Estimating Peak Demand Impacts of Energy Efficiency Programs: A National Review of Practices and Experience

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Abstract

From their inception in the late 1970s, electric energy efficiency programs have tended to focus primarily on saving energy (kilowatt-hours). While energy efficiency programs can and often do produce reductions in peak demand (kilowatts), that typically has not been as much of a priority. Over the past few years, however, there has been a renewed and rapidly growing interest in drawing upon the peak demand impacts of energy efficiency programs to improve system reliability and avoid costlier new investments in generation or transmission and distribution systems.

This paper presents results from a national review of current practices for estimating demand impacts from energy efficiency programs. A particular focus of the project was to review a set of existing databases and related technical references to examine reported energy and demand impacts for a selected representative set of common energy efficiency measures included in programs.

We found a surprising lack of actual ex-post measurement of demand savings from energy efficiency programs. As a proxy for the availability of impact evaluations that include some type of actual ex-post measurement of peak demand savings, we searched IEPEC and ACEEE Summer Study conference proceedings from 1994 through 2006 for relevant conference papers that reported such results. Overall we found relatively few such examples. Most of the conference papers we found that reported demand impacts derived such impacts from the estimated energy savings using load shapes or load factors. Our review and analysis of protocols and databases used by selected state and utility energy efficiency programs confirms this finding; most of the references for estimating demand impacts of energy efficiency measures are based on assumptions about load factors and shapes, not necessarily actual field-measured results.

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Introduction

Over two decades of experience with "demand-side management" (DSM) and related programs addressing customer energy use has demonstrated clearly that customer demand is indeed a variable that can be affected through utility and other types of programs. The two primary types of DSM programs—energy efficiency and load management—have historically had relatively different core objectives. Energy efficiency programs primarily seek to reduce customer energy use (kilowatt-hours or kWh) on a permanent basis through the installation of energy-efficient technologies. Load management, by contrast, generally focuses on either curtailing or shifting demand (kilowatts or kW) away from high cost, peak demand periods. The relative costs and benefits of each main type of program vary from utility to utility.

There is obvious overlap between energy efficiency and load management. Reducing peak demand may also yield some energy (kWh) savings, and most energy-efficient technologies also yield peak demand savings. While energy efficiency programs can and often do produce reductions in peak demand (measured in kW), such impacts historically have not been an area of priority focus for such programs. The focus on energy savings impacts also has affected evaluation priorities. The primary emphasis has been on estimating the energy (kWh) savings that have resulted from the programs—an emphasis largely driven by regulatory requirements, program objectives or specific rate mechanisms, such as shareholder incentives for energy efficiency program impacts. This emphasis on kWh savings has also been due in part to practical limitations, such as higher measurement costs and the general lack of time-differentiated customer end-use data.

Over the past few years however, increased concerns about electric system reliability have combined with concerns about the cost of new generation and transmission and distribution (T&D) investments to create a renewed interest and need for energy efficiency to be able to reduce peak demand as well as overall energy use. Because energy efficiency produces a number of additional benefits that load management alone does not, there is an understandable desire to use energy efficiency as a first priority resource to address both demand and energy resource needs, but only if energy efficiency can be shown to produce reliable peak demand reductions. This has led to a growing interest in being able to quantify the effects of energy efficiency on system peak demand.

The Relationship between Energy Efficiency and Peak Demand Reduction

Previous studies have examined how energy efficiency can be used to reduce peak electrical demand and address electric system reliability concerns (Nadel, Gordon, and Neme 2000; Kushler, Vine, and York 2002; York and Kushler 2005). These studies provided clear examples that energy efficiency programs have yielded significant peak demand savings—savings that have been critical in addressing system reliability.

In evaluating the impacts of energy efficiency programs, the primary emphasis historically has been on estimating the energy (kWh) savings that have resulted from the programs as such savings have been the primary program objective. Utilities and regulatory authorities have focused on measurement of energy savings as a principal metric by which to evaluate program performance. Another reason for this relative emphasis on estimating saved energy instead of related demand (kW) impacts is that by their nature, energy efficiency improvements save energy at all times that the affected equipment operates, not just during times of electric system peak demand. Therefore, focusing on peak demand would miss most of the impact of the energy efficiency measures. Finally, the lack of time-differentiated metering for the vast majority of customers has meant that measuring program impacts using available utility billing data has limited the analysis to total kWh consumption. Engineering estimates of demand impacts from efficiency measures also require judging the "coincidence" of efficiency measures on an hourly basis in relation to the system's peak load, as well as gauging the diversity of peak impacts from efficiency measures in many different customer installations, each of which may have different operating schedules.

Heightened concern about system reliability relative to problems created by rapidly increasing peak demand has led to the creation of "demand response" programs—which really are derivatives of the broader umbrella of "load management." Unfortunately, in contrast to energy (kWh) savings impacts (where there are over two decades worth of extensive and widely published evaluation results), there is a relative scarcity of information about the demand (kW) impacts of energy efficiency. It is not that program evaluations haven't estimated such peak demand impacts, but rather that such estimations have been mostly derived from estimation of energy savings impacts, not measured and estimated directly. This is both a technical issue (kW impacts, especially peak demand impacts, are much more difficult to measure, often requiring additional metering and associated costs) and an artifact of the historic lack of research in this area.

Research Objectives and Methodology

ACEEE initiated a project early in 2006 to examine peak demand savings of energy efficiency measures and programs. One primary objective of this project was to review existing research, program evaluations, and related literature on the relationship between energy efficiency and peak demand reduction. Another key objective was to review industry practices for estimating demand impacts from energy efficiency programs. This review included identifying and summarizing example programs and related experiences as case studies that demonstrate how energy efficiency programs have achieved significant peak demand savings.

A final key objective was to review existing datasets and technical references on the peak demand impacts of selected energy efficiency measures in order to provide a ready reference source for these types of data. We compiled data for a set of common end-use energy efficiency measures promoted through utility and other energy efficiency programs. This comparative database of selected common energy efficiency measures documents the data available and applied to estimate peak demand impacts from energy efficiency measures and programs. It illustrates how energy efficiency resources are quantified in order to be used within system planning, operations, and market transactions. Such measure-by-measure quantification can be a fundamental building block for aggregating multiple energy efficiency measures into resources of sufficient magnitude to be incorporated into utility resource portfolios along with supply resources.

Program Examples and Experience

For this project, we identified recent examples of energy efficiency programs that also demonstrate and document significant peak demand savings. A key criterion for selecting these examples is that the programs used some kind of ex-post measurement of peak demand impacts to estimate overall program impacts. Table 1 below presents the summary impacts reported for these selected case studies.

Table 1. Energy and Peak Demand Savings of Selected Programs

State	Program Name (year)	Annual Energy Savings (MWh)	Peak Demand Savings (MW)	MW/GWh*
CA	San Francisco Peak Energy Program (2003-5)	56,768	9.1	0.16
CA	Northern California Power Agency SB5x Programs (2000-1)	37,300	15.9	0.44
TX	Air Conditioner Installer and Information Program (2004-5)	20,421	15.7	0.77
CA	Comprehensive Hard-to-Reach Mobile Home Energy Saving Local Program (2002-3)	7,681	3.7	0.48
MA	NSTAR Small Commercial/ Industrial Retrofit Program (2000-1)	27,134	6.0	0.22
MA	Small Business Lighting Retrofit Programs (2003)	35,775	9.7	0.27
MA	National Grid Custom HVAC Installations (2003)	980	0.17	0.17
NY	New York Energy $mart℠ Peak Load Reduction Program (2001-3)	—	15.0	—
MA	National Grid Compressed Air Prescriptive Rebate Program (2004)	673	0.098	0.15
MA	National Grid Energy Initiative Program—Lighting Fixture Impacts (2003)	36,007	6.5	0.18
MA	National Grid Energy Initiative	1,593	0.266	0.17

	and Design 2000plus: Custom Lighting Impact Study (2004)			

* This column is derived values from reported peak demand savings and annual energy savings.

These case studies clearly illustrate that energy efficiency programs can yield measurable, significant peak demand savings. The derived value, "MW/GWh," shows that across this small set of programs, this relationship varies by a factor of about 5. This just mirrors the different relationships that exist between peak demand savings and energy savings of different end-use measures.

The success of energy efficiency programs providing measurable and significant resource benefits is leading some states and regions to "raise the bar" in terms of the role of energy efficiency in resource planning and acquisition. The Northwest offers a prime example. The Northwest Power and Conservation Council estimated that energy efficiency programs and related investments since such efforts were begun in 1978 in the region have yielded a cumulative impact of about 3,000 average megawatts[1] of energy savings in 2004. According to its latest long-range, integrated resource plan, the region plans to meet all demand growth through the year 2012 through energy efficiency (NPCC 2005). The near-term target for additional energy efficiency savings is 700 average megawatts by 2009.

The state of New York provides another example of a long-term and ongoing record of using energy efficiency as a utility system resource. NYSERDA estimated that between 1990 and 2001, the state's major energy efficiency programs saved achieved cumulative annual energy savings of 7,095 GWh and reduced summer peak demand by nearly 1,700 MW (NYSERDA 2002), which yields an aggregate program total of 0.24 MW/GWh[2] using the derived metric described above.

An emerging application of energy efficiency is to target specific geographic areas (rather than utility- or statewide areas) for relieving load on constrained T&D systems. Kushler, Vine, and York (2005) described two recent examples of targeted energy efficiency programs. ISO-New England (ISO-NE) needed an emergency supplemental capacity in 54 targeted communities in southwest Connecticut to avoid potential disruptions in service resulting from the constraints on supplying power to this area. After soliciting bids to provide "demand response" to meet this need, ISO-NE awarded one contract to deliver 4 MW of demand reduction through projects utilizing a variety of energy-efficient lighting technologies (other demand response projects typically reduce load by other means, such as load curtailments associated with lowering lighting or cooling levels). Long Island Power Authority (LIPA) provides another example. In 2004 LIPA announced a comprehensive portfolio of new energy resources—both supply and demand resources-- that will add over 1,000 MW to LIPA's portfolio by 2012. The LIPA plan includes 73 MW of demand savings through energy efficiency. To procure such demand savings, one contractor alone proposed to provide almost 24% of the reductions (17.5 MW) through retrofitting buildings with energy-efficient lighting, heating and ventilation systems, appliances, and refrigeration systems.

Review of Published Evaluation Results

It is difficult to access and review the body of evaluation research available in this field. Many such reports are not publicly available, particularly as the industry has become more competitive and more information and data are proprietary. There is no over-arching program evaluation industry "index" that reports on evaluation activity or results.

[1] "Average megawatt" is a unit of energy used as a convention in the Northwest region, largely because of the hydropower dominance for power generation. An average megawatt is equal to the energy produced by one megawatt over one entire year (8,760 hours), or 8,760 megawatt-hours.

[2] NYSERDA (2002) estimated that the total cumulative energy savings over this period was 57,256 GWh.

As a proxy for such a data set, however, we turned to two key sources within the energy efficiency program industry. These are biennial conferences where program practitioners—planners, managers, consultants, implementers, evaluators, researchers, and others—present and publish papers relative to their work with energy efficiency programs, technologies, and policies. These conferences are:

- ACEEE biennial Summer Study on Energy Efficiency in Buildings, and
- International Energy Program Evaluation Conference.

We reviewed the published conference proceedings for the International Energy Program Evaluation Conference (IEPEC 1993–2005) and the ACEEE Summer Study on Energy Efficiency in Buildings (ACEEE 1994–2006) for evaluations of energy efficiency measures and programs that demonstrated demand impacts. Specifically, when the conference proceedings were available on CD-ROM, we electronically searched the proceedings for keywords like "kW," "MW," "demand savings," etc. In years for which we only had a paper copy of the proceedings, we visually scanned each paper for demand savings. Since the primary objective was to identify energy efficiency measures or programs with demand savings, we eliminated evaluations of load management and demand response programs, as well as efficiency standards and/or building codes. In addition, we only considered energy efficiency papers with specific demand savings figures. We then categorized the evaluations by sector (residential, commercial/industrial, and agricultural), whether the study provided demand savings by measure or program, and whether the study included some level of metered demand savings for one or more of the measures in the study.

We found that only 2.9% (78/2,664) of the conference papers that we reviewed presented energy efficiency measures or programs with numerical demand energy savings. A little more than half (45/78) of those evaluations involved some type of actual metering as part of the methodology. A slightly higher percentage (3.3% vs. 0.9%) of conference papers in the earlier years (1993–1997) included actual metered demand savings compared to studies from conferences in the later years (1998–2006).

Finding so few energy efficiency studies that documented demand impacts in the fourteen years of conference proceedings is an important finding. Whereas energy savings (kWh) were commonly provided in the energy efficiency evaluations, demand savings were established much less often. Another related key finding is the change in these numbers over time. In the early '90s we found a relatively large number of papers directly on this topic—but as the '90s proceeded, we found fewer and fewer such papers. Published papers in this latter period tended to rely on applying load curves (developed in the '80s and early '90s) to the estimated energy (kWh) impacts, rather than using metered demand data specific to the program being evaluated. This trend may well be at least in part due to the onset of electric "restructuring" in the mid-1990's, which tended to re-define energy efficiency as a "public benefit" rather than an explicit utility system "resource."

These overall findings reflect evaluation priorities, and technical and cost issues associated with estimating peak demand impacts. Historically, the emphasis for evaluation of energy efficiency programs has been to estimate energy (kWh) savings since such savings are the primary program objective. Estimating peak demand impacts typically has not been a high priority. As shown in our review and analysis of conference proceedings, many evaluations simply did not estimate or report peak demand impacts. This by no means suggests any kind of shortcoming of the evaluators or program managers; it simply reflects the prevailing needs and objectives of program administrators and evaluators working within budget and resource constraints.

Other factors that explain the relative lack of research and evaluation on peak demand impacts of energy efficiency programs are technical and cost issues, which clearly also influence prioritization and evaluation resource allocation. Peak demand impacts are typically much more difficult to measure and estimate accurately than energy (kWh) savings impacts, generally requiring additional, dedicated metering (time-of-use or other demand metering, monitoring, and logging hardware) and associated costs. It is no surprise that when faced with limited—and even diminishing—evaluation budgets over the period examined in this analysis, evaluation budgets and resources have focused on accurate estimation of the impacts (kWh savings) that are most readily measurable.

Comparison of Leading Databases and Technical References

A final objective of this project was to create a practical comparative database of estimated peak demand impacts for selected energy efficiency measures. The purpose of this component of the project was to create a simple and practical information resource that program planners and evaluators could access to obtain reasonable "illustrative" estimates of the peak demand impacts of common energy efficiency measures for use in initial program design and assessment.

We began this aspect of the project with a review of leading technical references used to estimate energy and peak demand impacts of energy efficiency measures, which in several cases take the form of electronic databases. We conducted a search to identify databases and similar technical references that are used by leading utility-sector energy efficiency programs. From this review we selected the following databases and technical references to use in the creation of a comparative database of selected energy efficiency measures:

- *Database for Energy Efficiency Resources* (DEER). California Energy Commission and California Public Utilities Commission (2005).
- *Deemed Savings Database, Version 9.0.* New York State Energy Research and Development Authority (2006).
- *Deemed Savings, Installation & Efficiency Standards: Residential and Small Commercial Standard Offer Program, and Hard-to-Reach Standard Offer Program.* Public Utility Commission of Texas (2003).
- *Conservation Resource Comments Database.* Northwest Power and Conservation Council (2007).
- *Technical Reference User Manual* (TRM). Efficiency Vermont (2003).

To compare data across these references we identified a set of common end-use energy efficiency measures included in programs. We then collected data on these measures from each of the technical references and databases to create a comparative database. The purpose of this review and collection of data is to illustrate the types of measures commonly included in utility sector program databases. We also sought to show typical values used for peak demand and energy savings associated with specific measures. Our comparative database should be viewed as a selected detail from a much larger picture. The data we compiled and report are really starting points for program design, implementation, and evaluation. The data could readily be used at the program scoping and development stage for certain types of programs.

In reviewing these databases, we found that the measures for which it is possible to have the most uniform definition (for example, residential 15 watt compact fluorescent light bulb replacing a 60 watt incandescent) show the most uniformity in terms of reported energy and demand savings. Other measures that were not as uniformly defined (for example, variable speed motor drives or packaged rooftop HVAC units) tended to show wider variations. Similarly, measures that are climate sensitive also tend to show wider variations, as would be expected. The databases and technical references are most useful for fairly well-defined, "standard" measures. Energy efficiency measures that involve more complex or customized services generally require a project-specific estimation of energy and demand savings; standardized or deemed savings estimates are not well suited to such applications. We found that generally the databases provide reasonably good documentation of the data references and key assumptions. This is critical to allow ready checking on the source and accuracy of reported data and to understand key assumptions. It also easily allows updating and comparison to other references. Table 2 gives summary data that we have compiled from the individual databases and technical references. The data reflect the most recent data available from each of the databases that we reviewed. Technical specifications, such as for ENERGY STAR products, and equipment performance change over time. The values in Table 2 do not necessarily reflect the latest such specifications and performance data.

Table 2. Summary Table from the Comparative Database of Selected Energy Efficiency Measures

	Coincident Summer[1] Peak Demand Savings				**Annual Energy Savings**			
	Reported kilowatt (kW) savings				**Reported kilowatt-hour (kWh) savings**			
	Min	**Max**	**Median**	**Records**	**Min**	**Max**	**Median**	**Records**
Residential Measures								
ENERGY STAR room air A/C	0.058	0.067	0.063	3	40	181	47	4
Energy-efficient central A/C	0.435	0.864	0.742	4	288	666	378	5
ENERGY STAR refrigerators	0.006	0.011	0.009	4	52	212	61	5
ENERGY STAR freezers	0.005	0.005	0.005	1	39	39	39	1
ENERGY STAR clothes washers	0.009	0.193	0.051	4	298	676	463	5
Compact fluorescent light bulbs	0.004	0.009	0.006	4	39	95	58	5
Fluorescent torchiere	0.020	0.028	0.025	3	180	325	231	4
ECM furnace fan	0.147	0.147	0.147	1	396	396	396	1
Infiltration reduction	Four out of the five references report values for infiltration reduction of single-family homes. However, there is too much variation in how this measure is defined and how the savings are reported (not common units) to provide meaningful comparative data in this summary table.							
Commercial Measures								
Energy–efficient packaged roof-top HVAC units 5–12 tons	0.020 kW/ton	0.232 kW/ton	0.083 kW/ton	4	20 kWh/ton	202 kWh/ton	143 kWh/ton	4
Energy-efficient chillers 150–300 tons centrifugal	0.067 kW/ton	0.102 kWh/ton	0.085 kW/ton	2	99 kWh/ton	205 kWh/ton	152 kWh/ton	2
HVAC controls/energy management systems	Two out of the five references report values for some type of HVAC controls/EMS improvements. However, there is too much variation in how this measure is defined and how the savings are reported (not common units) to provide meaningful comparative data in this summary table.							
Variable speed motor drives	0.071 kW/hp	0.252 kW/hp	0.203 kW/hp	3	822 kWh/hp	1656 kW/hp	1001 kW/hp	3
Compact fluorescent light bulbs	0.006	0.039	0.026	4	37	190	143	4

Daylight controls	Three out of the five references report values for some type of daylighting control. However, there is too much variation in how this measure is defined and how the savings are reported (not common units) to provide meaningful comparative data in this summary table.							
Occupancy sensors	Three out of the five references report values for occupancy sensors for lighting. However, there is too much variation in how this measure is defined and how the savings are reported (not common units) to provide meaningful comparative data in this summary table.							
Premium efficiency motors—5 hp	0.056	0.070	0.063	2	148	329	163	3
Premium efficiency motors—10 hp	0.117	0.148	0.133	2	146	690	311	3
Premium efficiency motors—25 hp	0.151	0.191	0.171	2	547	893	788	3
T-8 fluorescent lamps with electronic ballasts	0.006	0.008	0.008	3	22	49	46	4
Commercial packaged refrigeration	0.112	0.112	0.112	1	1088	1088	1088	1
Commercial vending machine controls ("Vending Miser")	0	0.114	0.057	2	1022	1635	1406	4
High efficiency copiers	0.041	0.041	0.041	1	324	324	324	1
Industrial Measures								
Premium efficiency motors—40–50 hp	0.219	0.471	0.345	2	1026	1346	1294	3
Premium efficiency motors—75 hp	0.474	0.551	0.513	2	1575	2795	2585	3
Premium efficiency motors—150 hp	0.575	0.728	0.652	2	2080	4032	3394	3
Premium efficiency motors—200 hp	1.146	1.450	1.298	2	3255	6759	5343	3

[1]Data for four of the technical references used are for summer peaking systems (California, New York, Texas, and Vermont). The fifth technical reference is for the Pacific Northwest, which is a winter peaking system. Comparable summer peak demand reduction data are not available; only winter peak demand savings are reported for the Pacific Northwest (NPCC 2007), as well as annual energy savings.

Findings and Conclusions

Our major findings in this study are:

- Energy efficiency programs clearly have achieved significant peak demand reductions. We found examples of clear, well-documented estimates of such impacts from individual measures, entire programs, and entire state and regional utility systems.
- While we found well-documented estimates of peak demand impacts of energy efficiency, most program evaluations have not used direct, on-site measurement of the demand impacts. Rather, program evaluations typically have relied on customer billing or other measurements of kilowatt-hour use as primary data. Load shapes or load factors are then applied to these data to estimate the peak demand impacts.
- As utilities and system operators increase their use of energy efficiency programs as energy system resources to deliver both energy (kWh) and peak demand (kW) savings, the need for greater understanding and accurate quantification of the peak demand impacts of energy efficiency will increase.
- There are solid foundations in place for establishing a firmer, broader knowledge base of the peak demand impacts of energy efficiency. One of these foundations is the growing number of technical manuals and databases in use that provide measure-by-measure quantification of these impacts.

With the renewed interest and use of energy efficiency as a resource, the importance of estimating both energy and demand impacts accurately is increasing. Emerging market structures and transactions that allow demand resources to participate in energy markets similarly will increase the importance of accurate estimation of these resources. For example, there is work underway to include energy efficiency resources within the ISO New England Forward Capacity Market (Peterson et al. 2006). With this growing importance of accurate quantification of the energy and demand impacts of energy efficiency programs, we expect to see renewed and expanded evaluation efforts that will explicitly include metered demand impacts as part of the program evaluations.

The expanding use of more advanced customer metering technology will also facilitate the use of demand data in program evaluations. New and expanded use of advanced metering technologies also may help address cost issues associated with estimation of peak demand impacts. As utilities increase the number of customers with time-of-use meters in place for routine billing purposes (clearly in conjunction with time-of-use rate structures), program evaluators will be able to use this time-differentiated usage data without the need to install separate, dedicated metering and logging equipment. This alone will greatly reduce costs associated with estimating peak demand impacts. Advances in metering technology also have greatly reduced the costs associated with many monitoring and evaluation practices. The advent and advancement of numerous “smart” technologies, such as those used in building systems, along with advances in communication technologies have created new opportunities to gather data at relatively low costs. Most data-gathering functions can be performed remotely, especially if such capabilities are integrated with the monitoring and control functions of end-use equipment and systems.

There well may be an advantageous convergence of need, capabilities, and costs emerging for estimating peak demand impacts. As utilities and system operators rely more and more on demand-side options to address peak demand and related reliability concerns, their needs for accurate and timely quantification of demand-side impacts increases commensurately. Parallel with these trends are rapid increases in the capabilities of monitoring and communications technologies that can yield relatively low costs for data gathering and analysis. It was beyond the scope of our project to explore more specific costs and possible benefits of these new evaluation opportunities relative to past and present practices. It will be important for utilities and regulators to work with the program evaluation community to address these issues and weigh the many factors that go into developing evaluation plans, including program objectives, evaluation priorities, budgets, costs, capabilities, and needs.

References

[ACEEE] American Council for an Energy-Efficient Economy. 1994-2006. Proceedings from the Biennial Summer Studies on Energy Efficiency in Buildings:
1994: Building Tomorrow: The Path to Energy Efficiency.
1996: Profiting from Energy Efficiency.
1998: Energy Efficiency in a Competitive Environment.
2000: Efficiency and Sustainability.
2002: Teaming for Efficiency.
2004. Breaking Out of the Box.
2006: Less is More: En Route to Zero Energy Buildings.
Washington, D.C.: American Council for an Energy-Efficient Economy.

[CEC and CPUC] California Energy Commission and California Public Utilities Commission. 2005. *Database for Energy Efficient Resources (DEER), Version 2.01.* On-line database available at: http://eega.cpuc.ca.gov/deer/ October 26.

Efficiency Vermont. 2003. Technical Reference User Manual (TRM), No. 4-19: Measure Savings Algorithms and Cost Assumptions Through Portfolio 19. Burlington, Vt.: Efficiency Vermont.

[IEPEC] International Energy Program Evaluation Conferences. *Proceedings.* 1993-2005.
1993. Energy Program Evaluation: Uses, Methods and Results.
1995. Uses, Methods and Results.
1997. The Future of Energy Markets: Evaluation in a Changing Environment.
1999. Evaluation in Transition: Working in a Competitive Environment.
2001: Evaluation: Providing Answers to Tough Questions.
2003. Evaluation: Meeting Diverse Needs.
2005. Reducing Uncertainty Through Evaluation.
Madison, Wis.: International Energy Program Evaluation Conference c/o Christensen Associates Energy Consulting. http://www.iepec.org/

Kushler, M., E. Vine and D. York. 2002. *Energy Efficiency and Electric System Reliability: A Look at Reliability-Focused Energy Efficiency Programs Used to Help Address the Electricity Crisis of 2001.* ACEEE-U021. Washington, D.C.: American Council for an Energy-Efficient Economy.

———. 2005. "Energy-Efficiency Measures Alleviate T&D Constraints." *Transmission and Distribution World.* Volume 57, Number 4. April.

Nadel, S., F. Gordon and C. Neme. 2000. Using Targeted Energy Efficiency Programs to Reduce Peak Electrical Demand and Address Electric System Reliability Problems. Washington, D.C.: American Council for an Energy-Efficient Economy.

[NPPC] Northwest Power and Conservation Council. 2007. *Conservation Resource Comment Database.*

Online database available at: http://www.nwcouncil.org/comments/default.asp. Portland, Oregon: Northwest Power and Conservation Council.

_____. Northwest Power and Conservation Council. 2005. *The Fifth Northwest Electric Power and Conservation Plan.* http://www.nwcouncil.org/energy/powerplan/plan/Default.htm. Portland, Oregon: Northwest Power and Conservation Council.

[NYSERDA] New York Energy Research and Development Authority. 2006. *Deemed Savings Database, Version 9.* Prepared for NYSERDA by Nexant. Albany, N.Y.: The New York Energy Research and Development Authority. August 14.

______. New York Energy Research and Development Authority. 2002. *State Energy Plan 2002.* Available on-line at: http://www.nyserda.org/Energy_Information/energy_state_plan.asp. Albany, N.Y.: New York Energy Research and Development Authority.

Peterson, P., D. Hurley, T. Woolf, and B. Biewald. 2006. *Incorporating Energy Efficiency into the ISO New England Forward Capacity Market.* Cambridge, Mass.: Synapse Energy Economics, Inc.

[PUCT] Public Utility Commission of Texas. 2003. Deemed Savings, Installation & Efficiency Standards: Residential and Small Commercial Standard Offer Program and Hard-To-Reach Standard Offer Program. Prepared for PUCT by Frontier Associates, LLC. Austin, Texas: Public Utility Commission of Texas.

York, D. and M. Kushler. 2005. Exploring the Relationship Between Demand Response and Energy Efficiency: A Review of Experience and Discussion of Key Issues. ACEEE-U052. Washington, D.C.: American Council for an Energy-Efficient Economy.