Talking Points from ACEEE Report U072:

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

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"Energy Efficiency and Peak Electricity Demand: Energy, Environmental and Economic Implications"

1. **Demand-side management is a proven way to affect customer energy use**
   a. Over 2 decades of experience with programs
   b. Two broad program categories:
      i. *Energy efficiency* programs primarily seek to reduce customer energy use (kilowatt-hours--kWh) on a permanent basis through the installation of energy-efficient technologies.
      ii. *Load management* generally focuses on either curtailing or shifting demand (kilowatts--kW) away from high cost, peak demand periods. *Demand-response programs* are really a type of load management---more "market-based"
   c. Over 2 decades of program evaluation experience, too.
   d. Are new drivers for peak demand reduction: reliability; volatile markets and high costs of new generation, transmission and distribution; reducing negative environmental impacts.

2. **Peak load management and energy efficiency**
   a. Are clearly overlaps, but peak demand impacts of energy efficiency programs have generally not been program priorities---which, in turn, has affected evaluation approaches and priorities.
   b. Primary emphasis of program evaluation has been estimating energy (kWh) savings.
   c. Estimating peak demand impacts also has faced practical limitations, such as higher measurement costs and general lack of time-differentiated end-use data.

3. **Quantifying peak demand impacts of energy efficiency**
   a. Somewhat surprising to find relative lack of data on these impacts
   b. Most reported impacts are derived by energy savings estimates---using engineering estimates and application of "load curves" to energy savings---NOT directly measured, ex-post estimates. Has been sufficient in most cases for evaluation needs.
   c. As a proxy for the published record on peak demand impacts of energy efficiency, we reviewed 14 years of proceedings from ACEEE's Summer Studies and the International Energy Program Evaluation Conferences. 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).

4. **Program Examples**
   a. We did find good examples of programs (in some cases, more research projects) that measured and estimated peak demand impacts associated with energy efficiency improvements. 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.

Table 1. Energy and Peak Demand Savings of Selected Programs

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

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

b. Examples of leading states and regions:
    i. Pacific Northwest (Bonneville Power Administration---Northwest Power And Conservation Council): Programs since 1978 have yielded cumulative impact of 3000 "average" megawatts (actually, a unit of energy)---plan to meet all demand growth through 2012 through energy efficiency---700 MWavg by 2009 alone.
    ii. New York: 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.
    iii. California: In its 2001 "electricity crisis" energy efficiency and related conservation "kept the lights on"---reduced summer peak demand by ~5000 MW—about a 10% reduction. The state continues aggressive pursuit of energy efficiency as a system resource, with record-setting levels of program activity ($2 billion in programs over 3 years---2006-2008).
    iv. An emerging area is geographic targeting of energy efficiency programs to relieve T&D constraints—examples: ISO-New England, Long Island Power Authority and BPA's "non-wires solutions"

5. Comparison of Leading Databases and Technical References

Individual energy efficiency measures are basis for estimating energy and demand savings; so what are leading states using?

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

Notes and Caveats:

- Measures that are most uniform in definition tend to show most uniformity in savings estimates.
- Climate sensitive measures show obvious variation.
- Standard databases and technical references best suited to fairly well-defined "standard measures"—more complex or customized measures generally require project-specific estimation of energy and demand savings.

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.

6. Findings and Conclusions

- 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. There are numerous technical references and databases in use that provide measure-by-measure quantification of these impacts and the professional evaluation community has well-established practices and protocols for addressing this growing need.

- 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.

- 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.