utility initiatives.

UTILITY SECTOR

Energy efficiency programs provide substantial multiple benefits to electric utility systems that go far beyond traditional avoided costs of energy. These benefits reduce utility system costs and thereby reduce customer bills over time. Energy efficiency is well documented as the least-cost system resource available to electric utilities. The economic value of multiple benefits to electric utility systems only reinforces the advantage of energy efficiency as a system resource.

There are several key utility system benefits to consider and include in cost-effectiveness screening of energy efficiency. These include nonenergy benefits such as reduced arrearages, as well as the avoided cost of energy, generation capacity, transmission and distribution capacity, and environmental compliance. Decades of study have demonstrated the value of these benefits and the best ways of determining them.

As an example of a nonenergy benefit, a customer who is able to reduce an electric bill through energy efficiency is more likely to avoid nonpayment and disconnection. This reduces administrative costs for utilities and increases program value.

Recent years have seen a rise in the use of geotargeted energy efficiency to avoid or defer transmission and distribution system investments. Currently, most utilities estimate the value of these avoided or deferred investments on a whole-system basis. However this value is higher in some areas than in others. Geotargeting allows distribution system planners to use energy efficiency as a resource to capture this value.

Cost-Effectiveness Testing

Multiple benefits are not regularly quantified as a part of the effort to evaluate energy efficiency programs. As a result, they are often left out of cost-effectiveness testing, even when many of the tests used (most commonly the Total Resource Cost) are designed to include them. The challenge of quantifying multiple benefits does not justify their dismissal. Massachusetts includes most energy efficiency program benefits in cost-effectiveness testing based on a comprehensive evaluation of its programs. Many states are using different mechanisms to include some portion of benefits beyond energy savings in their testing. Some (e.g., Vermont and Oregon) use adders to assign an approximate value to benefits. Others, like Rhode Island and Maryland, have adapted the values determined in Massachusetts' comprehensive study to derive estimates for their own programs. Moving forward, more states should integrate measurement of a consistent set of benefits into program data collection and evaluation.

Conclusion

The comfort, health, financial, and risk-abatement consequences of energy efficiency's multiple benefits contribute to the betterment of regional economies. This outcome underscores the need for energy policy and resource planners to recognize and account for these values.

Introduction

As policymakers and regulators make judgments about energy resource options, it is important that they recognize and incorporate the multiple benefits of energy efficiency. Multiple benefits refer to any value created over and above the energy savings value attributed to an energy efficiency improvement. Traditional cost–benefit screening of energy efficiency investments fails to describe truly equitable resource allocations if the scope of evaluation excludes coincident multiple benefits. Conversely, program evaluators' recognition of multiple benefits reduces the tendency to underestimate the full value created by implementing an energy efficiency measure. A one-dimensional, energy-only approach is akin to valuing a house solely for its square footage, while ignoring the value imputed to its location, integrity of construction, and maintenance requirements.

Multiple benefits are traditionally categorized as societal, participant, or utility benefits. Society as a whole benefits from energy efficiency, such as when it reduces pollutants associated with traditional energy extraction, supply, and use or when it allows investment capital to serve purposes more productive than building unnecessary energy supply capacity. Participant benefits accrue to the people and businesses that participate in energy efficiency programs. For example, energy-efficient households may enjoy comfort and convenience benefits as well as expense reductions. For businesses, energy savings tend to beget other, nonenergy impacts that ripple through financial statements, e.g., improved worker productivity. Utility system multiple benefits extend beyond avoided costs of energy to include other savings (e.g., reduced need for transmission and distribution investments) that may eventually translate into reduced rates for customers. This paper focuses on participant benefits in the residential and business sectors, and on multiple utility system benefits.

Our discussion of multiple benefits asks several questions. Which multiple benefits should be included in the cost-effectiveness evaluation of energy efficiency programs? What is the value of these benefits, and how can that value be determined? How can program administrators communicate these advantages to prospective customers to engage them in multiple-benefit programs?

This paper builds on three previous ACEEE studies: *Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening* (Cluett and Amann 2015), *Multiple Benefits of Business-Sector Energy Efficiency: A Survey of Existing and Potential Measures* (Russell 2015), and *Everyone Benefits: Practices and Recommendations for Utility System Benefits of Energy Efficiency* (Baatz 2015).

Multiple Benefits in Residential Energy Efficiency Programs

OVERVIEW

A wide variety of multiple benefits may accrue to the residential sector. Many of these benefits have been quantified for existing single-family and multifamily residential energy efficiency programs. Whole-home and whole-building retrofit program results are of particular interest to policy and program administrators because of the magnitude of the energy savings generated by retrofits.[1] The costs of these programs are split between administrators and participants (figure 1).

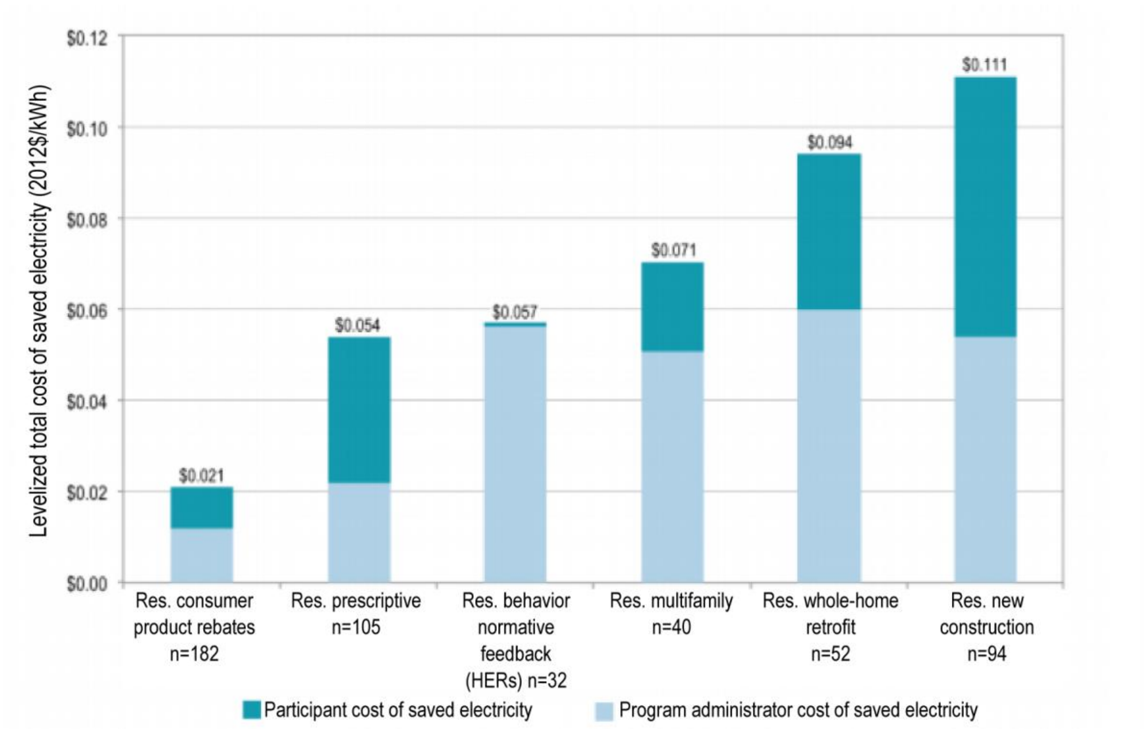

Figure 1. Total cost of saved electricity for program administrators and participants, by program type. *Source:* Hoffman et al. 2015.

Program administrators have an interest in a more comprehensive assessment of the multiple benefits from whole-home energy efficiency programs, for two reasons. One is increased ability to market the range of benefits that home or building owners can expect from energy efficiency upgrades. A better understanding of the benefits of energy efficiency improvements for participants, beyond energy savings, can help program administrators reach more customers by shaping marketing and outreach efforts. While savings from whole-home retrofit programs can be substantial, these programs entail higher upfront costs for building owners, which can limit participation and interest.

The second reason is to better represent the value of these programs to regulators and to subject them to cost–benefit analysis for comparison with other programs in the portfolio. These programs involve a larger contribution from participants than consumer product rebate and behavior programs, so incorporating participant multiple benefit values is even more critical to accurate valuation of the program.

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[1] Prescriptive energy efficiency programs provide incentives for more-efficient heating, ventilation, and cooling systems (HVAC), water heaters, and shell improvements such as air sealing and insulation. Whole-home programs tend to promote more-comprehensive retrofits, in which several of these measures are implemented.

The next sections focus on the valuation of benefits from the program participant perspective (i.e., the single-family homeowner and the multifamily-building owner).

SINGLE-FAMILY BENEFITS

Homeowners often invest in energy efficiency improvements for reasons beyond utility bill savings. Numerous market research studies have shown that along with energy savings, primary drivers for homeowners to undertake comprehensive whole-home efficiency upgrades include community pride, environmental responsibility, and improvements in home comfort, temperature control, and indoor air quality (Lutzenhiser Associates 2006; Fuller et al. 2010; GDS Associates 2013). Comfort can be as important a motivation as energy bill reduction, if not more important (Knight and Lutzenhiser 2006).

A number of studies have evaluated an extensive range of multiple benefits resulting from residential energy efficiency programs including the Weatherization Assistance Program. Over a number of years, benefit values have been calculated for some home retrofit programs targeting HVAC and building shell improvements (air sealing and insulation). While the categories of benefits have remained consistent, the specific benefits evaluated have varied between studies. Benefit values also vary due to evaluation method, program type, and delivery. However ranges have emerged for a majority of these benefits. Table 1 draws from the latest evaluations and literature reviews to compile value ranges for some of the most regularly quantified benefits in each category.

Table 1. Multiple participant benefits of single-family retrofit programs

Category	Benefit	Measure applies to	Calculation method	Value range (% of utility bill savings)
Readily quantified and monetized benefits				
Resource	Reduction in water and sewer costs	Faucet aerators, showerheads, clothes washers, dishwashers	Algorithm based on water savings from each device, and cost of water and sewer service	5–60%
Highly important to participants, quantified/valued by some				
Operations	Increased home durability, less maintenance	Retrofit programs	Survey	7%
	Reduced equipment and appliance maintenance	Retrofit, lighting, equipment, and appliance programs	Survey	2–26%
Comfort	Higher comfort levels	Retrofit programs (primarily insulation, air sealing, and HVAC)	Survey	2–25%
	Noise: quieter indoor environment	Retrofit programs	Survey	5–15%

Category	Benefit	Measure applies to	Calculation method	Value range (% of utility bill savings)
Safety	Improved safety (fewer fires, reduced CO poisoning)	Retrofit programs	Incidence from program data	1–12%
Home improvements	Increased housing property value	Retrofit programs	Survey	2–20%, or quantified as a one-time value (NMR Group 2011)
Potentially significant, but less readily quantified				
Health	Reduced illness, fewer sick days	Retrofit programs	Survey methods have been used to report incidence of symptoms or occurrences of specific health problems pre and post retrofit.	0–36%
	Improvements in indoor air quality	Retrofit programs	Testing using sensors to measure indoor air quality	Not yet monetized.

Sources: NMR Group 2011; Skumatz 2014; Itron 2014; Amann 2006; Tonn et al. 2014; Pigg et al. 2014.

The overall value of participant benefits for single-family whole-home programs is between approximately 50% and 300% of utility bill savings (Amann 2006; Skumatz 2014; NMR Group 2011). For example, if $6,000 is spent, with an expected energy cost savings of $400 a year over 15 years, accounting for participant benefits at a value of 50% of utility savings would improve a simple benefit–cost ratio from 1.0 to 1.5 (without taking into account discount rate or net versus gross savings). Program administrators that rely on a Total Resource Cost (TRC) test or Societal Cost Test (SCT) (any test that includes participant costs) should be valuing the full range of participant benefits.

Single-family programs also benefit utilities and society. As discussed in a later section, utility benefits include reducing arrearages and their carrying costs, bad debt write-offs, and low-income rate discounts. Societal benefits include increased economic development, more jobs, and reduced air emissions.

MULTIFAMILY BENEFITS

Efforts to value multiple benefits in the multifamily sector have increased in recent years, in conjunction with increasing energy efficiency program activity targeting whole-building multifamily upgrades. Benefits that accrue to the participant differ between single-family and multifamily programs in some important ways. Multifamily property owners have financial costs, goals, and risks distinct from those of single-family homeowners. Ownership and occupancy usually coincide in single-family homes. Multifamily program benefits are bifurcated: energy efficiency provides operations and maintenance benefits to the owner/manager, while comfort and health improvements accrue to occupants. Benefits to owners are positively compounded when occupancy rates improve directly along with occupant comfort.

Cluett and Amann (2015) summarized studies documenting benefits to building owners, including maintenance, durability, property value, and rental value. These studies indicate that from the perspective of the building owner—the likely participant in a whole-building multifamily retrofit program—a number of benefits can yield financial gain. Standard accounting practices can measure many of these benefits, including reduced maintenance and repair costs and reduced costs of other utilities, particularly water and delivered fuels. Table 2 presents the participant benefits that generally accrue to multifamily building owners.

Table 2. Participant benefits in multifamily programs

Category	Benefit	Measure applies to	Calculation method	Value range (% of utility bill savings)
Resource	Reduced water and sewer costs	Faucet aerators, showerheads, clothes washers, dishwashers	Algorithm based on water savings from each device, and cost of water and sewer service	Not available
Improved operations	Reduced need for lighting and equipment maintenance	Retrofit, lighting, equipment, and appliance programs	Survey and building financial data	3–150%
Vacancy and turnover	Lower vacancy rates	Retrofit programs	Building financial data	100% (few examples)
Building improvement	Improved property value and durability	Retrofit programs	Survey	Property value: 10%. Durability: 18%

Sources: Cluett and Amann 2015; Elevate Energy 2014a and 2014b; Majersik 2004; NMR Group 2011.

Cluett and Amann (2015) also included studies evaluating the impact of energy efficiency improvements on tenants. Despite the fact that the building owner is usually the official program participant for retrofit programs, some work has evaluated the benefits of multifamily programs from both the tenant perspective and the building owner perspective, so that the relationship between tenant satisfaction and outcomes for building owners can be better understood. Tenant surveys have revealed that multifamily building occupants are more comfortable in their units, can pay utility bills with greater ease, and are more likely to renew their leases.

Table 3, adapted from Cluett and Amann (2015), shows the types and scale of benefits that can be realized in the multifamily sector, using data from a Massachusetts program evaluation (NMR Group 2011).

Table 3. Value of benefits from building owner perspective

Impact	Value (% of estimated bill savings
Marketability of rental units	8%
Equipment maintenance	3%
Lighting maintenance	28%
Durability	10%
Tenant satisfaction (both positive and negative results)	4%
Other (both positive and negative results)	18%
Total	71%

"Other" includes the effect on the bottom line of lower energy bills, increasing tenants' awareness of energy efficiency, increased safety, respect from the community, and shorter-than-expected lifetime of bulbs. *Source:* NMR Group 2011.

For example, if $10,000 is spent, with expected energy cost savings of $1,000 a year over 15 years, accounting for participant benefits at a value of 71% of utility savings would improve a simple benefit–cost ratio from 1.5 to 2.6 (not taking into account discount rate or net versus gross savings).

VALUATION METHODS

Surveys

Resource benefits, such as cost savings from reduced water and sewer fees, can be readily quantified using established methodology in the literature. Many of the other important benefits are valued through participant self-reporting surveys. Since the 1990s, energy efficiency program evaluators have used a number of survey methods to monetize participant benefits, including contingent valuation (willingness to pay), conjoint analysis, and relative valuation (Skumatz 2014; Amann 2006; NMR Group 2011). Researchers have compared methods for their reliability, clarity of meaning, and transparency of method.

Contingent valuation, or willingness to pay, is a survey method that asks respondents how much they would pay for a particular benefit. The method has a history of use in efforts to value different aspects of the natural world for which there is no market value. Researchers have used surveys to ask respondents about their willingness to pay to protect natural resources. This survey method is useful as a direct and simple method of obtaining value; however it has a number of drawbacks. Values are widely divergent across respondents and are generally much higher than those obtained through other survey methods (NMR Group 2011). In addition, contingent valuation surveys tend to suffer from low response rates.

Conjoint analysis is another survey method that has been used to a lesser extent to value benefits of energy efficiency programs. The method is commonly used in marketing research to assess the value of hypothetical attributes of a product by asking respondents to choose between two different products. The approach relies on lengthy sets of survey questions. It does not require respondents to directly place a value on each benefit, but instead asks about preferences, which may more accurately depict how people value intangible things (NMR Group 2011; Wobus et al. 2009).

The *relative valuation* method asks respondents to value a benefit relative to the energy bill savings provided. This approach has emerged as one of the most relied-upon survey methods for nonenergy benefit valuation (NMR Group 2011). It differs from contingent valuation because it bounds potential values by the value of the energy savings. Relative valuation reduces variation in reported values compared to contingent valuation methods, which ask participants how much they would pay for a benefit without reference to any other value or benefit. This method is also likely to result in higher response rates than willingness-to-pay methods, because respondents find bounded (predefined) benefit values more tangible than values derived from abstract questions (NMR Group 2011).

The relative valuation approach limits the valuation of benefits to the perceived or confirmed value of energy bill savings. This could have a misleading effect, particularly in instances of low-income energy efficiency. For example, in a home that was kept at lower temperatures before weatherization because of malfunctioning equipment or out of a need to save money, energy savings from improvements could be very modest, while the improvements in health, safety, and comfort from a warmer home could be much more significant. One way practitioners have addressed this barrier is by including an estimate of average program savings from which to anchor valuation questions (NMR Group 2011). This issue is less of a concern for non-low-income programs that are designed primarily to save energy.

Another consideration is that this method may link the valuation of benefits to energy prices rather than to the volume of energy saved. In other words, we would see higher benefit values correlated to higher energy prices rather than a perceived change in benefit value.

While relative valuation is not perfect, it is a straightforward approach to acquiring information from program participants, and it has an easy-to-follow methodology for valuing benefits. Relative valuation surveys can support a robust understanding of benefit values identified by program participants when (1) the valuation methodology is transparent and (2) the situational limitations of the survey scope and method are clearly documented.

Using Methods and Values from Other Programs

Now that many studies have served to establish values and methodologies, more-recent evaluation efforts are building upon the existing work to reach values in less time- and resource-intensive ways. A study for the Massachusetts Program Administrators, conducted by NMR Group (2011) to quantify the nonenergy impacts of their energy efficiency programs, surveyed the literature on a host of different benefits that had already been quantified for other programs. For some benefits, values and methods from existing evaluations were deemed appropriate for characterizing the nonenergy impacts specific to Massachusetts' programs (NMR Group 2011). The benefits in table 4 were quantified and recommended for use in cost-effectiveness testing in Massachusetts. For participant benefit values that are usually determined via survey methods, researchers chose to run their own surveys, because existing research did not evaluate programs of a sufficiently comparable type and scope (NMR Group 2011).

Table 4. Benefits quantified for use in cost-effectiveness testing in Massachusetts

Benefit	Method of quantification
Participant (single-family)	
Reduced water use and sewer costs	Algorithm from literature
More durable home, lower maintenance	Survey
Appliance and equipment maintenance	Survey
Comfort	Survey to program participants
Quiet interior environment	Survey to program participants
Lighting quality and lifetime	Technical resource manual (TRM) values
Safety (heating system, ventilation, CO, fire)	Algorithm from literature and program data
Increased property value	Survey
Health impacts	Survey
Participant (multifamily)	
Maintenance (lighting, heating and cooling equipment)	Survey
Marketability/ease of finding renters	Survey
Tenant complaints	Survey
Reduced tenant turnover	Survey
Property value	Survey
Property durability	Survey
	Survey
Utility	
Arrearages	Value from literature
Bad debt write-offs	Value from literature
Terminations	Value from literature
Rate discounts	Algorithm from literature and program data
Customer calls	Value from literature
Collections notices	Value from literature
Safety-related emergency calls	Value from literature
Insurance savings	Value from literature
Societal	
National security	Algorithm from literature

The full range of impacts evaluated for potential valuation is included in the evaluation report. This table captures only the benefits that researchers recommended to program administrators for quantification. Certain benefits were excluded because they were too intangible or difficult to quantify. *Source:* NMR Group 2011.

While these values are not always easily translated to other programs, each additional evaluation of nonenergy benefits has been critical in building justification for including these benefits in the evaluation of energy efficiency programs. In a 2014 study of nonenergy impacts for the state of Maryland, researchers applied findings on the value of comfort benefits for Massachusetts energy efficiency programs to the Maryland Home Performance with ENERGY STAR® Program (Itron 2014). A per-participant comfort value from the Massachusetts study ($136) was used to calculate the estimated lifetime benefit per participant for the Maryland program ($1,416) based on Maryland program discount rates and the measure lifetime (Itron 2014). While only one of many benefits found in the Massachusetts study was applied to the Maryland case, the cost-benefit analysis results show a positive outcome. The statewide TRC benefit-cost ratio for the Maryland Home Performance with ENERGY STAR Program improved from 0.6 to 0.79 (Itron 2014).

Regional Approaches

Program administrators may also consider a regional approach to assessing the multiple benefits of programs. In regions where similar programs are offered in different states, the cost burden of an evaluation of multiple benefits could be shared. For example, in the absence of nonenergy impact evaluations of Rhode Island programs, the state has relied on Massachusetts' benefit valuation work, as they have similar program types (Woolf et al. 2013).

Using Secondary Data Sources and Studies

Another way benefits have been quantified is through estimates derived from secondary studies or data. For participant benefits, the most commonly used secondary data source has been utility studies on the impact of programs on the ability of customers to pay their utility bills on time, through data on late bill payments, notices, shutoffs, and reconnects in utility reporting. These aspects of customer interaction with the utility can be readily monetized based on late fees, interest, the cost of reconnects, and so on. The value of these benefits tends to vary directly with the household income of participants. In other words, utility bill relief has a greater impact on low-income households.

Secondary data sources and studies can also be used to better establish differences in property value for homes that have undergone retrofits. The value of energy-efficient, green, and high-performance homes in the market has been studied to some extent, but there is still considerable opportunity to understand the value of retrofitted homes in the real estate market (Kok and Kahn 2012; Stukel et al. 2014; Adomatis 2015; Kaza, Quercia, and Tian 2013). In addition independent studies of the health benefits of weatherization improvements on occupants could be used to better understand the value of energy efficiency improvements. For instance, the recently released national evaluations of the Weatherization Assistance Program quantify various health benefits attributable to weatherization of low-income homes (Tonn et al. 2014).

Tracking Incidence of Benefits

If valuing certain benefits is not possible, programs may also track the incidence of benefits in order to support program activity in regulatory settings. For example, programs could track the number of homes that now have safe carbon monoxide levels as a result of the program, or where other health and safety issues were mitigated as a result of energy efficiency improvements. This information can be used to help justify the value of the program in a regulatory setting.

LEVERAGING MULTIPLE BENEFITS FOR PROGRAM MARKETING

Programs may build support for home performance initiatives by marketing improvements based on the variety of benefits they provide (Cluett and Amann 2015). Case studies and personal anecdotes about residential multiple benefits have long been used to market whole-building programs for both single-family and multifamily properties. More recently, program administrators are incorporating research on the customer motivations that underlie multiple benefits into evaluations of their programs, to refine program marketing to reflect the benefits that customers want and experience. For example, PG&E performed a marketing and targeting analysis for their whole-home performance program, which included an evaluation of participants' motivations for joining the program. Many of these motivations involved nonenergy benefits including comfort (Campbell 2014). MassSave has developed program marketing materials for its multifamily program that aim to resonate with building owners, highlighting the improvements in property value, occupancy rates, and tenant retention that can result from their eligible energy efficiency upgrades (MassSave 2015).

The national Home Performance with ENERGY STAR (HPwES) program leverages multiple benefits in its marketing materials. Improving home performance is the primary goal of this program, which focuses on making healthier, more comfortable buildings:

> Home Performance with Energy Star is a programmatic platform designed to systematically enhance home performance for healthier and more comfortable living environments, enhanced durability of the homes' structures and systems, and improved energy savings for the homeowners. (DOE 2014, 74)

Health and safety are key benefits of home performance programs. Most current sponsors of the HPwES program have adopted the Building Performance Institute (BPI) Building Analyst and/or RESNET Home Energy Rating System (HERS) Rater certifications as part of their minimum qualifying criteria for participating contractors. These certifications require that contractors evaluate and remediate key health and safety issues in the home before moving forward with energy efficiency improvements. This includes evaluation of carbon monoxide levels, mold and moisture, the presence of unsafe materials including asbestos and vermiculite insulation, and the presence of knob and tube wiring.

Multiple Benefits in Business-Sector Energy Efficiency Programs

Business facilities clearly differ from residential structures not only in the way they are used but also in the way they use energy. Less obvious is how energy efficiency's multiple benefits are perceived within the business sector. Although energy is a necessity for all business facilities, perceptions of energy's importance vary among them. For certain enterprises, multiple benefits are often more compelling than energy savings alone.

The business sector may be segmented to reflect facilities' mechanical energy needs as well as their business and market dynamics. Energy resource program managers may distinguish between commercial properties (office, retail, and institutional) and industrial facilities (manufacturing, mining, and agricultural).

Commercial properties emphasize human comfort over mechanical activity. Here, the multiple benefits of energy efficiency begin with increased ease of facility management tasks, reduced maintenance costs, and improved occupant comfort. External benefits are also evident, as businesses build their corporate and brand reputations by demonstrating their efficiencies to customers and shareholders alike.

Multiple benefits from industrial energy efficiency are mostly distinct from those found in commercial facilities. Many industrial facilities will enjoy some mix of improved occupant comfort, enhanced process productivity, optimization of simultaneous resource inputs, improved product quality, and workplace safety (ASE 2013).

Energy resources are a factor of production in the industrial sector and therefore integral to the core business. Efficiency improvements are more likely to affect the core business processes of industrial facilities than those of commercial counterparts. Accordingly, industrial decision makers are typically more sensitive to any changes that may interfere with process continuity and production targets. Conversely, they are receptive to opportunities to improve productivity.

PREVIOUS FINDINGS

The most practical information on energy efficiency's multiple benefits would both list the many evident kinds and ascribe a definite value to each. Ideally, we would be able to confidently predict the dollar value of one or more multiple benefits made possible by each unit of energy saved (Russell 2015). Decision makers, however, do not have enough good data to make such statistically reliable inferences. Most of the literature describes multiple benefits in qualitative terms, providing a list of positive outcomes, sometimes with an illustrative anecdote. A few more-ambitious studies present a list of benefits and count the number of times that each occurs within a small sample of observations.

Table 5 presents a summary of earlier studies that attempt to quantify multiple benefits using more than just anecdotes. All of the studies rely on self-reported results, which should be interpreted with caution. First, the definitions of benefit types are inconsistent across respondents. The components of each category, such as maintenance costs, can vary across respondents. Labor costs may or may not be segregated from maintenance. The savings values for factors such as labor and materials are intended to reflect volume reductions, but prices for these factors vary across facilities, thus compromising the comparability of value saved.

Table 5. Summary of previous findings on business-sector multiple benefits

Author, year	Description	Benefits	Quantification offered
Lung et al. 2005	Aggregate across sample of 81 US industrial energy improvement projects implemented between 1999 and 2004. Includes improved operations and maintenance, productivity, workplace comfort, and more. Observations from a wide range of industries.	Reduced costs Improved operations and maintenance Enhanced production Higher product quality Better work environment Environmental benefits	Ancillary value created is 44% of energy savings
Worrell et al. 2003	Aggregate results for sample of 52 US industrial improvement case studies. Results not broken down by technology, industry, or fuel type.	Reduced costs Reduced maintenance Enhanced production Higher product quality Better work environment Capital expense reduction Decreased risk Enhanced public image Improved worker morale Environmental benefits	Productivity savings equal to 122% of energy savings. Ratio of nonenergy benefits to energy-only benefits ranged from 0.03 to 70.0 across individual projects.
Loftness et al. 2003	Number of facilities and types not specified	Improved productivity	Average of 43% energy savings for a sample of facilities that replaced centrally controlled HVAC systems with units scaled for individual workspace occupancy. Concurrent benefits included 11% worker productivity improvement and a 67–90% reduction in churn costs (the cost associated with the spatial reconfiguration of offices in response to a changing mix of activities and workspace technologies).
BC Hydro 2013*	Sample of British Columbia–based facilities only; energy improvements considered here did not include lighting upgrades. "Additional value" derived from a variety of multiple benefit types.	Reduced costs Reduced maintenance Improved product quality	Of 1,071 industrial improvement measures, 7% presented additional value above electricity savings.

Author, year	Description	Benefits	Quantification offered
Woodroof et al. 2012	Sample includes a variety of businesses	Reduced costs Reduced maintenance Capital expense reduction Enhanced public image	Percentage of 63 businesses reporting each benefit type: reduced maintenance material cost (92%); reduced maintenance labor (71%); avoided procurement cost (63%); enhanced public relations image (44%); permanent capital expenditure avoidance (33%); avoided purchases of carbon offsets (10%).
Hall and Roth 2004	Sample includes a variety of commercial, institutional, and industrial facilities	Reduced costs Reduced maintenance Enhanced production Higher product quality Increased sales Improved worker morale	Percentage of 15 respondents reporting each benefit type: decreased nonenergy operating costs (47%); decreased maintenance (40%); increased production or productivity (33%); increased employee morale and satisfaction (27%); decreased waste generation (20%); decreased defect/error rates (20%); decreased personnel needs (13%); increased sales (13%); increased equipment life (7%).

*** BC Hydro internal review document, December 20**

Additional industry- and technology-specific studies provide a handful of energy improvement case studies. Some case studies will recognize multiple benefits, but only a subset of those attempt to quantify them (examples: CADDET 1998; Martins and Lima 2008; L. Gregg, principal, LCG Energy Management Group, pers. comm., November 18, 2013; D. Gray, engineer, Hydro Quebec, pers. comm., November 19, 2013). However each of these case studies, as well as those contained in the studies summarized in table 5, describes a unique facility configuration, technology application, industry or process type, and mix of related production factors. It should also be noted that various benefits may either precede or lag the realization of energy savings—again, these timing discrepancies vary with each unique facility or business situation (IEA 2014). In short, it is virtually impossible to infer future multiple benefit values from the results of one case study. Taken as a whole, these case studies demonstrate that multiple benefits frequently exist. When proposed business investments offer marginal returns based on energy savings alone, the likelihood of contingent multiple benefits may lead to greater acceptance.

Given the absence of sufficient data, we are not yet able to statistically infer the value of multiple benefits coincident with any given energy improvement. The data requirements for doing so are enormous, considering the need to qualify results by type of technology and industry in which the application is installed, the variation in factors and factor prices involved, differences in process design and production scheduling, and so forth. All of these must be defined consistently and measured accurately across observations (Russell 2015). Intermediate approaches are more viable, at least in the near term, as suggested by the following typology.

Nevertheless the earlier studies reveal many positives, and in some cases multiple benefits are evident in orders of magnitude so dramatic that business decision makers should not ignore them. We expect that business managers will be more interested in investments that provide greater returns. Accordingly the potential for multiple benefits may mitigate these managers' ambivalence toward simple energy savings. As multiple benefit values become clearer to business decision makers, we may anticipate more and faster acceptance of energy efficiency investments.

TYPOLOGY OF MULTIPLE BENEFITS

The multiple benefits of energy efficiency found in industrial settings are situational and often unique to each individual facility configuration (Russell 2015). On one hand, the variety of impacts defies easy categorization and measurement. On the other, we may reasonably assume that some benefits are easier to detect and measure than others. This naturally leads to a categorization that stratifies tangible, easily identified benefits and those that are less apparent. To facilitate this report, ACEEE convened a group of energy experts to devise a preliminary categorization of multiple benefits that accrue to the business sector. We describe the advisory group's methodology in Appendix A. The benefit categories (with examples) identified by the experts are:

- *Cost reduction* (reduced electricity demand and power factor charges, water use, other fuel consumption, maintenance, labor, compliance costs, taxes)

- *Business efficiency* (reduced cycle times, improved productivity and reliability, stoppage reductions, equipment reconfiguration, better process control technology, improved cost accounting)
- *Quality improvements* (improved product, process, or service quality; faster cycle times; reduced defects; customer and employee comfort)
- *Capital value enhancements* (enhanced real property value, reduced wear on mechanical assets, reduced scale of future investment in renewable power capacity)
- *Risk abatement* (reduction in energy market supply disruptions and price volatility, fewer lapses in emissions and safety compliance, fewer industrial process bottlenecks, less spending to offset equipment and real property degradation)
- *Revenue enhancements* (demand response incentives, market appeal of green products, new product lines, quick turnaround times, product customization, high margins)
- *Ancillary benefits* (enhanced corporate image, upgraded workforce skills)

Concurrent Cost Reduction

Informed facility analysis may reveal how an energy-saving initiative can yield a variety of concurrent nonenergy cost reductions. Along with reducing energy expenses, energy efficiency may also reduce expenses for labor, materials, and maintenance required by facility operations. Our advisors concluded that the most likely (and most easily measured) concurrent reductions applied to costs within the traditional purview of facilities management, such as:

- Electricity demand and power factor charges coincident with electric energy consumption
- Water use
- Dissimilar energy consumption (e.g., an improvement in overall boiler fuel utilization resulting from optimization of the electric fans that supply induction air for combustion)
- Maintenance and/or labor required for facilities operation
- Costs to comply with emissions or workplace safety regulations

As a whole, these benefits should be easiest for a facility's energy manager to identify, measure, and document. This is especially true for activities grouped under a single budget and administrative authority for facilities management. In this case, the facility manager may escape the hassle of crossing departmental lines to find or generate information, a chore often complicated by departmental rivalries and the need to explain the task to skeptical colleagues. Similarly, the most easily quantified benefits are best suited for inclusion in the work scope of energy performance contracts.

Broader impacts may also accrue beyond the scope of facility operations. For example, infrastructure installed for industrial energy performance monitoring may be easily adapted for monitoring the quality of material inputs. A case in point is the handling of starches that serve as inputs to various food processing applications: equipment intended to reduce the cost of air and humidity control can simultaneously monitor material quality, which helps to reduce material waste. Many similar opportunities can be found throughout food, pharmaceutical, and chemical processing.

Businesses may also count tax relief among potential expense reductions. In the United States, a variety of tax incentives have been designed to accelerate the adoption of energy-efficient technologies:

- The Energy-Efficient Commercial Buildings Tax Deduction as provided by Section 179D of the Energy Policy Act of 2005. Section 179D gives building owners a deduction from taxable income for the year that the energy-efficient assets were certifiably placed in service.[2]
- Section 45L of the Tax Increase Prevention Act of 2014 allows residential home developers to claim a $2,000 tax credit for each energy-efficient dwelling unit they produced through 2014. While this can apply to single-family homes, the tax credit becomes especially valuable when applied to multifamily construction such as apartments, condominiums, and affordable living units (DSIRE 2014a).
- Abandonment is a tax administration concept that allows property owners to write off the value of building components that are retired or removed because of renovation. Abandonment effectively accelerates the depreciation of deleted assets, which is in turn reflected in the owner's after-tax cash flow. The abandonment concept provides an effective construction subsidy for facility owners who make energy efficiency upgrades.

Energy-related tax benefits are grossly underutilized by US businesses. For example, one source estimates that only 3% of eligible claimants have filed for Section 179D tax deductions (Goessel 2015). Many business leaders simply lack awareness of tax benefits, while others are reluctant to incur the cost of certifying their energy improvements for tax scrutiny. In addition organizational disconnects between finance and maintenance professionals may present barriers to action. These disconnects become evident when disputes arise over which department budget will book the proceeds from potential tax benefits. Widespread underutilization of tax benefits reveals a potential need for both energy efficiency program administrators and utility key account administrators to make these benefits more transparent to their business customers.

Business Efficiency

Business efficiency refers to any enhancement in productivity, such as reduced cycle times for certain industrial production runs, improved productivity of material inputs, and avoidance of unscheduled work stoppages and resulting revenue loss.

In many situations industrial energy optimization involves not just new equipment but also the repositioning, consolidation, or elimination of equipment across one or more stages of a process. Equipment reconfiguration may reduce the number or duration of certain maintenance tasks. In addition, from a maintenance perspective, efficiency and reliability are often interconnected, as problem equipment often makes inefficient use of energy and other inputs. In some instances energy optimization results in a reconfiguration of facility equipment that is conducive to additional productivity.

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[2] See Appendix B for more details.

Increased control over facility assets usually permits greater flexibility in how those assets are used. Controls installed for energy management purposes may interconnect with process controls relevant to the length or pace of industrial production runs. Improved controls may also allow operators to spot and avoid potential bottlenecks as they form during an industrial process.

Improved cost accounting may be another benefit of better process monitoring and control. Enhanced data describing energy and other industrial inputs yield a more precise tabulation of direct expenses as they are incurred. Absent detailed process data, managerial accountants tend more frequently to identify costs as indirect or overhead. The inherent looseness of indirect-cost accounting can be detrimental to commodity manufacturers that compete on the thinnest of cost margins. As a result managerial accountants in these industries are eager to convert indirect costs to direct costs wherever possible. Advanced monitoring and control systems can be configured to provide the necessary detail.

Though beneficial, business efficiencies are not always as easy to quantify as those expenses that traditionally fall within the purview of facility management. Demonstration of business efficiency value requires access to cost accounting data outside of the facilities department. The detection, measurement, and tracking of multiple benefits concurrent with energy savings will often require a business to either modify its existing performance metrics or develop new metrics from scratch. Despite the need for accounting precision, business enterprises vary greatly in their ability and willingness to implement advanced monitoring and control technologies.

Quality Improvements

The same actions that improve an industrial process's energy efficiency can also improve the quality of the resulting product. One example is improved consistency of food processing or pharmaceutical products resulting from optimization of heat and humidity levels. A commercial-sector example is increased comfort levels in office or client spaces due to energy-saving initiatives, leading to reduced complaints from occupants.

Energy savings often result from the implementation of advanced process controls. Consider processes that depend on motor drives: the unprecedented variability of motor drive speeds allows some manufacturers to streamline the steps of product fabrication, thus reducing the cycle time (i.e., the length of time from start to finish of the process). Similarly, optimized steam systems are not only more energy efficient but also more effective in achieving process work. An example is the steam-based heat transfer required for the manufacture of composite wood products such as plywood, oriented strand board, and many others; measures that improve efficiency also provide greater control over heat transfer, which ensures proper adhesion of materials, consequently reducing material scrap rates. Faster cycle times and reduced defects translate into premium value for the customer, allowing the manufacturer to charge accordingly.

In addition advanced interior climate controls installed in retail or hospitality spaces may encourage prolonged customer loiter time, which translates into greater revenue receipts. These controls may help ensure employee comfort as well, with positive effects on absenteeism and staff turnover.

Improved Capital Value

Our advisors suggested that energy efficiency will in some circumstances enhance or sustain the value of real property (buildings) or will extend the economic life of certain energy-using assets. The latter point recognizes new technologies that provide energy efficiency while simultaneously reducing wear on energy-consuming mechanical assets, thus reducing or delaying inevitable capital expenditure for replacement equipment. Together these benefits become evident in capital asset valuation and management. Energy efficiency may also reduce the future investments needed to sustain a facility's value. For example, the solar photovoltaic capacity required to serve a building full of old T12 lighting fixtures is greater than the solar capacity required if that building's lighting is first converted to more efficient T8 or LED fixtures. Similarly, energy efficiency reduces a facility's need for investment in backup generation capacity.

Risk Abatement

Energy efficiency will often counteract a variety of energy-related business risks. These risks can be either direct consequences of energy use or indirect business liabilities that result from energy choices. Energy market supply disruptions and price volatility pose a direct risk to a business's operational viability, operating budget performance, and overall profitability. Indirect business risks accrue to areas such as emissions abatement, workplace safety, and asset management. For example, improved controls may allow operators to spot and avoid potential bottlenecks that form during an industrial process.

New, efficient technologies may also reduce fines or penalties resulting from lapses in emissions or safety compliance, such as workers' compensation claims or workers' health care costs. Risk reduction benefits may entail workplace safety derived from energy efficiency measures. Among many examples is LED lighting that reduces the explosion hazard in dusty environments or combustion optimization that reduces noxious fumes. Asset management risks are evident in the pace and volume of capital spending needed to offset equipment degradation. Similarly, the risk of real property valuations may vary directly with the performance of their energy-related mechanical assets. As a whole, these values are readily perceived. It is difficult to measure the worth of avoided penalties, claims, and asset value adjustments. However the risk abatement value attributable to energy efficiency varies directly with the magnitude of the potential damages that these measures guard against.

Revenue Enhancements

Energy efficiency improvements may indirectly result in new revenue receipts. A practical example comes from demand response (DR) program participation, in which a demand response provider pays a business to curtail power consumption from the electricity grid during periods of peak demand. Aside from energy and demand charge savings, a business may receive additional payment simply for enlisting as a DR program participant. Another revenue enhancement, albeit one more difficult to quantify, is the marketability of new products and services that somehow leverage a business's improved energy performance. One example is Frito-Lay's line of Sun Chips products, which are produced in a Modesto, CA, facility that is served in part by renewable energy sources and energy-efficient production systems (Vom Brocke, Seidel, and Recker 2012). An additional example is the revenue earned by material or service suppliers that must meet their business customers' criteria for green or sustainable provisions.

An energy-saving measure may bring about coincident *savings* of other resources, but this is not the same as *creating new business value*. A typology of new values is as extensive and varied as the range of facility activities, designs, configurations, vintages, and usage patterns found in the commercial/industrial sector. The few examples that follow provide only an introduction. In one case, an initiative to optimize compressed air costs allowed a facility to consolidate the floor space needed to host air compressors. The newfound floor space was then used to host a new production line, at a fraction of the cost of new facility construction or remodeling. In another case, by adopting a variable-speed motor for its grinding activities, a precision pipe manufacturer not only reduced the time required to mill pipes to customer specifications, but gained the ability to fill quick-turnaround orders at an unprecedented price premium. Control variability begets process variability, thus facilitating product customization, which in turn allows a facility to produce a greater number and variety of high-margin products. Generally speaking, these examples describe revenue-making opportunities derived from energy efficiency initiatives.

Ancillary Benefits

This is a potentially broad catchall class of positive business consequences. These benefits are sometimes difficult to define and quantify, but may result from a variety of causal forces, perhaps more than one simultaneously, some of which do not relate to energy efficiency. A corporation may enjoy an enhanced corporate image as a result of publicity for its energy efficiency efforts, but how much recognition and over what period of time? How are these energy efficiency benefits disaggregated from other publicity-seeking efforts? A completely different phenomenon may arise from workforce training. For example, if a business invests in energy measurement and verification training for its staff, the staff can very easily transfer those methodologies to other (nonenergy) resource management activities. This creates additional value that is difficult to quantify, especially over time.

A wider perspective reveals regional economic benefit as companies become more profitable through their energy efficiency measures. Such companies sustain the corporate tax base for the communities in which they are located. Profitable industrial facilities are very often fundamental to sustaining the stores, services, and institutions in a local economy.

Energy-saving measures often introduce new technologies, which in turn require a complement of new skills. In particular the energy monitoring, measuring, and remediation tasks made possible by information technologies present facility staff with opportunities for career enhancement and growth. Analytical and management techniques implemented for energy efficiency purposes may often translate to nonenergy matters within the same facility. Skill sets developed this way become more difficult to evaluate as individuals are transferred within facilities. When individuals take this experience to a new job, this benefit becomes less tangible.

MARKET SEGMENTATION

Business-sector decision makers will vary widely in their understanding of and interest in obtaining energy efficiency's multiple benefits, as well as their motivation and abilities to participate in an efficiency program. Accordingly we should expect certain kinds of multiple benefits to be more relevant than others—to participants and program administrators alike. This implies a segmented market for energy efficiency's multiple benefits. Market segmentation will be the key to program design, outreach, and implementation.

Electric and gas utilities typically segment their customers according to class of service. These classes reflect the practical logistics of energy distribution; customers' load profiles, facility designs, and equipment selections shape the way they use energy. Thus we see utilities distinguish service to single-family homes from service to multifamily properties due to the very different exigencies of energy service provision on the customer side of the meter. Similarly, different segments of commercial and industrial customers are distinguished by the nature of their load and technology profiles.[3] Business energy use may be categorically distinguished somewhat by the mechanical demands of each industry, such as washing machines for laundromats, ovens for bakeries, compressed air for vacuum-formed plastics fabrication, and so on. Customers' eligibility for supply interruption, curtailment, or transportation-only options also implies functional segments for utility service.[4] These distinctions determine tariff structures and, very often, the organizational chart of the utility itself. It is natural for energy efficiency program stakeholders to use this long-standing approach to customer segmentation.

As we have seen, business-sector segmentation may begin broadly with a distinction between (1) commercial, institutional, and office facilities and (2) industrial/manufacturing facilities. Except for occupant comfort considerations, commercial facilities' energy-related equipment can be selected, operated, and maintained almost independently from core business decisions.[5] This independence often provides commercial facility departments with more freedom than their counterparts in the industrial sector to decide how and when to optimize their energy-related equipment. In addition the relative homogeneity of commercial building types and eligible energy solutions allows energy efficiency program administrators to enjoy economies of program design and outreach. Conversely, facility management is of relatively marginal importance to most commercial enterprises. This limits the facility department's access to capital and diminishes its relative standing among investment priorities. Accordingly, proper articulation of multiple benefits may tip the balance of commercial-sector interest in energy efficiency improvements.

Because of the volume of energy they consume, industrial facilities often present attractive energy savings potential per measure installed. In contrast with commercial facilities, the

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[3] See Russell 2015 for a comprehensive listing and discussion of various approaches to assigning value to energy efficiency's multiple benefits in commercial and industrial sectors.

[4] Transportation-only options, in this context, refer to instances of a customer paying the utility only to receive an energy commodity, without the additional maintenance services offered to other utility customers.

[5] See aceee.org/files/proceedings/2014/data/papers/4-181.pdf for a discussion of specific small business programs and their success with market segmentation.

magnitude of savings, as well as the low cost per unit of energy saved, underscores the value of industrial energy improvements as a least-cost energy supply resource. Industrial enterprises make energy-related choices that usually affect the volume, pace, and quality of production. Compared with those in the commercial sector, industrial managers are less likely (or able) to respond quickly to energy efficiency proposals. Conversely, industrial managers may respond well if a compelling case can be made for energy improvements that also decrease production risks, reduce coincident costs, boost process productivity, or improve product quality.

Because of the often-unique features of industrial facilities and their equipment configurations, the detection of benefits will require more scrutiny of facilities than it does in the commercial sector. For energy efficiency programs, this implies a custom approach to defining efficiency measures. Indeed, the close and ongoing collaboration between program administrator and participant may itself be counted, if not as a multiple benefit, as a precursor to realizing multiple benefits.

Finally, even if an industry has consistent mechanical requirements across all facilities, these entities may display very different business cultures, investment priorities, and asset management philosophies. It will be possible for two companies in the same industry, with identical facilities, products, or service offerings, to respond very differently to an appeal for energy efficiency and its attendant multiple benefits.

Motivations for Business Participation in Multiple Benefits Initiatives

Energy efficiency program administrators usually reach out to potential participants through a series of program initiatives, each of which promotes some energy-efficient technology and the incentives for investing in it. Program initiatives are added and deleted over time, crafted to match the program's energy resource goals with consumer needs and interests. Program initiatives may include product initiatives such as lighting, motors, and compressed air, as well as analytical support initiatives such as energy audits or retro-commissioning.

Consequently we may anticipate some variety of multiple benefit initiatives, each of which promotes one or more of energy efficiency's multiple benefits for participant satisfaction. The program administrator's goal of advancing energy efficiency as a resource remains the same, but these results are achieved by promoting the multiple benefits that lead to energy savings. For policy and program professionals who want to advance energy efficiency, a multiple benefits initiative may be useful for engaging industrial managers, who are often ambivalent about the promise of mere energy savings. Multiple benefits may encourage business choices that ultimately advance energy efficiency program goals.

We provided our advisors a list of possible reasons that would compel a business to participate in a multiple benefits initiative. We then asked them to add to that list and to rank each item by its probable importance to business decision makers.[6] Here are the reasons, ranked in order of importance.

Force of Law or Regulation

While coercion is neither preferred nor advisable, compliance with the law would understandably be the most compelling reason for businesses to participate in a multiple benefits initiative. This approach may be modified to be less severe. For example, if an incentive for an energy efficiency project is paid in stages over time, payment of latter stages may hinge on the participant's compliance with the program administrator's need to collect data documenting ancillary savings, such as savings on water, maintenance, or labor.

Financial Incentives

This group includes capital investment rebates, advantageous financing mechanisms, and technical assistance grants, all of which are designed to accelerate the uptake of energy efficiency improvements. As part of a multiple benefits initiative, incentives would be designed to encourage investment in business improvements that yield coincident improvement in energy efficiency along with nonenergy impacts. Incentives to capital investment that promote water savings—with coincident and demonstrable electricity savings—are a good example.

Suasion

Business decision making must often weigh the real or perceived onus of external scrutiny. Boards of directors, customers, surrounding communities, and media observers impose certain expectations on business leaders. The power of suasion varies widely with circumstances. There are and will be numerous risks and concerns for business stakeholders, including extremes of weather, geopolitical threats, and socioeconomic concerns. We may surmise that the business sector's uptake of energy efficiency initiatives varies directly with the coincidental impact on other business agendas. The opportunity, then, is to promote investments that provide multiple benefits. We have already seen this with the advent of environmental sustainability initiatives, which almost always feature an energy efficiency component. Similarly, community reaction to power outages caused by weather or grid disruption can often indirectly give rise to investment in energy efficiency. Consider also policy interest in job creation spurred by a perennially sluggish economy: energy efficiency benefits become a raison d'être for employment in the manufacture, installation, and management of energy-related infrastructure. Ultimately, a wide range of persuasive forces have the potential to influence business decision making. Energy efficiency program administrators may anticipate nonenergy concerns to be ameliorated at least in part by investments that also just happen to yield energy efficiency benefits, and they have the opportunity to tailor program initiatives accordingly. Such an approach implies consistent interaction by energy program administrators with a broad range of policy and industry agendas, not merely the usual nexus of utility and regulatory authorities.

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[6] See the previous footnote, which applies here as well.

Internal Force

As a category, this refers to priorities formulated internally by a business organization or by a trade group specifically for its incumbents. An industry example is the American Chemistry Council's Responsible Care initiative, which develops collaborative industry standards for managing the environmental, health, and safety impacts of chemical product manufacturing. Such an initiative is effective for generating practical measures while also allowing the industry to proactively thwart the development of pernicious regulation. Energy improvements are an inevitable component of Responsible Care initiatives. In contrast, managers of a single enterprise may autonomously declare any number of organizational goals—perhaps for a year only, for several years, or indefinitely. Such initiatives may seek improved product or service quality, expense reduction, employee engagement or advancement, or refinement of community goodwill. Priorities articulated for any of these purposes may be linked conceptually to energy efficiency initiatives, and investment may be influenced accordingly.

Recognition, Goodwill, and Vanity

Competition, both between and within business organizations, is a dynamic that can indirectly lead to energy efficiency improvements. Consider the corporate need for recognition and goodwill that ultimately boost its revenue potential. Toward that end, some government or industry entities publicize the admirable achievements of business organizations, hoping that others will take notice and follow suit. A good example is the ENERGY STAR Awards, which are presented annually by the US Environmental Protection Agency to corporations that demonstrate environmental protection through superior energy management. Award winners undoubtedly enjoy the positive exposure that results. Similarly, individuals within facilities may lead energy efficiency efforts not only for the utility bill savings but also to enhance their careers by demonstrating leadership capacities. Energy efficiency programs often provide recognition or skills enhancement, although program administrators may struggle to balance the core mission of energy efficiency with what may be perceived as corporate largesse. Assuming that energy program administrators and their regulators are comfortable with assistance of this nature, the potential exists to apply the same approach to reward various nonenergy initiatives that bring coincident energy efficiency benefits. An obvious example would be a sustainability initiative, implemented for competitive public affairs purposes, that nevertheless brings about energy efficiency improvements.

PACE OF PARTICIPATION IN MULTIPLE BENEFITS INITIATIVES

Interested facilities almost certainly cannot respond all at once to a program initiative. Energy efficiency program administrators can expect to gather participants over time as each business's management team sorts through its unique priorities and circumstances. The factors that determine the pace of business-sector participation in an energy efficiency program's multiple benefits initiative may be as follows.

Prospective participants' capital budget cycles. Even if a business expresses verifiable interest and ability to invest in multiple-benefit improvements, its actions are almost always paced by its capital budget planning calendar. This means that a business may take three to five years to commit, although incentives may help offset investment delays.

Management stability. During the time required by capital budget processes, many businesses will experience personnel turnover on their management teams. A project proponent may exchange duties or leave the facility. Similarly, financial decision makers may change. Either case could have negative consequences for implementing a proposed multiple benefits project.

Economic conditions. Decision makers' receptiveness to multiple benefits concepts may be tempered by prevailing economic conditions. This can work one of two ways: a good economy may bode well for investment, or managers in a good economy may be too busy to analyze proposals and implement projects. A poor economy often means limited available investment capital. Conversely, a slower pace of output means that more resources are idle and therefore available to pursue facility improvements. The level of opportunity depends largely on perception.

Product market evolution. Over time, businesses will add, eliminate, and refine the products and services they offer. They do so in response to perceived market opportunities as well as changes to their own business attributes and strategies. These changes may impact facility operations and energy use in particular. The task for energy efficiency program administrators is to work with business leaders to detect opportunities to match multiple benefit investment proposals that become evident as the needs of business facilities change. For example, a hotel may wish to convert a number of units into long-term suite rentals, requiring kitchen appliance installations and HVAC controls different from those installed in short-term rentals.

Coordination with other utility program initiatives. The mix of resources and priorities managed by the sponsoring utility (or equivalent energy program authority) may constrain the work of the energy efficiency program administrator. A multiple benefits initiative may complement or conflict with other program initiatives, and the utility's resource budget may be the deciding factor.

Coordination with allied industry initiatives. A variety of diverse business issues—labor turnover, training, and regulatory compliance, to name just a few—may weigh heavily on business leaders. Many of these issues are the focus of economic developers, trade associations, or professional societies that have their own outreach agendas. These could be opportunities for energy efficiency program administrators to co-promote multiple benefits along with these allied organizations.

OVERCOMING SKEPTICISM OR LACK OF INTEREST

Policymakers' Uncertainty

Policymakers and regulators vary in their receptiveness to multiple benefit concepts when framing the costs and benefits of energy efficiency programs. Typical concerns include:

- Potential for economic misallocation of utility ratepayer funds, if such funds are allocated to any activity beyond energy-saving measures that strictly offset investment in traditional utility generation, transmission, and distribution assets
- Fomenting economic inequality by issuing windfall incentives to investors who are already committed to their investment choices (i.e., free riders)

- Economic misallocation of energy resource investments as a consequence of the inaccurate valuation of multiple benefit outcomes

These concerns may be ameliorated somewhat by stratifying multiple benefits according to their ease of definition and measurement. In effect, policymakers and regulators should find some multiple benefits to be more tangible than others, and therefore more practical to pursue and evaluate. The typology of multiple benefit classes presented earlier in this section provides a model for stratification.

Investors' Lack of Interest

Advocates of energy efficiency may presume that energy efficiency's multiple benefits are transparent to business customers as net-positive business value. However the promise of these benefits is not always obvious to the intended audience. Energy savings and their allied benefits tend to get lost in the noise of competing priorities that reverberates within every business organization. Despite a desire to express bottom-line benefits to top business leaders, energy efficiency program administrators must often settle for outreach to middle managers who have limited influence within their organizations. Before a facility can realize energy efficiency's multiple benefits, one or more staff champions must devote time and effort to pursuit of that goal. From an employment perspective, it may feel safer to keep staff focused on core business goals to the exclusion of lesser distractions. If the business community is not interested in energy efficiency, then energy efficiency program administrators may need to promote multiple benefits to get business leaders' attention.

Very often business leaders will find certain nonenergy benefits to be more compelling than energy savings. In effect nonenergy benefits may often serve as the primary value proposition to business leaders, with energy efficiency being a secondary consequence. Occupant comfort or labor savings may be among the lead investment drivers. For industrial facilities, we may add to that the potential for enhanced productivity or product quality. By illuminating certain nonenergy benefits of an energy efficiency project, program administrators are likely to raise greater interest from a larger number of managers within a business organization. If so, this raises the probability that the management team will choose to invest in an initiative that (indirectly) leads to energy efficiency.

A successful multiple benefits energy efficiency program initiative will accelerate business investment in energy savings. The underlying premise is that potential energy savings will be realized more often when the enabling investments are functionally bundled with other positive, nonenergy outcomes. In addition a multiplicity of benefits increases an investment proposal's attractiveness to a wider range of decision makers, compared to the facilities department audience that typically manages energy concerns.

Multiple Benefits in Utility Systems

Energy efficiency programs provide a range of multiple benefits to the electric utility system. Traditionally, the focus of such benefits has been on the avoided cost of energy and generation capacity. Other benefits include reduced costs of compliance with environmental regulations, reduced risk for the utility system, and increased system reliability. These benefits are shown in table 6. The values for specific benefits represent data from recent publicly available sources; they are not comprehensive.

Table 6. Utility-specific multiple benefits of energy efficiency programs

Benefit	Description	Range of values
Utility nonenergy benefits	Value of cost savings to a utility stemming directly from energy efficiency programs	$3.68 to $63.87 per participant per year*
Avoided cost of transmission and distribution capacity	Value of avoiding or deferring the construction of additional transmission and distribution assets	$0 to $200.01 per kilowatt-year (kW-year)
Avoided cost of energy	Avoided marginal cost of energy produced	$0.024 to $0.19 per kilowatt-hour (kWh)
Avoided cost of generating capacity	Avoided cost of constructing or purchasing new generating capacity	$22.25 to $433.90 per kW-year
Demand reduction induced price effects (DRIPE)	Value of energy or capacity market price mitigation or suppression resulting from reduced customer demand	Energy: $0 to $0.024 per kWh Capacity: $0.62 to $34.07 per kW-year
Avoided cost of renewable portfolio standards	Value of a reduced cost of compliance with renewable portfolio standards as electricity sales decrease	$0.50 to $9.82 per megawatt-hour (MWh)

Values are in nominal terms. * Participants are low-income residential customers. *Source:* Baatz 2015.

The following sections highlight two benefits that have received increased attention lately: utility-specific nonenergy benefits and avoided transmission and distribution (T&D) capacity costs. Below is a brief explanation of the other benefits.

The *avoided cost of energy* is the benefit most often used for the electric utility system. The value comprises avoided cost of fuel (often natural gas) and operations and maintenance expense savings from not generating the marginal unit of electricity. The avoided cost of energy is often expressed in a single value, dollars per kilowatt-hour (kWh). However the cost of energy fluctuates throughout the day. The value of not generating a kilowatt-hour is much higher during times of peak electric demand. While most program administrators do not account for this fact, some states, such as California, are beginning to calculate this value at a more granular level to account for this fact.

The *avoided cost of generating capacity* represents the avoided cost of constructing new generating capacity or purchasing capacity in a wholesale market environment. The ranges in table 6 include avoided capacity costs used by 21 program administrators. Thus these values demonstrate the variance in assumptions used by different program administrators (Hawaii, for example, assumes the avoided capacity is from a renewable source and has a higher value). The variance also represents the difference in market costs for generating capacity. A common assumption is a natural gas combustion turbine, which is often constructed to meet peak demand.

Demand reduction induced price effects (or DRIPE) are the economic benefits associated with reducing wholesale power and capacity prices through the reduction of demand caused by energy efficiency programs. As wholesale demand declines, prices for energy and capacity decrease. Several states including Massachusetts, Rhode Island, Vermont, Connecticut, Delaware, Maryland, and the District of Columbia calculate this benefit, and its value can be substantial. A recent study completed for two investor-owned utilities in Illinois estimated the levelized DRIPE energy benefits would be approximately 20–40% of the total avoided cost of energy (Chernick and Griffiths 2014).

The *avoided cost of renewable portfolio standards* is the financial savings to a utility from a reduced obligation to increase renewable generation as a result of reducing electric sales. Most renewable portfolio standards are based on achieving a specific percentage of generation from renewable sources. If the total electric sales requirement decreases, so does the associated percentage of electricity required for additional sales. This value has been quantified in both Maryland (Exeter 2014) and New England (Hornby et al. [AESC] 2013).

Two other benefits of energy efficiency programs accrue to utilities. First, programs can reduce costs for ancillary services, i.e., the services required to balance the grid. Examples include reactive power, spinning reserves, and energy imbalance services. The Federal Energy Regulatory Commission approves the rates for these services, often in the context of a transmission rate case.

Energy efficiency can also reduce the cost of compliance with existing and future environmental regulations. For example, it can reduce reliance on coal-fired generation, thereby reducing the volume of sulfur dioxide emissions. This reduces a utility's cost to comply with statutory requirements to reduce sulfur emissions. Energy efficiency is also a compliance option for states under the Clean Power Plan. Where it is the least-cost compliance option, this will reduce statewide compliance costs for reducing carbon dioxide emissions.

NONENERGY BENEFITS

Utility system nonenergy benefits largely involve the cost savings to utilities that result directly from program implementation. For example, if a program reduces an electric bill for a low-income customer, the likelihood of disconnection due to nonpayment is reduced. Utilities incur several costs related to disconnection and reconnection of services.[7] These costs can be reduced or avoided through the implementation of energy efficiency programs.

Analysis of utility nonenergy benefits has a history dating back over 20 years, and the value of these benefits has been well demonstrated (Skumatz 2013). The methods used to estimate these benefits have advanced over this time period and are also now well established. The majority of the research in this area has focused on benefits related to improved ability to pay electric bills, so these benefits figure prominently in the evaluation of low-income programs. Table 7 shows a list of several of these benefits from a 2011 study of nonenergy benefits in Massachusetts. The study reviewed reported values for utility nonenergy benefits from dozens of independent studies.

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[7] Electric utilities that have installed smart meters face much lower administrative costs associated with disconnecting and reconnecting service. Disconnecting service for an electric customer with traditional metering requires a utility employee to physically disconnect or reconnect service on the customer's premises, a costly undertaking.

Table 7. Range of utility nonenergy impacts for residential customers

Benefit	Range of values in literature
Reduced arrearages	$0.50–7.50
Bad debt write-offs	$0.48–7.00
Terminations and reconnections	$0.02–7.00
Customer calls	$0.00–1.58
Collection notices	$0.00–1.49
Safety-related emergency calls	$0.07–15.58
Rate discounts	$2.61–23.57
Insurance savings	$0.00–0.15

Values are in dollars per participant per year. *Source:* NRM 2011.

Program administrators should consider location in applying these values. For example, the cost of disconnecting and reconnecting electric service for a customer varies greatly depending on the type of metering infrastructure.

Of the eight utility nonenergy benefits presented in table 7, Massachusetts adopted six for low-income and residential programs. The state did not adopt rate discounts or insurance savings because these benefits were already accounted for in cost-effectiveness testing or were too difficult to quantify.

Other states have opted to use simple percentage "adders" to account for nonenergy benefits instead of undertaking analysis of specific benefits. These states include: Iowa (10%), Colorado (10%, 25% for low-income programs), Oregon (10%), Washington (10%), Vermont (30% for low-income programs), and the District of Columbia (10%) (Malmgren and Skumatz 2014). While these adders often focus on including other nonenergy benefits (such as participant and societal benefits), they can also include utility nonenergy benefits.

AVOIDED TRANSMISSION AND DISTRIBUTION

A significant utility system benefit is the potential for avoided or deferred cost of T&D investments to increase system capacity. T&D systems are sized to serve peak customer demand. If a utility is able to reduce peak demand, future infrastructure investments to increase T&D capacity may be avoided or deferred. Reducing investments and costs for utilities is advantageous for both utility customers and investors. Utility rates are based on the utility's level of infrastructure investment and annual operating costs. Therefore avoiding investment in T&D infrastructure, while maintaining a safe and reliable energy delivery system, lowers utility rates. This benefits customers by freeing up cash flow for savings or other goods and services and benefits utility investors by keeping utility rates competitive and freeing up scarce investment capital for potentially higher-value projects.

T&D investments represent significant annual costs for utilities. Electric utilities in the United States invested $37.7 billion in the T&D system in 2013 (EEI 2015). The level of investment has increased annually since 2000. Between 2000 and 2011, utilities invested a total of $237 billion in T&D (EEI 2012). T&D costs have also been increasing at a real rate since 1990 (Baatz 2015). Figure 2 shows the trend in increasing construction costs for distribution facilities against inflation.

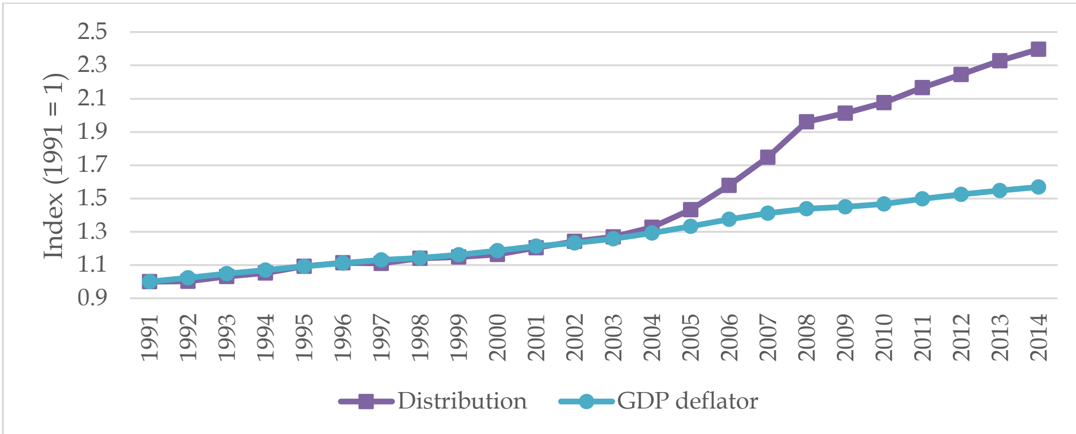

Figure 2. National average of T&D construction cost indices. *Source:* WRA (Handy-Whitman) 2014; BEA 2015.

Nontargeted Programs

In traditional electric utility energy efficiency program planning or market potential studies, avoided T&D is often included as a benefit. Quantification methodologies vary widely among utilities and jurisdictions that include this benefit. For example, a recent report presented a survey of 36 different estimates of avoided T&D costs (Mendota 2014). Estimates of avoided distribution costs ranged from $0 to $171 per kilowatt (kW), with an average of $48.37 per kilowatt-year (kW-year). For transmission, the average was $20.21, with a range of $0 to $88.64 per kW-year. The study concluded that the calculation of avoided T&D benefits is dependent on location, systemwide impacts, and time of day and year.

A recent ACEEE study graphed estimated values of avoided T&D for 44 utilities (figure 3).

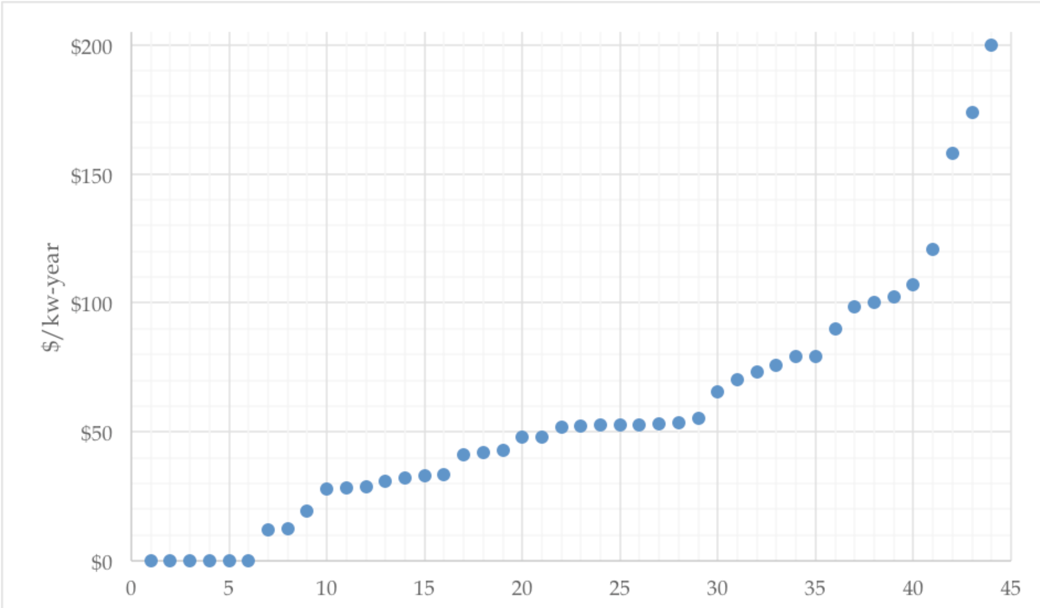

Figure 3. Survey of values of avoided cost of T&D. Each point in the graph represents the avoided cost of T&D for a specific utility. Six jurisdictions did not include a benefit for avoided T&D. *Source:* Baatz 2015.

As the figure demonstrates, wide variation exists between estimates. Actual variation in the avoided cost of T&D is one factor; others include the difficulty associated with estimating avoided T&D and the various methodologies for quantifying this benefit. In any case, however, the benefits are greater than zero and should be considered when planning and evaluating a program.

Estimation methodologies vary significantly among jurisdictions. Some estimates avoid T&D by assuming it to be 10% of the avoided generating capacity costs. Other methodologies are more complex and include the following:

- *Mix of historical and forecast data*. This method is best exemplified by the ICF Tool (used in the *Avoided Energy Supply Costs in New England* annual studies [Hornby et al 2013]), which collects data on historical and forecast T&D investments, determines what portions are due to load growth, and weights the historical and forecast contributions to arrive at T&D capacity marginal costs in dollars per kW-year (Mendota 2014, 6–7).
- *Rate case marginal cost data*. This approach relies on a detailed review of distribution and transmission system investments to determine the marginal cost of system capacity as it relates to load growth (Mendota 2014, 8). Values can be allocated to specific hours or climate zones in territories to provide greater accuracy in these estimates.
- *System planning*. According to EPA:

> The system planning approach uses projected costs and projected load growth for specific T&D projects based on the results from a system planning study—a rigorous engineering study of the electric system to identify site-specific system upgrade needs. Other data

> requirements include site-specific investment and load data. This approach assesses the difference between the present value of the original T&D investment projects and the present value of deferred T&D projects. (EPA 2011, 76)

Geotargeted Programs

OVERVIEW

Program administrators have included the avoided cost of T&D as a program benefit in cost-effectiveness evaluation for decades. To date, most quantifications of this benefit have been broad, average values over an entire service territory. However avoided or deferred T&D benefits are very specific to location, making it difficult to estimate the benefit over an entire system. Since energy efficiency programs have not typically been targeted geographically, estimates of the avoided cost of T&D have had to capture high value in some areas while also considering low value in others. Geotargeted energy efficiency programs and policies can provide more precise estimates (Neme and Sedano 2012; Neme and Grevatt 2015).

While not commonplace, geotargeting of energy efficiency does have historic precedent and has been utilized for over two decades. In a 2012 report on the value of avoided distribution, the Regulatory Assistance Project documented several successful projects or policies to geographically target energy efficiency to defer or avoid T&D investments. The report refers to this concept as an active deferral (Neme and Sedano 2012). The T&D cost savings of geotargeted efficiency programs have been substantial. The report details several projects in which T&D infrastructure investments were delayed by several years. The documented success of these specific cases revealed that energy efficiency can be a cost-effective T&D resource. In one specific example, highlighting the successes of a Consolidated Edison program in New York City from 2003 to 2010, T&D savings alone were greater than the cost of implementing targeted efficiency (Neme and Sedano 2012, ii).

A 2015 report released by Northeast Energy Efficiency Partnerships (NEEP) offers a more up-to-date review of geotargeted energy efficiency impacts (Neme and Grevatt 2015). The report highlights several recent examples of geotargeted efficiency used to avoid or defer new distribution or transmission upgrades and the associated benefits. Some of the projects highlighted in this report include recent efforts by PG&E (discussed later in this section), the Boothbay pilot in Maine, the Indiana & Michigan Niles project, and Consolidated Edison of New York's Brooklyn-Queens project (discussed later in this section). The report offers a distinction between active and passive deferral of T&D investments. Active deferral refers to geographically targeted efforts that promote energy efficiency in order to intentionally defer specific T&D projects. Passive deferral refers to when specific T&D investments are deferred unintentionally as a result of broad-based systemwide efficiency programs.

We discuss three examples of geotargeted demand-side projects in the following subsections. The three projects represent variation in the level of data analytics employed and in geographic location. All three projects represent the value of using energy efficiency as a cost-effective solution to defer or avoid building new distribution infrastructure.

HOLLYDALE PROJECT: XCEL MINNESOTA

The original Hollydale Project was a $23.1 million proposal for Xcel Minnesota (also known as Northern States Power Company) to purchase and upgrade a 69-kilovolt (kV) line in a residential area. The plan would have upgraded the line from 69 kV to 115 kV and required substantial construction through an existing residential area of Plymouth, Minnesota. The original proposal was meant to address capacity deficiencies of the existing distribution system and alleviate low-voltage conditions on the transmission system (Xcel Energy 2014). Following substantial local opposition to this project, Xcel withdrew the original petition. In the order approving the withdrawal of the application, the Minnesota Public Utilities Commission (MNPUC) requested that Xcel file information on using demand-side management to address the reliability issues presented in the original petition (MNPUC 2014).[8]

In late 2014 Xcel expressed intent to implement a three-phase approach to increasing demand-side management programs in the area in question. The three phases are detailed in table 8. While it is still early in this process, the compliance filings thus far have demonstrated Xcel's commitment to using energy efficiency to reduce future demand and thereby reduce the need for some future infrastructure investments (Xcel Energy 2015a). The company is currently implementing Phase 1 of the plan and is in early development of Phase 2 (Xcel Energy 2015b). This approach could be a model for utilities in the future to engage with local communities to increase reliability, decrease costs, and improve relationships.

Table 8. Xcel MN Hollydale three-phase demand-side management plan for Hollydale reliability

Phase	Description
1	Uses existing programs with targeted marketing promotion and outreach to maximize effectiveness in the project area
2	Uses a new marketing approach, Partners in Energy, which entails working in a defined area to partner with the community in the development and implementation of a strategic energy plan
3	Will investigate and develop a new program or suite of programs targeted at localized electric load relief

Source: Xcel Energy 2014

BROOKLYN-QUEENS PROJECT: CONSOLIDATED EDISON NEW YORK

Consolidated Edison of New York (Con Ed) is currently in the early phases of implementing a new location-targeted demand-side project to avoid major upgrades to two substations in the Brooklyn and Queens areas of New York. This project is part of a greater ongoing effort by Con Ed that began in 2003. Figure 4 shows the area affected by the project. The estimated cost of upgrading the two substations is approximately $1 billion. The New York State Public Service Commission recently approved a proposal by Con Ed to implement demand-

[8] The commission also required information on several other areas such as public outreach efforts, improvements to the distribution system, load-serving capacity of the distribution system, and the use of other resources to meet reliability needs.

side solutions as an alternative to upgrading the substations. The approved cost of $200 million is also capped, meaning that any cost overruns will be absorbed by Con Ed shareholders, not customers of the company (NYPSC 2014).

The demand-side solutions will rely on several resources, including solar, battery storage, and energy efficiency. These resources will be primarily customer owned, but some will be owned by Con Ed. The project consists of three components to reduce demand by 69 megawatts (MW) by the summer of 2018. The first 17 MW will be met with traditional utility infrastructure investment in distribution facilities, while the remaining 52 MW will be met with a combination of utility-owned and customer-owned demand-side solutions. The demand-side projects will consist of energy efficiency, energy management, energy storage, customer engagement, distributed generation, and demand response. These programs include Small Business Direct Install and Multi-Family Energy Efficiency, as both of these programs were identified as having strong potential for producing early results. The Small Business Direct Install program was able to enlist more than 1,900 customers in under five months, between August 2014 and January 2015. The projected load reduction from these 1,900 customers is 5.9 MW. The multifamily program is also a direct-install program, focused on multifamily dwellings with 5 to 75 units. The projected load reduction from this program is 1 MW (Con Ed 2014).

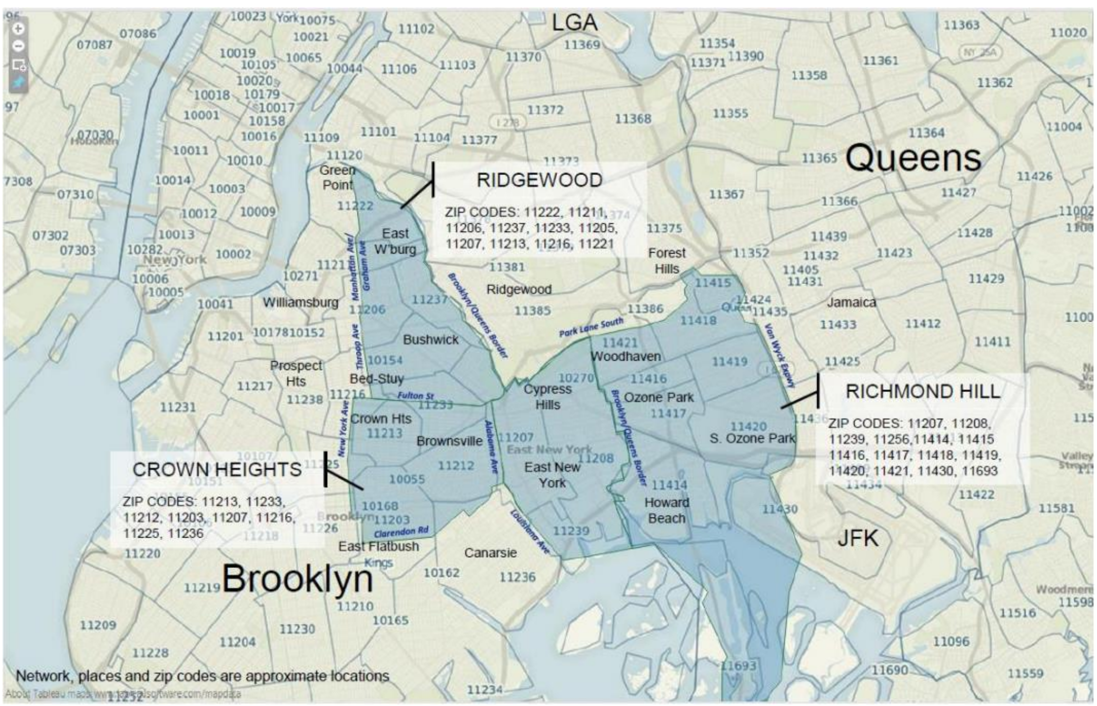

Figure 4. Brooklyn-Queens targeted location. *Source:* Con Ed 2014.

MULTIPLE PROJECTS: PACIFIC GAS AND ELECTRIC, CALIFORNIA

PG&E has a long history of using targeted energy efficiency to defer T&D upgrades. In the early 1990s, the company was able to reduce peak demand by 2.3 MW, mostly through a targeted residential retrofit program, and deferred the need to construct a new substation by at least two years. PG&E also implemented the project quickly; its planning and launch phase required only six months, while the implementation phase lasted two years (Neme and Grevatt 2015).

More recently, PG&E has been pursuing a greater number of targeted efforts to defer or avoid construction of T&D infrastructure.[9] PG&E refers to this process as targeted demand-side management or TDSM. These projects include all distributed resources such as battery storage, onsite solar, demand response, and energy efficiency. The primary goal of the TDSM efforts is to reduce peak load on customer sites on capacity-constrained substations (Aslin 2015). The early focus of the program has been incentives for energy efficiency and demand response in four geographic areas, shown in figure 5.

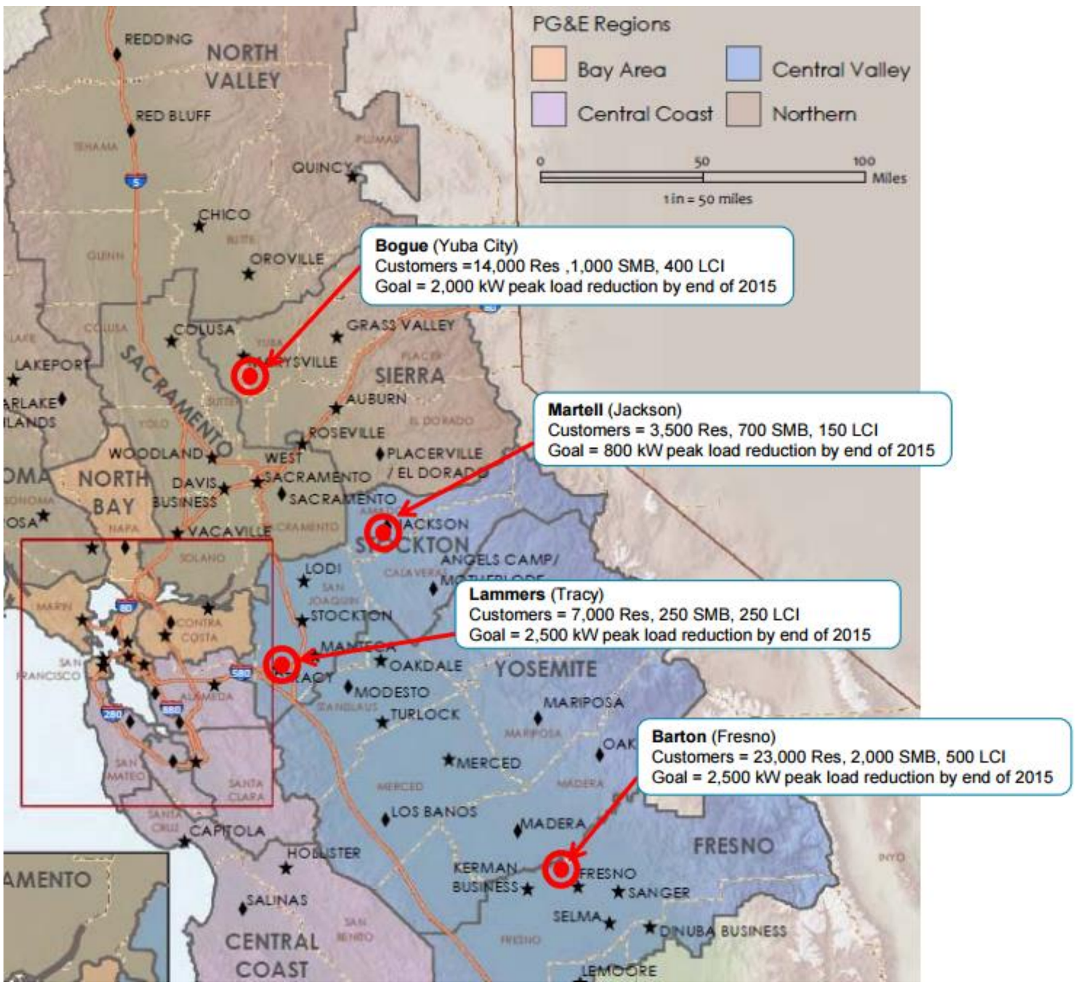

Figure 5. TDSM primary areas in 2015

[9] This is in part due to the passage of Assembly Bill 327 in 2013, which required utilities to begin considering the locational value of distributed resources including energy efficiency. The bill also required utilities to identify potential locations for deployment and initiate the planning process for implementation of such projects (Neme and Grevatt 2015).

Energy efficiency and demand response are primary tools in the PG&E locational targeting effort. Energy efficiency programs focus on providing reductions in peak demand on the system. The nonresidential programs include new construction, direct install, custom projects, and retro-commissioning, while the residential programs include home upgrades focused on insulation, air sealing, pool pumps, HVAC maintenance, mobile home improvements, and maintenance for multifamily HVAC units (Aslin 2015).

As with the other programs featured in this section, the PG&E projects are in early stages, and the results are not yet fully available. PG&E expects early results in 2016 and also plans to expand the scope of this effort to 10–15 projects in the coming years (Aslin 2015).

INCREASING USE OF DATA ANALYTICS

Although geotargeted efficiency has been used for decades, technological advances in communication and data analytics allow an even more precise evaluation of benefits for these efforts. Among the recent and most beneficial advancements of this practice has been the implementation of data analytics enabled by real-time data collection on energy demand across a service territory. Data analytics have increased the ability of program administrators to select cost-effective geotargeted projects to defer distribution system upgrades.

For example, in the P&G projects discussed above, new technologies and the integration of data analytics allow PG&E to better understand where the greatest savings opportunities exist. Software tools projecting economic growth and customer load in given areas allow distribution system planners to anticipate when a specific substation may become overloaded. Other data, such as interval-level customer data, can allow PG&E to target specific households or businesses with programs to reduce demand in order to defer the construction of a new substation or upgrade an existing substation. The integration of customer load profile data with the distribution planning forecasts allows PG&E to determine the feasibility of reducing load in the given area with distributed resources. This information in turn allows PG&E to determine the least-cost circuits and substations to pursue (Aslin 2015).

While advanced metering infrastructure (AMI) or smart meters are not completely necessary for implementing geotargeted energy efficiency, they are highly advantageous because they allow program administrators to understand data and identify savings opportunities on a more granular level. Other analytical tools can optimize which resources achieve the deferral of distribution infrastructure at the lowest cost, based on a number of factors.

One example of a recent analytical tool that can improve geotargeted energy efficiency is LoadSEER, a proprietary software tool developed by Integral Analytics. LoadSEER is a spatial load-forecasting tool used by electric distribution system planners to predict load and power changes, where on the grid the loads will occur, how distributed generation changes the load shape, and when it must be supplied (Integral Analytics 2010). This tool relies on several sets of data to forecast changes in load to the distribution system. The granularity of the data allows for planners to understand where load changes will occur and the most cost-effective means of preemptively addressing stresses on the system. One significant advantage of this program is its ability to estimate the value of locating new resources where they are most needed. This is extremely important when determining the best way to spend limited financial resources on energy efficiency programs and provides tremendous value compared with prior ways of locational targeting.

Recognizing Multiple Benefits in Cost-Effectiveness Testing

Understanding the nature of energy efficiency's multiple benefits, and how they manifest differently within economic sectors, is a prerequisite for quantifying the true costs and benefits of energy efficiency program activities. Cost-effectiveness tests should compare the costs of an energy efficiency improvement with all the benefits that come from it, beyond the energy saved. Although quantification is often elusive due to the costs and difficulties of documentation, this does not justify the categorical dismissal of multiple benefits. A more practical approach is to ensure the consistency of definition and observation within and among programs, both in defining benefit types and in specifying the market segments in which they occur.

Utilities and their regulators employ a variety of cost-benefit frameworks for energy efficiency program evaluation.[10] In practice, these cost-effectiveness tests do not consistently incorporate multiple benefits. This is true even of tests that are designed to include co-benefits, such as the TRC test. The result is an inaccurate assessment of the cost–benefit ratio of efficiency improvements.

Based on the experience of states in its region, NEEP's Regional Evaluation, Measurement and Verification Forum offers a framework of the steps states should take to incorporate multiple benefits into screening practices. States should first identify which category of benefits is included in the screening test used in their state to determine whether to focus on utility, participant, and/or societal benefits. Next, states should prioritize which benefits to focus on in the near term and what methodology to use for quantification. Once the benefits have been prioritized, the states should estimate values (NEEP 2014).

As described by Cluett and Amann (2015), an approach called the Resource Value Framework (RVF) addresses the shortcomings in the current application of cost-effectiveness tests and recommends particular strategies for dealing with program benefits:

> First, the value of benefits should be monetized whenever possible; when not possible, estimates or proxies should be used. . . . . When monetary values and estimates are difficult to quantify, the RVF recommends the use of alternative screening benchmarks or regulatory judgment. For example, programs with particular public interest benefits may pass screening with a benefit–cost ratio less than one. In practice, many states allow this type of alternative benchmark for low-income programs. Regulators may also give program administrators the flexibility to account for benefits that defy

[10] See (Russell 2015) for a listing of energy efficiency program cost–benefit screening frameworks and a discussion of the suitability of each for evaluating multiple benefits.

quantification, such as market transformation effects. (Cluett and Amann 2015, 3; NESP 2014)

A few states already include at least some multiple benefits of energy efficiency in cost-effectiveness testing. While some states, such as Massachusetts, rely on quantitative assessments of benefits specific to their programs to determine the value of benefits, other states, including Vermont and Colorado, assign an approximate value to benefits. Table 9 shows how specific benefits are treated in cost-effectiveness tests in various states and the District of Columbia.

Table 9. Multiple benefits included in primary cost-effectiveness tests by state or district

State or district	Participant benefits						Utility benefits	Societal benefits
	Resource	Low-income	Comfort	Equipment	Health & safety	Property value		
CT		Qualitative						
DC	Included in 10% adder			Quantified (O&M)	Included in 10% adder			Included in 10% adder
IL	Quantified	Qualitative						
MA	Quantified							
MD			Quantified				Quantified (for low-income programs)	Quantified (air emissions)
MI		Qualitative						
MN		Qualitative						
NY	Quantified	Qualitative		Qualitative				
OR	10% adder							
RI	Quantified							
VT	Quantified	15% additional low-income adder	Part of 15% adder	Quantified (O&M)	15% adder for participant, utility, and societal benefits			
WI	Quantified							

Sources: Synapse 2013; NEEP 2014

In Massachusetts and Rhode Island, where at least some portion of benefits is quantified (as noted in the table above), each state's Technical Reference Manual (TRM) details the monetary value of nonenergy impacts per measure and per program participant.[11] In both states, most values are derived from an evaluation of the Massachusetts program administrator's programs by NMR Group, Inc. (2011). While both states account for the same participant benefits, there is some difference in the value of benefits that accrue to each sector, as shown in table 10. These differences in value are likely a result of differing

[11] The TRM spells out how program administrators measure savings from all energy efficiency measures in the program portfolio.

program design between the two states, and from the types and sizes of programs in each state's portfolio.

Table 10. Value of multiple benefits as a percentage of utility bill savings

	Value as a percentage of utility bill savings	
Sector	MA	RI
Residential	63%	17%
Low-income	70%	39%
Commercial and industrial	12%	14%

Source: NEEP 2014

In jurisdictions where benefits are not formally included in cost-effectiveness testing, program administrators and program evaluators are more systematically measuring other benefits of energy efficiency that result from their programs. For instance, the New York State Research and Development Authority (NYSERDA)'s reports on its energy efficiency programs for regulatory requirements—system benefits charge (SBC) and energy efficiency portfolio standard (EEPS) requirements—include multiple calculations of cost effectiveness, with and without nonenergy impacts included to illustrate their value. The Program Administrator Cost (PAC) test ratio is 4.3 with resource benefits and 6.2 when nonenergy impacts are added. Similarly, the TRC test ratio is 1.3 with resource benefits and 1.9 when nonenergy impacts are added (table 11). Resource benefits (water and other fuels) are included in cost-effectiveness testing in New York State, while nonenergy impacts are evaluated but not formally included (NYSERDA 2011).

Table 11. Cost-effectiveness testing results in New York State

Benefit type	Program Administrator Cost (PAC) test	Total Resource Cost (TRC) test
Resource	4.3	1.3
Resource + nonenergy impacts	6.2	1.9

Source: NYSERDA 2011

Program administrators who have yet to determine multiple benefits specific to their state's programs often rely on other states' benefits research. Doing so encourages regulators to include these benefits in future program evaluations.

Recommendations

RESIDENTIAL SECTOR

It is important that program administrators measure multiple benefits from residential energy efficiency programs, particularly whole-building single-family and multifamily programs, where homeowners and building owners foot a significant portion of the project cost. Determining the value of these benefits for residential programs is important for (1) showing the value of whole-building programs versus other programs in the portfolio, (2) representing the value of programs to regulators, and (3) marketing the benefits that can result from energy efficiency upgrades to potential program participants.

Program administrators can start accounting for these benefits by prioritizing a segment of benefits to evaluate for key programs, such as comprehensive whole-building retrofits. They can prioritize benefits based on findings from similar programs, as presented in this report, and based on anecdotal evidence from their own program experience. Based on the types of benefits included, administrators can devise a plan for quantification and valuation. For the most streamlined application to cost-effectiveness testing, monetary values are preferred.

Monetary values for some benefits can be determined using existing program data such as water and wastewater reduction benefits. For other benefits participants' self-reported survey responses are the preferred method of determining the value of benefits relative to the expected energy bill savings. In regions where program offerings are similar across different utilities, program administrators may consider pooling resources to support an evaluation of multiple benefits. In the absence of surveys of program participants, approximate values can be determined based on values already known for similar program types. For example, Maryland calculated comfort benefits for its residential whole-building program based on findings from an evaluation of a similar program in Massachusetts.

For benefits that are not easily monetized, program administrators may also collect data to substantiate the existence of these benefits from their programs. This information should be applied to both program marketing and cost-effectiveness testing. Benefits should be applied in cost-effectiveness screening practices according to the guidance set forth in the RVF.

BUSINESS SECTOR

Any claim that a proposed improvement is good for business requires elaboration, regardless of the benefit's origin. A number of reasons to pursue energy efficiency's multiple benefits may point to potential gains as well as potential risks or losses. However a statement of reasons may not always reveal the actual rewards. Energy efficiency program administrators who plan to promote multiple benefits to an uninformed audience should prepare accordingly. The list of business-sector multiple benefits and accompanying rewards, as presented in this report, should provide a starting point.

Energy efficiency program administrators face a certain trade-off when actively promoting multiple benefits. Two approaches frame the range of possibilities:

- Reach out to as many facilities as possible by promoting a wide variety of benefits. This implies spreading incentives and resources across dissimilar energy improvement activities.
- Concentrate on a limited variety of benefits, focusing on customer segments most interested in those benefits.

Note that the first scenario does not presuppose which multiple benefits are most valuable or feasible. By casting a wide net of promoted benefits, this approach presumes that the best multiple benefit concepts will emerge over time. The second scenario, on the other hand, presumes customer affinities for certain benefits in advance. This suggests a multiple benefits pilot initiative in which program administrators work with a select group of interested consumers.

In either case we suggest that the most attractive benefits from a program perspective are (1) those related to expenses already subject to monitoring and billing, (2) those managed by the same departmental authority that is also responsible for energy, and (3) those which by nature are easily tracked for benchmarking, trending, and performance analysis purposes. Savings on water, labor, taxes, dissimilar energy commodities, and other direct costs of facility management fit this description. Reliance on these most tangible values should appeal to program evaluators who need to make solid conclusions. In addition the most tangible values are also the most suitable for inclusion in the scope of energy performance contracts. For targeted efforts, impacts on industrial product quality and reduced waste can be very important and a good place to start.

To implement a multiple benefits initiative, energy efficiency program administrators may need to coordinate with policy and program agendas between, and beyond, electric and gas utilities. Given the cautious nature of policy development and regulatory oversight, energy efficiency program administrators should expect challenges to initiatives that direct utility ratepayer resources to nonenergy investments. A viable multiple benefits program initiative must be able to stand up to regulator scrutiny while promoting concepts that are of critical interest to business leaders. Given these challenges and goals, a multiple benefits initiative may start on a pilot basis, connecting energy to a few crucial parallel agendas. For example, the urgent need for water supply solutions in many parts of the United States in 2015 may catalyze combined energy–water efficiency program initiatives. The same potential exists for energy efficiency in concert with industrial productivity, investment, and job creation. When an energy efficiency program partners with a jobs creation initiative, for example, the combination of these agendas should achieve the critical mass of gravitas needed to assuage program regulators while capturing the attention of business leaders.

The industrial sector's multiple benefits tend to manifest in production or process activities. In contrast, commercial-sector benefits may accrue more to people who work in or patronize business facilities. Accordingly, commercial energy policy and program design may emphasize benefits such as occupant comfort, health, and safety. These benefits are evident in unique combinations that vary with facility purpose and configuration. One advantage intrinsic to many commercial industries is seasonal business phases and promotions: energy resource program administrators could craft multiple benefit initiatives timed and structured with content to fit the commercial-energy consumer's business trends.

Utilities and related energy efficiency program administrators typically enjoy the assistance of trade allies that provide energy-themed expertise. A multiple benefits initiative, however, may require a separate cadre of trade allies with requisite skill sets. For example, an energy monitoring and verification initiative could be matched with a job skills training program. A professional society or industry association that can vet its own trade allies for the jobs training dimension may facilitate the latter.

UTILITY SECTOR

Program administrators should consider and include all relevant benefits in program screening. If all program costs are to be included, all relevant benefits should also be considered. Excluding benefits from program cost screening produces erroneous conclusions resulting in an inefficient level of energy efficiency deployment in a service territory. Exclusion of the low-cost system resource of energy efficiency will increase utility system costs, thereby increasing utility customer rates in the long term.

This report highlights ranges of values for several key multiple benefits to the utility sector. While these values illustrate the potential benefits from specific cost savings associated with energy efficiency program implementation, program administrators should be cautious when considering the value of these benefits to different states and regions. The value of utility system benefits will vary based on several key considerations including the makeup of a particular system and the geographic region in which the utility operates.

The presentation of values in this work is intended to offer insight into the potential value of each benefit. While some of these benefits are uniquely difficult to quantify, methodologies to determine these values are well established. Programs must balance the realities of finite financial resources and the benefits to be realized from a given level of detail. What is certain is that the value of these benefits is substantial and cannot be ignored.

This report also highlights the significant value of using energy efficiency as a distribution system resource. While geotargeting of energy efficiency is not new, advances in technology are allowing utilities greater opportunities in this field. Utilities should include energy efficiency as an option in distribution system planning.

Conclusion

The regulated utility paradigm has evolved in recent years to demand an objective comparison of energy supply options—including distributed energy resources such as energy efficiency—seeking especially those that minimize the costs ultimately borne by utility ratepayers. As technologies and utility business models evolve, so do the options for ensuring least-cost energy supply and distribution. As policymakers and regulators make judgments about utility resource allocation, it is important that they recognize and incorporate the multiple benefits of energy efficiency.

Energy efficiency's multiple benefits are large and varied. Efficiency program stakeholders almost always concede that multiple benefits exist, but problems remain with detection, measurement, and documentation of these benefits. This explains why some program administrators tend to evade or at best generalize multiple benefits' value. Programs will benefit from research that better articulates this value, both in qualitative and in quantitative terms. Because of the challenges and cost of quantifying some multiple energy benefits, it would be useful for states and utilities to share their processes and results more frequently. While priorities and approaches may vary by jurisdiction, the common issues point to opportunities for shared data development, which is certainly preferable to allowing each jurisdiction to work in isolation.

Although challenges abound in defining and measuring multiple benefits, jurisdictions are making progress as awareness and experience accumulate. A jurisdiction's predilection for recognizing multiple benefits depends in part on its chosen methodology for program evaluation. The RVF is emerging as a collaboratively developed standard for energy efficiency program cost–benefit screening. While most older frameworks dismiss nonenergy benefits due to the difficulty of evaluating them, the RVF explicitly embraces these values. RVF guidance for program evaluators continues to evolve.

The body of technical knowledge that quantifies multiple benefits awaits growth and refinement. A larger hurdle is to achieve broader acceptance of multiple benefits concepts in regulatory decision making. That acceptance will be supported by continued research fueled by data sufficient in volume to provide probabilistic measures of value. Several states, mostly independently from each other, have developed benefit valuation methodologies. There is obvious potential for collaboration among states, both to save on research costs and to amass statistically reliable data. ACEEE encourages this collaboration.

The ideal multiple benefit is one that can be quantified by program evaluators and, especially in the business sector, by facility managers as well. When quantification is elusive, the next best option is to use survey methods that demonstrate customers' realization of benefits in qualitative terms.

It will also be necessary to refine the customer segmentation framework through which benefits are ascribed in order to facilitate energy efficiency program outreach. This is especially true for commercial and industrial facilities, where business management styles, more than technical features, may determine a facility's readiness to consider multiple benefits. Opportunities for energy efficiency increase directly with perceptions of its value. Multiple benefits may be integral to demonstrating that value if they are presented in the right way to the appropriate decision maker.

References

Adomatis, S. 2015. *What Is Green Worth? Unveiling High-Performance Home Premiums in Washington, D.C.* Punta Gorda, FL: Adomatis Appraisal Services. www.imt.org/uploads/resources/files/HighPerformance_Home_Valuation_Report_Sept2015.pdf.

ASE (Alliance to Save Energy). 2013. *Advancing Productivity in American Manufacturing*. Alliance Commission on National Energy Efficiency Policy. Washington, DC: ASE. www.ase.org/sites/ase.org/files/resources/Media%20browser/commission_manufacturing_2-7-13.pdf.

Amann, J. 2006. *Valuation of Non-Energy Benefits to Determine Cost-Effectiveness of Whole-House Retrofits Programs: A Literature Review*. Washington, DC: ACEEE. aceee.org/research-report/a061.

Aslin, R. 2015. "Targeted DSM: Reducing Load Where It Really Counts." Presentation at OATI (Open Access Technology International, Inc.) Workshop. May 12.

Baatz, B. 2015. *Everyone Benefits: Practices and Recommendations for Utility System Benefits of Energy Efficiency*. Washington DC: ACEEE. aceee.org/everyone-benefits-practices-and-recommendations.

BEA (US Bureau of Economic Analysis). 2015. "Current-Dollar and 'Real' GDP." Excel spreadsheet. www.bea.gov/national/index.htm#gdp.

CADDET (Centre for the Analysis and Dissemination of Demonstrated Energy Technologies). 1998. *Industrial Electric Motor Drive Systems*. Energy Efficiency Analysis Series, No. 24. Netherlands: CADDET.

Campbell, M. 2014. *PG&E Whole House Program: Marketing and Targeting Analysis*. Oakland: Opinion Dynamics.

Chernick, P., and B. Griffiths. 2014. "Analysis of Electric Energy DRIPE in Illinois." Memo dated September 3. Arlington, MA: Resource Insight, Inc. switchboard.nrdc.org/blogs/pkenneally/IL%20DRIPE%20Memo%20Final.pdf.

Cluett, R., and J. Amann. 2015. *Multiple Benefits of Multifamily Energy Efficiency for Cost-Effectiveness Screening.* Washington DC: ACEEE. aceee.org/multiple-benefits-multifamily-energy-efficiency.

Con Ed (Consolidated Edison Company of New York, Inc.). 2014. *Request for Information: Innovative Solutions to Provide Demand Side Management to Provide Transmission and Distribution System Load Relief and Reduce Generation Capacity Requirements*. New York: Con Ed. www.coned.com/energyefficiency/documents/demand_management_project_solicitation-rfi.pdf.

DOE (US Department of Energy). 2014. *Home Performance with ENERGY STAR Sponsor Guide and Reference Manual (v1.5)*. Washington, DC: DOE. www.energystar.gov/ia/home_improvement/downloads/HPwES_Sponsor_Guide_v1-5.pdf.

DSIRE (Database of State Incentives for Renewables & Efficiency). 2014a. "Energy-Efficient New Homes Tax Credit for Home Builders." December 20. programs.dsireusa.org/system/program/detail/1272.

——. 2014b. "Energy-Efficient Commercial Buildings Tax Deduction." December 22. programs.dsireusa.org/system/program/detail/1271.

EEI (Edison Electric Institute). 2012. "EEI Survey Shows Transmission and Distribution Investment." December 20. Washington, DC: EEI. www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/EEI%20Survey%20Shows%20Transmission%20and%20Distribution%20Investment.aspx.

——. 2015. "EEI Survey Shows Electric Power Industry Made Record Levels of Investment in Transmission and Distribution." January 8. Washington, DC: EEI. www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/EEI%20Survey%20Shows%20Electric%20Power%20Industry%20Made%20Record%20Levels%20of%20Investment%20in%20%20Transmission%20and%20Distribution.aspx.

EPA (US Environmental Protection Agency). 2011. *Assessing the Multiple Benefits of Clean Energy: A Resource for States*. EPA-430-R-11-014. Washington, DC: EPA. epa.gov/statelocalclimate/documents/pdf/epa_assessing_benefits.pdf.

Elevate Energy. 2014a. *Preserving Affordable Multifamily Housing through Energy Efficiency: Non-Energy Benefits of Energy Efficiency Building Improvements*. Chicago: Elevate Energy. www.elevateenergy.org/wp/wp-content/uploads/Preserving_Affordable_Multifamily_Housing_through_Energy_Efficiency_Final_2.18.14.pdf.

——. 2014b. *Valuing the Financial Benefits of Energy Efficiency in the Multifamily Sector*. Chicago: Elevate Energy. www.elevateenergy.org/prod/httpdocs/wp/wp-content/uploads/Valuing-Financial-Benefits-of-Energy-Efficiency-in-Multifamily-Sector.pdf.

Exeter (Exeter Associates, Inc.) 2014. *Avoided Energy Costs in Maryland. Assessment of the Costs Avoided through Energy Efficiency and Conservation Measures in Maryland.* April.

Fuller, M., C. Kunkel, M. Zimring, I. Hoffman, K. Soroye, and C. Goldman. 2010. *Driving Demand for Home Energy Improvements*. Berkeley: Lawrence Berkeley National Laboratory. drivingdemand.lbl.gov.

GDS Associates. 2013. *Vermont Single-Family Retrofit Market: Market Research*. February 15. Prepared for High Meadows Fund, Inc. and Vermont Public Service Department.

www.efficiencyvermont.com/docs/about_efficiency_vermont/whitepapers/market-research-report-2013-02-15.pdf.

Goessel, A. 2015. "Federal Tax Deductions and Credits." In *Association of Energy Engineers (AEE) 2015 World Energy Engineering Congress Proceedings*. Atlanta: AEE.

Hall, N., and J. Roth. 2004. "Non-Energy Benefits from Commercial & Industrial Programs: What Are the Benefits and Why Are They Important to Participants?" In *Proceedings of the ACEEE 2004 Summer Study on Energy Efficiency in Buildings*, 4:123–135. Washington, DC: ACEEE. www.aceee.org/files/proceedings/2004/data/papers/SS04_Panel4_Paper13.pdf.

Hoffman, I., G. Rybka, G. Leventis, C. Goldman, L. Schwartz, M. Billingsley, and S. Schiller. 2015. *The Total Cost of Saving Electricity through Utility Customer-Funded Energy Efficiency Programs: Estimates at the National, State, Sector and Program Level*. Berkeley: Lawrence Berkeley National Laboratory. emp.lbl.gov/sites/all/files/total-cost-of-saved-energy.pdf.

Hornby, R., P. Chernick, D. White, J. Rosenkranz, R. Denhardt, E. Stanton, J. Gifford, B. Grace, M. Chang, P. Luckow, T. Vitolo, P. Knight, B. Griffiths, and B. Biewald. 2013. *Avoided Energy Supply Costs in New England.* Prepared for Avoided Energy Supply Component (AESC) Study Group. Cambridge, MA: Synapse Energy Economics, Inc. www.synapse-energy.com/sites/default/files/SynapseReport.2013-07.AESC_.AESC-2013.13-029-Report.pdf.

IEA (International Energy Agency). 2014. *Capturing the Multiple Benefits of Energy Efficiency*. Paris: Organisation for Economic Co-operation and Development (OECD)/IEA.

Integral Analytics. 2010. *LoadSEER: Spatial Electric Expansion and Risk.* www.integralanalytics.com/files/documents/related-documents/LoadSEER%20White%20Paper.pdf.

IRS (US Internal Revenue Service). 2006. Notice 2006-52. *Deduction for Energy Efficient Commercial Buildings.* Internal Revenue Bulletin: 2006-26. June 26. Washington, DC: IRS. www.irs.gov/irb/2006-26_IRB/ar11.html.

Itron (Itron, Inc.). 2014. *Development and Application of Select Non-Energy Benefits for the EmPOWER Maryland Energy Efficiency Programs*. Silver Spring, MD: Itron. webapp.psc.state.md.us/newIntranet/Casenum/NewIndex3_VOpenFile.cfm?filepath=C:%5CCasenum%5C9100-9199%5C9153%5CItem_597%5C%5C9153-57-NonEnergyBenefitsReport-Itron-022415.pdf.

Johnson, K., and E. Mackres. 2013. *Scaling Up Multifamily Energy Efficiency Programs: A Metropolitan Area Assessment*. Washington, DC: ACEEE. www.aceee.org/research-report/e135.

Kaza, N., R. Quercia, and C. Tian. 2013. *Home Energy Efficiency and Mortgage Risks*. Washington, DC: Institute for Market Transformation. www.imt.org/uploads/resources/files/IMT_UNC_HomeEEMortgageRisksfinal.pdf.

Kok, N., and M. Kahn. 2012. *The Value of Green Labels in the California Housing Market*. Berkeley: University of California. www.usgbc.org/sites/default/files/ValueofGreenHomeLabelsStudy_July2012.pdf.

Lazar, J., and K. Coburn. 2013. "A Layer Cake of Benefits: Recognizing the Full Value of Energy Efficiency." Presentation. Montpelier, VT: Regulatory Assistance Project. www.raponline.org/event/recognizing-the-full-value-of-efficiency-theres-more-layers-in-the-layer-cake-than-many-account.

Loftness, V., V. Hartkopf, B. Gurtekin, and D. Hansen. 2003. *Linking Energy to Health and Productivity in the Built Environment: Evaluating the Cost-Benefits of High Performance Building and Community Design for Sustainability, Health and Productivity*. Pittsburgh: Center for Building Performance and Diagnostics, Carnegie Mellon University. www.usgbc.org/Docs/Archive/MediaArchive/207_Loftness_PA876.pdf.

Lung, R., A. McKane, R. Leach, and D. Marsh. 2005. "Ancillary Savings and Production Benefits in the Evaluation of Industrial Energy Efficiency Measures." In *Proceedings of the ACEEE 2005 Summer Study on Energy Efficiency in Industry*, 6:103-114. Washington, DC: ACEEE. aceee.org/files/proceedings/2005/data/papers/SS05_Panel06_Paper10.pdf.

Lutzenhiser Associates. 2006. *California Retrofit Home Performance Program, Phase 2: 2004–2005, Final Evaluation Report*. Prepared for the California Building Performance Contractors Association and Pacific Gas and Electric Company. Portland: Lutzenhiser Associates. www.calmac.org/publications/CBPCA_PH_2_FINAL_Eval_Rpt_CPUC-1398-04.pdf.

Majersik, C. 2004. *The Impact of Energy Costs on Multi-Family Residential Building Value. Case Study: Pine Harbor Apartments*. Prepared for NYSERDA (New York State Energy Research and Development Authority). Washington, DC: Institute for Market Transformation. www.imt.org/uploads/resources/files/PineHarborCaseStudy2004.pdf.

Malmgren, I., and L. Skumatz. 2014. "Lessons from the Field: Practical Applications for Incorporating Non-Energy Benefits into Cost-Effectiveness Screening." In *Proceedings of the ACEEE 2014 Summer Study on Energy Efficiency in Buildings*, 8:186-200. Washington, DC: ACEEE. aceee.org/files/proceedings/2014/data/papers/8-357.pdf.

Martins, G., and E. Lima. 2008. "How to Improve Reliability in Centrifugal Pump Systems through the Automatic Tuneup of Pumps within Their Best Operational Condition." In *Proceedings of the Twenty-Fourth International Pump Users Symposium*. College Station, TX: Texas A&M University. turbolab.tamu.edu/proc/pumpproc/P24/02-martins.pdf.

MassSave. 2015. "Improve Your Bottom Line: Energy Efficiency Services for All Types of Multi-Family Facilities." Accessed November 17.

www.masssave.com/~/media/Files/Business/Brochures-and-Literature/NPI0030MultiFamilyBrochure08032015.pdf.

Mendota (The Mendota Group, LLC). 2014. "Benchmarking Transmission and Distribution Costs Avoided by Energy Efficiency Investments." Filed on behalf of Public Service Company of Colorado. October 23.

MNPUC (Minnesota Public Utilities Commission). 2014. "Order Permitting Withdrawal with Conditions." May 12. Dockets No. E-002/CN-12-113 and E-002/TL-11-152. www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={89855D89-A15D-4DC4-AE37-E85A68778CD2}&documentTitle=20145-99402-01.

NEEP (Northeast Energy Efficiency Partnerships). 2014. *Cost-Effectiveness Screening Principles and Guidelines for Alignment with Policy Goals, Non-Energy Impacts, Discount Rates, and Environmental Compliance Costs, Version 1.0*. Lexington, MA: NEEP. www.neep.org/sites/default/files/resources/Forum_C-E_Screening_Guidelines_Final_No_2014.pdf.

Neme, C., and J. Grevatt. 2015. *Energy Efficiency as a T&D Resource: Lessons Learned from Recent U.S. Efforts to Use Geographically Targeted Efficiency Programs to Defer T&D Investments*. Lexington, MA: Northeast Energy Efficiency Partnerships. www.neep.org/file/2414/download?token=bNV2vVea.

Neme, C., and R. Sedano. 2012. "US Experience with Efficiency as a Transmission and Distribution Resource." Montepelier, VT: Regulatory Assistance Project. www.raponline.org/document/download/id/4765.

NESP (National Efficiency Screening Project). 2014. *The Resource Value Framework: Reforming Energy Efficiency Cost-Effectiveness Screening*. Washington, DC: National Home Performance Council. www.homeperformance.org/sites/default/files/nhpc_nesp-recommendations_20140816.pdf.

NMR Group. 2011. *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non Energy Impacts (NEI) Evaluation*. Prepared for: Massachusetts Program Administrators. Madison, WI: NMR Group and Tetra Tech, Inc. ma-eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf.

NYPSC (State of New York Public Service Commission). 2014. "Order Establishing Brooklyn/Queens Demand Management Program." December 11. Case Number 14-E-0302. documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={83594C1C-51E2-4A1A-9DBB-5F15BCA613A2}.

NYSERDA (New York State Research and Development Authority). 2011. *New York's System Benefit Charge Programs Evaluation and Status Report: Quarterly Report to the Public Service Commission, Quarter Ending March 31, 2011*. Albany: NYSERDA. www.nyserda.ny.gov/-

/media/Files/Publications/PPSER/NYES-Program/2011/2011-Q1-NY-Energy-Smart-Program-Evaluation-Status-Report.pdf.

Pigg, S., D. Cautley, P. Francisco, B. Hawkins, and T. Brennan. 2014. *Weatherization and Indoor Air Quality: Measured Impacts in Single-Family Homes under the Weatherization Assistance Program*. Oak Ridge, TN: Oak Ridge National Laboratory. weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-2014_170.pdf.

Russell, C. 2015. *Multiple Benefits of Business-Sector Energy Efficiency: A Survey of Existing and Potential Measures*. Washington, DC: ACEEE. aceee.org/research-report/ie1501.

Skumatz, L. 2013. "Non-Energy Benefits: What Have We Learned in 20 Years? Capturing the Multiple Benefits of Energy Efficiency." Presentation for IEA Roundtable on Energy Provider and Consumer Benefits, Ottawa. October 15. www.iea.org/media/workshops/2013/energyproviders/NEB_Skumatz_OttawaIEA_v6final.pdf.

——. 2014. *Non Energy Benefits/Non Energy Impacts (NEBs/NEIs) and Their Role and Values in Cost-Effectiveness Tests: State of Maryland*. Prepared for the Natural Resources Defense Council (NRDC). Superior, CO: Skumatz Economic Research Associates, Inc. (SERA). energyefficiencyforall.org/sites/default/files/2014_%20NEBs%20report%20for%20Maryland.pdf.

Stukel, L., R. Scheu, C. Gamba, and P. Brookstein. 2014. "Valuing Home Performance Improvements in Real Estate Markets." In *Proceedings of the ACEEE 2014 Summer Study on Energy Efficiency in Buildings*, 10:302–315. Washington, DC: ACEEE. www.elevateenergy.org/wp/wp-content/uploads/Valuing_Home_Performance_Improvements.pdf.

Synapse (Synapse Energy Economics, Inc.). 2013. "Appendix D: Energy Efficiency Cost-Effectiveness Tests." Cambridge, MA: Synapse. www.synapse-energy.com/sites/default/files/Appendix%20D%20from%20Michigan%20Report.pdf.

Tonn, B., E. Rose, B. Hawkins, and B. Conlon. 2014. *Health and Household-Related Benefits Attributable to the Weatherization Assistance Program*. Oak Ridge, TN: Oak Ridge National Laboratory. weatherization.ornl.gov/Retrospectivepdfs/ORNL_TM-2014_345.pdf.

Vom Brocke, J., S. Seidel, and J. Recker, eds. 2012. *Green Business Process Management: Towards the Sustainable Enterprise*. New York: Springer Science+Business Media.

Wobus, N., J. Meissner, B. Barkett, D. Waldman, K. Train, J. Thacker, and D. Violette. 2007. "Exploring the Application of Conjoint Analysis for Estimating the Value of Non-Energy Impacts." International Energy Program Evaluation Conference, Chicago.

Woodroof, E., W. Turner, W. Heffington, and B. Capehart. 2012. "Energy Conservation Also Yields: Capital, Operations, Recognition, and Environmental Benefits." *Energy Engineering* 109 (5).

Woolf, T., E. Malone, J. Kallay, and K. Takahashi. 2013. *Energy Efficiency Cost Effectiveness Screening in the Northeast and Mid-Atlantic States*. Cambridge, MA: Synapse Energy Economics, Inc. www.synapse-energy.com/sites/default/files/SynapseReport.2013-10.NEEP_.EMV-Screening.13-041.pdf.

Worrell, E., J. Laitner, M. Ruth, and H. Finman. 2003. "Productivity Benefits of Industrial Energy Efficiency Measures." *Energy Journal* 28 (11): 1081–1098.

WRA (Whitman, Requardt & Associates, LLP). 2014. *The Handy-Whitman Index of Public Utility Construction Costs.* Bulletin 180: July 2014. Baltimore: WRA.

Xcel Energy. 2014. "November 12 Compliance Filing in the Matter of the Application for a Certificate of Need for the Hollydale 115 kV Transmission Line Project in the Cities of Plymouth and Medina." Minnesota Public Utilities Commission Docket Number E002, ET2/CB-12-1.

———. 2015a. "April 1 Compliance Filing in the Matter of the Application for a Certificate of Need for the Hollydale 115 kV Transmission Line Project in the Cities of Plymouth and Medina." Minnesota Public Utilities Commission Docket Number E002, ET2/CB-12-113.

———. 2015b. "July 1 Compliance Filing in the Matter of the Application for a Certificate of Need for the Hollydale 115 kV Transmission Line Project in the Cities of Plymouth and Medina." Minnesota Public Utilities Commission Docket Number E002, ET2/CB-12-113.

Appendix A. Business-Sector Advisory Group Methodology

In April 2015, ACEEE organized a small, informal group of advisory experts to discuss the multiple benefits that may be concurrent with business-sector energy efficiency improvements. Analysis of the advisors' responses is presented here to inform the development of future energy efficiency program activities.

For current purposes, the businesses discussed include industrial, commercial, and institutional structures. The following points were considered:

- *Different types of multiple benefits and their ease of measurement*. Advisors were provided a list of suggested benefits, then asked to (1) add any other benefits not listed and (2) comment on their ease of measurement.
- *Reasons why business energy consumers may participate in a multiple benefits initiative integral to an energy efficiency program*. Advisors were provided a list of reasons and asked to add to the list and comment on the level of importance for each.
- *Rewards accruing to business entities, which may be derived from multiple benefits*. The business sector's reasons for pursuing energy efficiency's multiple benefits may be distinct from the rewards that are eventually obtained.
- *Hurdles or issues* relevant to the implementation of a multiple benefits initiative within the context of an energy efficiency program.
- *Characteristics of businesses* that would indicate their potential for successful participation in a multiple benefits initiative.

Advisors' responses yielded the listing of multiple benefit types as well as their anticipated rewards as described in this paper.

Appendix B. Tax-Based Multiple Benefits: Section 179D

Section 179D of the Energy Policy Act of 2005 enabled US for-profit entities to take a one-time deduction from taxable income as an incentive for installing energy efficiency improvements. The allowance was intended to encourage the implementation of energy technologies that would potentially improve building energy consumption by up to 50%, relative to the prevailing ASHRAE 90.1-2001 performance standard.

Although this provision expired at the end of 2014, eligible entities may apply this income tax deduction to properties either placed in service or renovated during 2014, or, by way of amended tax return, during any of the three prior tax years (2011–2013). The deduction is a dollar amount offered per square foot of space affected by the improvement. Section 179D, as amended, allowed building owners to claim any or all of the deductions, as shown in table B1 (IRS 2006).[12]

Table B1. Section 179D deductions

Technology type	Lighting*	HVAC	Building envelope	Total
Application examples	Interior lighting	Variable air volume systems, variable frequency drives, economizers, energy recovery ventilation, high-SEER/EER air-conditioning units	Cool/white roof systems, increased wall/roof/floor insulation, window films/treatments, doors	Any combination of technologies listed to the left
Percentage energy reduction to be achieved**	16.67%	16.67%	16.67%	Must total 50%
	Or 25%	Or 15%	Or 10%	
Amount of tax deduction per square foot of facility space	$0.60	$0.60	$0.60	$1.80

* Interim lighting rule: the tax deduction is scalable over a range of $0.30 to $0.60 in proportion to an achieved reduction in lighting power density ranging from 25% to any result equal to or greater than 40%. ** Relative to ASHRAE 90.1-2001 standard.
Source: DSIRE 2014b.

This provision is worth following. At the time of this report's release, good potential existed for the extension of Section 179D as a part of evolving federal tax legislation.

[12] In the case of buildings that are publicly owned or whose owners are otherwise without tax liability, the building owner may assign the benefit to the design firms that engineered the energy efficiency improvements.